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# PROCEEDINGS OF THE 2nd INTERNATIONAL CONFERENCE QUANTITATIVE AND QUALITATIVE METHODOLOGIES IN THE ECONOMIC AND ADMINISTRATIVE SCIENCES

25-27 MAY 2009

Technological Educational Institute of Athens, Greece

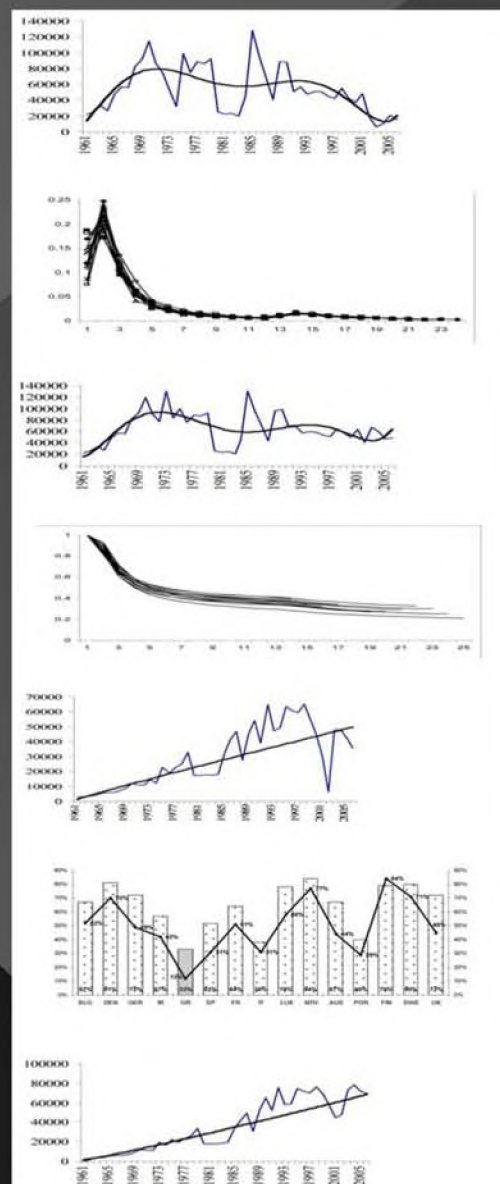
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Απαγορεύεται η ολική ή μερική αναπαραγωγή του παρόντος με οποιονδήποτε τρόπο χωρίς την  
έγγραφη άδεια του Επιστημονικού Επιμελητή Έκδοσης και του Εκδότη.

## Preface from the Scientific Committee

*Statistical thinking will one day be as necessary a qualification for efficient citizenship as the ability to read and write.*

H.G. Wells (1866-1946)

Dear colleagues,

On behalf of the Scientific and Organizing Committees of the 2nd International Conference for the Quantitative and Qualitative Methodologies in the Economic and Administrative Sciences, I would like to welcome you to the TEI of Athens, Athens, Greece. I begin this preface with the famous quote by the author Herbert Wells, which points out the significance of statistics in today's life. I suppose that almost everyone here has the feeling that without the knowledge of statistics (and statistical packages), no research can be optimally executed.

Quantitative research is the systematic scientific investigation of quantitative properties and phenomena and their relationships. The objective of quantitative research is to develop and employ mathematical models, theories and/or hypotheses pertaining to natural phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships. Over the past years the theory and practice of finance has increasingly drawn on the quantitative skills of the mathematician, statistician and econometrician. This has accompanied and also facilitated the increasing use of quantitative analysis of the behavior of financial markets. Other fields, like marketing research and communication, have also been facilitated by quantitative methods. Today, organizations are very complex and firm decision making policies are required; the marketing department is involved in decisions on research, forecasting, production, personnel, sales, organizational strategy and operations management, as well as decisions on marketing strategy and marketing mix. Such a decision policy is highly dependent on statistics and quantitative methods. Are only financial sciences dependent on quantitative methods? Psychology, Medicine, Communication Research, Sociology, Administration science, Agricultural sciences etc. depend very much on statistics to obtain their results.

But did the quantitative Revolution of the 1950s and 1960s manage to diminish the significance of Qualitative science? The answer is no. Qualitative research is a field of inquiry that crosscuts disciplines and subject matters. Qualitative researchers aim to gather an in-depth understanding of human behavior and the reasons that govern such behavior. The discipline investigates the why and how of decision making, not just what, where, when. Qualitative research methods remain important and are used for conducting research in marketing – along with statistics -, health, public health, social sciences etc.

During this conference, scientists from all over the world have been gathered. All continents are represented and there shall be speeches from Europe, Asia, Africa, America and Oceania. This is very significant, because the collision of ideas from so many people – with different backgrounds and experiences – will lead to innovative suggestions. There is a huge indicative list of topics for contributed paper meetings (CPMs) that broadly cover the mainstream of theoretical, methodological and applied recent advances in Statistics, leaving also room for presentation of new concepts and ideas in classical fields. All members of the international scientific community have been welcome to submit their work as contributed papers (CPs), and the rich variety and number of submissions (130 submissions) shows the livelihood and increasing complexity of our field, and its importance in all areas of knowledge building.

The aims of this conference remain the same with those of the 1<sup>st</sup> conference and are:

- a. To present papers in all aspects of quantitative and qualitative methodologies, in all fields of science.
- b. To create bonds and promote discussion between scientists
- c. and to educate our students.

Ending, I would like to wish you all a fruitful stay in Athens, and I hope you will leave considering that you have learnt something that you did not know before you came here.

Thank you very much.

Christos C. Frangos, BSc, MSc, PhD (London, LSE)

# A Greeting Speech by the Dean of the TEI of Athens, Demetrios Ninos

## Χαιρετισμός Πρόεδρου ΤΕΙ Αθήνας, Δημητρίου Νίνου

Αγαπητοί συνάδελφοι,

Μέσα σε ένα ιδιαίτερα αντίξοο περιβάλλον καταγιστικών εξελίξεων και πρωτόγνωρης ρευστότητας σε όλους τους τομείς της ανθρώπινης δραστηριότητας, τόσο σε εθνικό όσο και σε διεθνές επίπεδο, το ΤΕΙ Αθήνας, το μεγαλύτερο Τεχνολογικό Εκπαιδευτικό Ίδρυμα της χώρας, συνεχίζει τη δύσκολη αλλά επιτυχημένη του πορεία καταφέροντας όχι μόνο να διασφαλίσει το ακαδημαϊκό του πρόσωπο και το ρόλο του, αλλά και να εξελιχθεί σε υπολογίσιμη δύναμη και συχνά σε ρυθμιστικό παράγοντα θεμάτων τεχνολογικής εκπαίδευσης στη χώρα μας.

Η πρόοδος και η καταξίωση ενός εκπαιδευτικού ιδρύματος επιτυγχάνεται κυρίως μέσα από την ενθάρρυνση της ατομικής πρωτοβουλίας των μελών του και δεν είναι η πρώτη φορά που οι πρωτοβουλίες των μελών του εκπαιδευτικού προσωπικού του Τμήματος Διοίκησης Επιχειρήσεων της Σχολής Διοίκησης και Οικονομίας ανεβάζουν τον πήχη των αξιώσεών μας ακόμη ψηλότερα.

Σε μια εποχή όπου τα ISO αποτελούν τις πλέον αναγνωρίσιμες προϋποθέσεις αξιοπιστίας προϊόντων και υπηρεσιών το συνέδριο αυτό αποκτά ιδιαίτερη σημασία διότι διαπραγματεύεται όλες τις πτυχές του εξαιρετικά επίκαιρου θέματος των ποσοτικών και ποιοτικών μεθοδολογικών προτύπων, που συνιστούν τα πλέον απαραίτητα εργαλεία για τη μέτρηση και τη βελτίωση της ποιότητας σε κάθε επιχειρηματικό τομέα.

Ένα επιπλέον πλεονέκτημα του συνεδρίου αυτού είναι ότι επεξεργασία της ευρύτατης θεματολογίας του πραγματοποιείται με τη βοήθεια καταξιωμένων επιστημόνων της χώρας μας αλλά και του εξωτερικού, οι οποίοι μέσα από τις ποικίλες θεωρητικές προσεγγίσεις, αλλά κυρίως μέσα από τις πολύτιμες εμπειρίες που τους έχει προσφέρει η πολύχρονη θητεία τους στο χώρο της τεχνολογικής εκπαίδευσης, θα γίνουν για όλους εμάς πηγή έγκυρης και τεκμηριωμένης πληροφόρησης.

Είναι γνωστό ότι σε όλη της διάρκεια της ιστορικής του πορείας του ΤΕΙ Αθήνας αντιμετώπισε πλήθος προβλημάτων, τα οποία πάντοτε ξεπερνούσε χάρη στις ικανότητες, το μεράκι και στην έντονη δραστηριοποίηση των μελών του.

Το 2ο Διεθνές Συνέδριο που οργανώνεται σήμερα αποτελεί μια ακόμη απόδειξη των απεριόριστων δυνατοτήτων αυτών των ανθρώπων και κυρίως της βαθιάς τους πεποίθησης ότι το ΤΕΙ αποτελεί αναπόσπαστο κομμάτι της ελληνικής κοινωνίας, γι' αυτό καθημερινά όλη τους η δράση προσανατολίζεται σε αυτήν. Αφουγκράζονται τον παλμό της, αναγνωρίζουν και σέβονται τις βαθύτερες ανάγκες της κι εξελίσσονται μαζί της.

Αυτό το Συνέδριο πρόκειται να σημειώσει επιτυχία όχι μόνο λόγω της ευρύτητας και της σημαντικότητας της θεματολογίας ή των διακεκριμένων επιστημόνων – ομιλητών του, αλλά κυρίως γιατί επιχειρεί μια σοβαρή προσπάθεια πολύπλευρης προσέγγισης του επιχειρηματικού κόσμου που έχει ανάγκη από αυτό που μόνον εμείς μπορούμε να του προσφέρουμε. Στελέχη με έντονο επιχειρηματικό πνεύμα και γνώσεις, αλλά πάνω απ' όλα ανθρώπους με όραμα και στόχους.

Εύχομαι καλή επιτυχία στις εργασίες του συνεδρίου.

Ο Πρόεδρος του ΤΕΙ Αθήνας  
Δημήτριος Νίνος  
Καθηγητής

# **A Greeting Speech by the Head of the School of Administration and Economy, TEI of Athens, George Polychronopoulos**

## **Χαιρετισμός Διευθυντή της Σχολής Διοίκησης και Οικονομίας του ΤΕΙ Αθήνας, Γεωργίου Πολυχρονόπουλου**

Στη σύγχρονη εποχή, οι επιχειρήσεις λειτουργούν σε καθεστώς αβεβαιότητας και κινδύνου και οι συνθήκες αυτές γίνονται εντονότερες σε μια παγκοσμιοποιημένη κοινωνία που χαρακτηρίζεται από αυξημένη ανταγωνιστικότητα και σύνθετες τεχνολογίες.

Στις εργασίες του παρόντος Συνεδρίου αναπτύσσονται μέθοδοι, τεχνικές και εργαλεία περιορισμού της αβεβαιότητας και του κινδύνου στη διαδικασία λήψης επιχειρηματικών αποφάσεων.

Η φύση και το περιεχόμενο των συνθηκών δημιουργούν επιστημονικά ενδιαφέροντα όχι μόνο σε εθνικό αλλά σε παγκόσμιο επίπεδο αφού η διεθνοποίηση των οικονομιών είναι πλέον έντονη και διάχυτη παντού.

Η εφαρμογή της Οικονομικής Ποσοτικής Ανάλυσης στη Διοίκηση γίνεται για τον επαναπροσδιορισμό των στόχων και των προοπτικών λόγω των περιορισμένων εμπειριών σε ό,τι αφορά τον τρόπο αντιμετώπισης των δεδομένων και τη μέτρηση των επιπτώσεων.

Στο Συνέδριο αυτό παρουσιάζεται διεξοδικά η μεθοδολογία της έρευνας της αγοράς που αποτελεί σημαντικό εργαλείο της επιχείρησης και της επιτρέπει να συλλέξει, να επεξεργαστεί και να αναλύσει ποσοτικά δεδομένα για την υποστήριξη του συστήματος λήψης αποφάσεων. Αναπτύσσονται αρχές για την οργάνωση του Στατιστικού συστήματος της επιχείρησης και πλήρης παρουσίαση των στατιστικών πακέτων και ο τρόπος χρήσης της για την ανάλυση των ποσοτικών δεδομένων.

Στις ερευνητικές εργασίες γίνονται εφαρμογές Στατιστικών μεθόδων όπως η Ανάλυση Παλινδρόμησης η Ανάλυση Χρονολογικών Σειρών η παρουσίαση Οικονομικών Μοντέλων χρήσιμων για τις προβλέψεις των επιχειρήσεων καθώς και θέματα όπως η αριστοποίηση, η ανάλυση κινδύνου, η ανάλυση ισορροπίας και κόστος της επιχείρησης, η αξιολόγηση επενδυτικών σχεδίων, οι μορφές αγοράς και τιμολογιακή πολιτική.

Θα ήθελα να τονίσω ότι το Συνέδριο αυτό αποτελεί την απαρχή μιας προσπάθειας για την παρουσίαση ερευνητικών εργασιών στους τομείς της Ποσοτικής Ανάλυσης που αναφέρθηκαν, αφού στα θέματα αυτά υπάρχει πράγματι μεγάλο κενό.

Σε μια εποχή διεθνούς οικονομικής ύφεσης ο συνδυασμός των φαινομένων οικονομικής ύφεσης και των γνωστών διαρθρωτικών προβλημάτων οδηγεί τη χώρα μας στη διερεύνηση του οικονομικού ελλείμματος και σε αύξηση του δανεισμού του ελληνικού δημοσίου πέρα από κάθε οικονομική και κοινωνική λογική.

Τα προβλήματα για τη χώρα μας είναι μεγάλα και η κακή πορεία της οικονομίας μας με την ολοένα μεγαλύτερη δημοσιονομική αδυναμία οδηγούν σε δραματική αύξηση των δανειακών αναγκών του ελληνικού δημοσίου.

Θέλω να πιστεύω ότι μέσα από τις εργασίες του Συνεδρίου θα υπάρξουν λογικές και μέθοδοι χρήσιμες για τη δημιουργία προτάσεων παρουσίασης, ανάλυσης και ενδεχομένως εύρεσης τρόπων προσέγγισης του προβλήματος.

Θα ήθελα να συγχαρώ όλους όσους βοήθησαν στην οργάνωση του 2<sup>ου</sup> Διεθνούς Συνεδρίου με τίτλο «Ποσοτικά και Ποιοτικά Μεθοδολογικά Πρότυπα στις Οικονομικές και Διοικητικές Επιστήμες» και ειδικά τον Καθηγητή Χρήστο Φράγκο και να επισημάνω ότι τέτοιες πρωτοβουλίες αναβαθμίζουν το Ίδρυμα και βοηθούν στην προαγωγή της Επιστήμης κάτι που επιβάλλεται για όλα τα Ανώτατα Εκπαιδευτικά Ίδρύματα όπως το Τεχνολογικό Εκπαιδευτικό Ίδρυμα της Αθήνας.

Ο Διευθυντής της Σχολής Διοίκησης και Οικονομίας  
Γεώργιος Ι. Πολυχρονόπουλος  
Καθηγητής



**A Greeting Speech by the Head of the Department of Business  
Administration, TEI of Athens,  
Natalia Papavasiliou**

**Χαιρετισμός της Προϊσταμένης του Τμήματος Διοίκησης  
Επιχειρήσεων του ΤΕΙ Αθήνας,  
Ναταλίας Παπαβασιλείου**

Βρίσκομαι στην ευχάριστη θέση να ευχαριστήσω τους συντελεστές της επιτυχίας του 2<sup>ου</sup> Διεθνούς Συνεδρίου: Ποσοτικά και Ποιοτικά Μεθοδολογικά Πρότυπα στις Οικονομικές και Διοικητικές Επιστήμες και ειδικά τον κ. Χρήστο Φράγκο, Καθηγητή Ποσοτικών Μεθόδων του Τμήματος Διοίκησης Επιχειρήσεων του ΤΕΙ Αθήνας που είχε την οργανωτική και επιστημονική ευθύνη του Συνεδρίου.

Το Τμήμα Διοίκησης Επιχειρήσεων του ΤΕΙ Αθήνας, του οποίου προϊσταμαι, θα συνεχίσει να είναι πρωτοπόρο στη διδασκαλία, στην έρευνα και στη σύνδεση του εκπαιδευτικού έργου με τους παράγοντες της αγοράς.

Με αυτές τις σκέψεις απευθύνω θερμό χαιρετισμό προς τους εκλεκτούς συμμετέχοντες στο Συνέδριο επιστήμονες από την Ελλάδα και το εξωτερικό.

Ναταλία Παπαβασιλείου  
Προϊσταμένη Τμήματος Διοικ. Επιχ. ΤΕΙ Αθήνας

# Contents

<b>PREFACE FROM THE SCIENTIFIC COMMITTEE .....</b>	<b>III</b>
<b>A GREETING SPEECH BY THE DEAN OF THE TEI OF ATHENS, DEMETRIOS NINOS.....</b>	<b>IV</b>
<b>A GREETING SPEECH BY THE HEAD OF THE SCHOOL OF ADMINISTRATION AND ECONOMY, TEI OF ATHENS, GEORGE POLYCHRONOPOULOS.....</b>	<b>V</b>
<b>A GREETING SPEECH BY THE HEAD OF THE DEPARTMENT OF BUSINESS ADMINISTRATION, TEI OF ATHENS, NATALIA PAPAVALIIOU .....</b>	<b>VI</b>
<b>GENERAL INFORMATION ABOUT THE CONFERENCE .....</b>	<b>1</b>
<b>PAPERS .....</b>	<b>13</b>
<b>LEADERSHIP EFFECTIVENESS. THE CASE OF ATHENS MUNICIPALITY.....</b>	<b>14</b>
<b>CHRISTOS AKRIVOS</b> <b>GERASIMOS KOUTRAS</b>	
<b>APPROACHES TO LEARNING OF GREEK BUSINESS STUDENTS .....</b>	<b>19</b>
<b>SOFIA ASONITOU</b> <b>ELENI TOURNA</b> <b>KOSTAS KOUCOULETSOS</b>	
<b>QUALITATIVE METHODOLOGIES OR MEASURES TAKEN FROM FINANCIAL INSTITUTIONS REGARDING THE MANAGEMENT OF THEIR REPUTATION .....</b>	<b>30</b>
<b>MENELAOS BESKOS</b>	
<b>UTILIZING CONSENSUS MODELS IN DECISION MAKING. A PROCESS FOR DESIGN AND DEVELOPMENT OF A PUBLIC ADMINISTRATION REFORM SYSTEM: METHODOLOGY, ASSESSMENT, CONCLUSIONS AND PROPOSALS.....</b>	<b>37</b>
<b>JOHN D. BOURIS</b>	
<b>ANALYZING THE RELATIONSHIPS AMONG INNOVATION ACTIVITIES AND ORGANIZATION INNOVATION.....</b>	<b>44</b>
<b>THEODOROS BOZIOS</b> <b>FEDON KOMISOPOULOS</b> <b>NATASSA FRITAKI</b>	
<b>THE EVOLUTION OF ROMANIA'S SOCIAL INSURANCE REDISTRIBUTION SYSTEM.....</b>	<b>52</b>
<b>ANA ANTON CARP</b> <b>CIPRIAN CARP</b>	
<b>ANALYSIS AND FORECASTING OF THE NUMBER OF TRACTORS IN ITALY WITH TIME-SERIES METHODS.....</b>	<b>61</b>
<b>PETROS CHRISTODOULOU</b> <b>MICHAIL PAZARSKIS</b>	
<b>ESTIMATION OF <math>P(X&gt;Y)</math> IN CASE OF BIVARIATE NORMAL DISTRIBUTION USING RANKED SET SAMPLING WITH CONCOMITANT VARIABLE .....</b>	<b>66</b>
<b>WALID ABU-DAYYEH</b> <b>ATSU S. S. DORVLO</b> <b>OBAID AL-SAIDY</b>	
<b>FAIR TRADE SUPPORTING GROUP: WHAT THEY KNOW, FEEL AND PREFER.....</b>	<b>75</b>
<b>ANTONIA DELISTAVROU</b> <b>ATHANASIOS GOUNAS</b> <b>IRENE TILIKIDOU</b>	

<b>MULTI-CRITERIA ANALYSIS IN STUDENT'S SATISFACTION MEASUREMENT IN HIGHER EDUCATION: THE CASE OF HEALTH CARE MANAGEMENT DEPARTMENT IN THE TECHNOLOGICAL EDUCATIONAL INSTITUTE OF ATHENS .....</b>	<b>83</b>
<b>G. DIMAS</b> <b>A. GOULA</b> <b>G. PIERRAKOS</b>	
<b>IDEAL HUMAN RESOURCE MANAGEMENT PROFILE VERSUS EXISTING HUMAN RESOURCE MANAGEMENT PROFILE IN GREEK MANUFACTURING INDUSTRY.....</b>	<b>89</b>
<b>Efstathios Dimitriadis</b> <b>Despoina Kaltsidou</b>	
<b>A MULTIVARIATE LOGISTIC MODEL FOR COMPETING TECHNOLOGICAL PRODUCTS IN A MARKET .....</b>	<b>95</b>
<b>Ioannis Dimotikalas</b>	
<b>CONSIDERATION REGARDING THE EFFECT OF INTEGRATED USE OF TECHNOLOGIES AND TECHNIQUES FOR SMALL AND MEDIUM ROMANIAN ENTERPRISES BASED ON KNOWLEDGE ....</b>	<b>104</b>
<b>Ion Dobre</b> <b>Mariana Enusi</b>	
<b>DIFFERENCES IN MANAGEMENT ACCOUNTING BETWEEN FAMILY ENTERPRISES AND NON-FAMILY ENTERPRISES A STATISTICAL APPROACH.....</b>	<b>113</b>
<b>Christine Duller</b>	
<b>INTERNET ADDICTION: SOME DISTURDING RESULTS FROM A SAMPLE SURVEY AMONG UNIVERSITY STUDENTS FROM GREECE.....</b>	<b>117</b>
<b>Christos C. Frangos</b> <b>Constantinos C. Frangos</b> <b>Ioannis Aggelopoulos</b>	
<b>PSYCHOSOCIAL CHARACTERISTICS OF HEAVY AND NON HEAVY INTERNET USERS BASED ON A SAMPLE SURVEY AMONG UNIVERSITY STUDENTS, FROM GREECE.....</b>	<b>126</b>
<b>Christos C. Frangos</b> <b>Constantinos C. Frangos</b> <b>Ioannis Sotiropoulos</b> <b>Catherine C. Valvi</b>	
<b>FACTORS PREDICTING PROBLEMATIC INTERNET USE AMONG UNIVERSITY STUDENTS IN GREECE: NEW RESULTS OF A SAMPLE SURVEY .....</b>	<b>132</b>
<b>Christos C. Frangos</b> <b>Contantinos Frangos</b> <b>Catherine C. Valvi</b>	
<b>PARTISAN POLITICIANS AND ECONOMIC POLICY .....</b>	<b>138</b>
<b>Per G. Fredriksson</b> <b>Le Wang</b> <b>Patrick L. Warren</b>	
<b>UNDERSTANDING FRAME OF TRAINING EVALUATION IN MANAGEMENT DEVELOPMENT: AN ANALYSIS IN TWO PROCEDURES IN A GREEK CASE STUDY .....</b>	<b>141</b>
<b>Ekaterini Galanou</b>	
<b>CAN ALTMAN Z-SCORE MODEL PREDICT BUSINESS FAILURES IN GREECE?.....</b>	<b>149</b>
<b>Nikolaos Gerantonis</b> <b>Konstantinos Vergos</b> <b>Apostolos Christopoulos</b>	

<b>FACTORS AFFECTING INTERNET BANKING USAGE BEHAVIOR: AN EMPIRICAL INVESTIGATION OF GREEK CUSTOMERS .....</b>	<b>155</b>
<b>APOSTOLOS GIOVANIS</b> <b>SPIRIDON BINIORIS</b> <b>MARIA TSIRIDANI</b> <b>DIMITRIS NOVAS</b>	
<b>DEVELOPING AND TESTING A MODEL EXPLAINING CUSTOMER CONATIVE LOYALTY FORMATION IN THE MOBILE TELECOMMUNICATIONS SERVICES.....</b>	<b>164</b>
<b>APOSTOLOS GIOVANIS</b> <b>SPIRIDON BINIORIS</b> <b>GEORGE POLYCHRONOPOULOS</b>	
<b>PREDICTING MULTI-COHORTS' CUSTOMER RETENTION USING LIMITED INFORMATION .....</b>	<b>173</b>
<b>APOSTOLOS GIOVANIS</b> <b>CHRISTOS C. FRANGOS</b> <b>DIMITRIS PAPATHANASIOU</b>	
<b>PRODUCT INNOVATION AND INNOVATION PERFORMANCE OF ENTERPRISES: THE CASE OF GREECE WITHIN E.U. ....</b>	<b>179</b>
<b>YANNIS HATZIKIAN</b>	
<b>ASSESSING THE GLOBAL TRADE COMPETITIVENESS OF GREEK WINE.....</b>	<b>187</b>
<b>PANAYIOTIS E. KALDIS</b>	
<b>ERP PROJECTS FAILURE: ANALYSIS OF CRITICAL FACTORS BASED ON INTERNATIONAL EXPERIENCE .....</b>	<b>196</b>
<b>DIMITRIOS KALLIVOKAS</b> <b>ATHANASSIOS VOZIKIS</b>	
<b>LEARNING CONCEPTIONS AND STUDENT PERFORMANCE IN ACCOUNTING COURSES: THE CASE OF BUSINESS STUDENTS ON TAX ACCOUNTING COURSES OF TEI OF ATHENS.....</b>	<b>203</b>
<b>IOANNIS KAPANTAIDAKIS</b>	
<b>DOES OWNERSHIP, SIZE OR COMPETITION MATTER? THE EFFECTS OF TELECOMMUNICATIONS REFORM ON PRICING IN GREECE .....</b>	<b>209</b>
<b>KOSTAS KARAMANIS</b>	
<b>A NEW APPROACH ON THE PROCESSING OF QUESTIONNAIRES BASED ON THE PRINCIPLES OF SEMIOMETRY .....</b>	<b>219</b>
<b>DIMITRIOS KARAPISTOLIS</b> <b>VICTORIA KOEMTZOPOULOU</b> <b>EVDOKIA KONSTANTINIDOU</b>	
<b>MANAGEMENT ACCOUNTING AND TOURISM ORGANIZATIONS: THE CASE OF THE KOZANI TOURIST COMPANIES .....</b>	<b>225</b>
<b>NIKOS D. KARTALIS</b> <b>DIMITRIOS ZISOPOULOS</b> <b>NIKOS SARIANNIDES</b> <b>EFTHIMIOS GRAVAS</b>	
<b>A THRESHOLD MODEL FOR MONETARY POLICY RULES FOR OPEN ECONOMIES.....</b>	<b>232</b>
<b>THANASSIS KAZANAS</b> <b>ELIAS TZAVALIS</b>	
<b>CORPORATE GOVERNANCE IN A GLOBAL ECONOMY .....</b>	<b>242</b>
<b>VASSILIS KEFIS</b>	
<b>THE LIFE AND SCIENTIFIC DISCOVERIES OF GEORGE BERNARD DANTZIG "FATHER OF LINEAR PROGRAMMING AND FOUNDER OF OPERATIONAL RESEARCH" .....</b>	<b>251</b>
<b>DIMITRIS KIVOTOS</b> <b>CHRISTOS C. FRANGOS</b>	

<b>LOOKING FOR A FLEXIBLE FUNCTIONAL FORM: THEORY AND EVIDENCE .....</b>	<b>260</b>
<b>GEORGE M. KORRES</b>	
<b>THE ROLE OF STATISTICAL DESIGN IN SAMPLING PLAN AND PILOTING SERVICE IMPROVEMENT INITIATIVE SURVEY - QATAR CASE .....</b>	<b>276</b>
<b>MUWAFaq AL-KUBAISI</b>	
<b>MULTIPLIER ANALYSIS AND TOURISM DEVELOPMENT.....</b>	<b>287</b>
<b>DIMITRIS G. LAGOS</b>	
<b>GRANGER CAUSALITY IN PHILLIPS CURVES: DOES INFLATION RUN FROM OUTPUT TO PRICES OR PRICES TO OUTPUT IN GREECE? A PRELIMINARY ECONOMETRIC MODEL.....</b>	<b>294</b>
<b>IOANNIS LALIoTIS</b>	
<b>IOANNIS SKLAVAKIS</b>	
<b>NIKOLAOS BARTZIS</b>	
<b>DECISION MAKING UNDER RELATIVE UNCERTAIN CONDITIONS IN HOTEL SECTOR: DECISION TREES.....</b>	<b>298</b>
<b>DIMITRIS LALOUMIS</b>	
<b>THIRD PARTY LOGISTICS (3PL) MODELS: PERSPECTIVES AND PRACTICES. THE CASE OF THE GREEK PHARMACEUTICAL INDUSTRY.....</b>	<b>303</b>
<b>GEORGE MALINDRETOS</b>	
<b>JOHN SKAVAKIS</b>	
<b>ALEXANDRA MOTOU</b>	
<b>ANNA KREMMYDA</b>	
<b>THE FARM SIZE, THE USE OF THE RESOURCES FOR AGRICULTURAL PRODUCTION AND THE IMPORTANCE OF THEM TO THE REGIONAL DEVELOPMENT IN GREECE IN 1981.....</b>	<b>310</b>
<b>IOANNIS BAS. MANOLOPOULOS</b>	
<b>THE PALATIAL ACCOUNTING SYSTEM – DISCLOSURES FROM THE HELLADIC BRONZE AGE.....</b>	<b>320</b>
<b>DIMITRIOS G. MAVRIDIS</b>	
<b>QUANTITATIVE METHODS IN SERVICES MARKETING: AN APPLICATION IN MEASURING SUBURBAN RAILWAY’S CUSTOMERS SATISFACTION .....</b>	<b>328</b>
<b>DIMITRIS NOVAS</b>	
<b>DIMITRIS ZONDIROS</b>	
<b>SPYROS FILIOS</b>	
<b>THE EFFECT OF COMPANIES' DIVIDEND AND ECONOMIC POLICY OF FTSE/ASE-20 INDICATOR IN THE CONFIGURATION OF THEIR STOCK EXCHANGE PRICE.....</b>	<b>334</b>
<b>VASSILIS ORFANOS</b>	
<b>MIHALIS EVRIPIOTIS</b>	
<b>IMPLEMENTATION OF THE DELPHI METHOD IN THE CHOICE OF AN ERP SYSTEM.....</b>	<b>346</b>
<b>HELEN PAPACHARALAMBOUS</b>	
<b>ANDREAS P. KAKOURIS</b>	
<b>NEED AND IMPORTANCE OF INFORMATION TECHNOLOGY IN SMALL ENTERPRISES AND THE PROCESS OF DEVELOPING A JOB DESCRIPTION BY MANAGERS .....</b>	<b>353</b>
<b>LEONIDAS A. PAPAKONSTANTINIDIS</b>	
<b>ELENI D. VLACHOU</b>	
<b>EVANGELOS D. VLACHOS</b>	
<b>UNITED NATIONS HUMAN DEVELOPMENT INDEX-THE CASE OF GREECE .....</b>	<b>357</b>
<b>CONSTANTIN PAPAGIANNOULIS</b>	
<b>GREEK CONTROLLED SHIPPING AND ITS IMPORTANCE TO THE WORLD ECONOMY.....</b>	<b>363</b>
<b>CONSTANTIN PAPAGIANNOULIS</b>	

<b>INTERNATIONAL FINANCIAL REPORTING STANDARDS IN GREECE REAL ESTATE SECTOR .....</b>	<b>370</b>
<b>MICHAIL PAPAILIAS</b> <b>IOANNA DIMOPOULOU – DIMAKI</b>	
<b>ROLE CONFLICT IN ORGANIZATIONS.....</b>	<b>379</b>
<b>CONNIE PAPANICOLAS</b> <b>K. BOGA KARTERI</b> <b>AIKATERINI KALAMARA</b>	
<b>THE IMPACT OF MERGERS AND ACQUISITIONS ON ECONOMIC PERFORMANCE OF GREEK FIRMS: AN ACCOUNTING PERSPECTIVE .....</b>	<b>385</b>
<b>MICHAIL PAZARSKIS</b> <b>THEOFANIS KARAGIORGOS</b> <b>PETROS CHRISTODOULOU</b> <b>IORDANIS ELEFTERIADIS</b>	
<b>RISK PREMIUM EFFECTS ON IMPLIED VOLATILITY REGRESSIONS.....</b>	<b>389</b>
<b>LEONIDAS S. ROMPOLIS</b> <b>ELIAS TZAVALIS</b>	
<b>GREECE IN THE “NEW” ERA OF GLOBALIZATION .....</b>	<b>401</b>
<b>PHILIPPOS SACHINIDIS</b> <b>ALEXANDROS SAHINIDIS</b>	
<b>SERVICE QUALITY: A CRITICAL REVIEW OF SERVICE QUALITY MODELS .....</b>	<b>406</b>
<b>IOANNA SIAMETI</b> <b>ANDREAS P. KAKOURIS</b>	
<b>GLOBALISATION AND ALIMENTARY CONSUMPTION: AN ECONOMIC ANALYSIS OF ECONOMIC CRITERIA IN THE CASE OF GREECE (1957-2005).....</b>	<b>414</b>
<b>IOANNIS SOTIROPOULOS</b> <b>GEORGIOS GEORGAKOPOULOS</b> <b>KOSTANTINOS KYRITSIS</b>	
<b>A NEW APPROACH TO THE DESCRIPTION OF ALIMENTARY CONSUMPTION PATTERNS: THE CASE OF GREECE.....</b>	<b>421</b>
<b>IOANNIS SOTIROPOULOS</b> <b>CONSTANTINOS C. FRANGOS</b>	
<b>FINANCIAL ACCOUNTING REFORM IN GREEK PUBLIC HOSPITALS: AN EMPIRICAL STUDY OF THE IMPLEMENTATION .....</b>	<b>428</b>
<b>FILIPPOS STAMATIADIS</b> <b>ANTONIS PASPARAKIS</b>	
<b>MEASURING EXCHANGE RATE PASS-THROUGH FOR A CANDIDATE COUNTRY OF THE EUROZONE .....</b>	<b>437</b>
<b>THEODOROS V. STAMATOPOULOS</b>	
<b>NONPARAMETRIC REGRESSION: A BRIEF OVERVIEW AND DEVELOPMENTS .....</b>	<b>445</b>
<b>C.J. SWANEPOEL</b>	
<b>THE BOOTSTRAP: RECENT SIGNIFICANT TRENDS AND DEVELOPMENTS .....</b>	<b>464</b>
<b>J.W.H. SWANEPOEL</b>	
<b>CAN INTERNATIONAL DIVERSIFICATION REDUCE PORTFOLIOS’ RISK AND COSTS THROUGH THE USAGE OF VARIATIONS OF CAPITAL ASSET PRICING MODEL? AN EMPIRICAL REVIEW .....</b>	<b>484</b>
<b>KANELLOS TOUDAS</b> <b>NIKOLAOS GERANTONIS</b> <b>GEORGIOS MAKRIDIS</b>	

<b>COMPARISON OF THE CLASSICAL METHODS WITH THE BOOTSTRAP. COMPUTER INTENSIVE TECHNIQUES IN ESTIMATING PARAMETERS OF THE BIVARIATE POISSON DISTRIBUTION.....</b>	<b>492</b>
MICHAEL TSAGRIS IOANNIS ELMATZOGLOU CHRISTOS C. FRANGOS	
<b>TECHNO-ECONOMIC ANALYSIS OF INFORMATION SECURITY EXPENDITURES .....</b>	<b>501</b>
THEODOSIOS TSIAKIS DIMITRIOS NOTARAS DIMITRIOS PANODIMOS	
<b>CITIZEN SATISFACTION FROM THE LOCAL GOVERNMENT AFTER THE ADMINISTRATION REFORM OF 1997 IN GREECE: THE CASE OF THE GREEK ISLAND THERA (SANTORINI).....</b>	<b>508</b>
CATHERINE C. VALVI CONSTANTINOS C. FRANGOS CHRISTOS C. FRANGOS	
<b>TOWARDS THE IMPROVEMENT OF LOCAL GOVERNMENT IN GREECE: A MINI-QUALITATIVE SURVEY.....</b>	<b>515</b>
CATHERINE C. VALVI CONSTANTINOS C. FRANGOS CHRISTOS C. FRANGOS	
<b>COMMON PERFORMANCE INDICATORS FOR PUBLIC SERVICES' TRAINING CENTRES .....</b>	<b>521</b>
ATHANASIOS VASILAKIS	
<b>APPLICATIONS OF MARKOV CHAINS TO BUSINESS PROBLEMS .....</b>	<b>528</b>
MICHAEL GR. VOSKOGLOU	
<b>COMBINING CASE-BASED WITH FUZZY REASONING IN COMMERCIAL PROBLEMS.....</b>	<b>536</b>
MICHAEL GR. VOSKOGLOU	
<b>HOUSEHOLD ENERGY FOOTPRINT: RESEARCH OUTCOMES FROM THE REGION OF ATTICA .....</b>	<b>544</b>
A. VOZIKIS E. SAMBRACOS D. PRIFTIS	
<b>THE FOLLIES OF FINANCIAL LIBERALIZATION: SOME STATISTICAL EVIDENCE FROM MALAYSIA .....</b>	<b>549</b>
CHOW FAH YEE EU CHYE TAN	
<b>THE VALIDITY OF PPP IN THE DAIRY SECTOR AND THE ROLE OF MACROECONOMIC VARIABLES: CASE OF GREECE.....</b>	<b>557</b>
E. ZAFEIRIOU	
<b>BRAND EQUITY REVISITED: AN INSTITUTIONAL THEORY APPROACH TO AIRLINE CUSTOMER SUPPORT .....</b>	<b>562</b>
ANNA ZARKADA	
<b>THE EFFICIENCY OF THE HEALTH SYSTEM IN GREECE COMPARED TO RELEVANT E.U.'S STANDARDS .....</b>	<b>570</b>
KYRIAKOS ZERVAKAKIS ANASTASIA PLAKAROU	
<b>INDEX OF AUTHORS.....</b>	<b>579</b>

## General Information about the Conference



2ND INTERNATIONAL CONFERENCE:  
QUANTITATIVE AND QUALITATIVE METHODOLOGIES IN THE ECONOMIC AND  
ADMINISTRATIVE SCIENCES.  
(Q.M.E.A.S. 2009)

25-26-27 MAY 2009

TECHNOLOGICAL EDUCATIONAL INSTITUTION OF ATHENS  
SCHOOL OF ECONOMY AND ADMINISTRATION  
DEPARTMENT OF BUSINESS ADMINISTRATION  
AGIOU SPIRIDONOS STREET  
AIGALEO, P.C. 122 10  
ATHENS  
GREECE

### 1ST ANNOUNCEMENT AND CALL FOR PAPERS

#### 1. PURPOSE

In today's world of technology, the Quantitative and Qualitative Methods are important tools for the improvement of quality of products, services and decision making in all kinds of Business. Quantitative Techniques are applied at every stage of operation of a public or private company such as production, sales, accounting, finance, personnel management and public relations.

Using Quantitative and Qualitative Methods, management can analyze data, identify trends and relationships between different operations of a company and can predict the performance of the company on the face of uncertain conditions.

#### **THE CONFERENCE**

#### **QUANTITATIVE AND QUALITATIVE METHODOLOGIES IN THE ECONOMIC AND ADMINISTRATIVE SCIENCES**

aims to facilitate the interaction between two worlds: the world of Business and the world of Academic Community. The organizers of this Conference have the ambition to establish a forum for discussions on the theory and applications of the Quantitative and Qualitative Methods in all aspects of business activity.



## 2. TIME AND VENUE OF CONFERENCE

**DATES OF CONFERENCE:**

25-26-27 May 2009

**VENUE OF CONFERENCE:**

TECHNOLOGICAL EDUCATIONAL INSTITUTION OF ATHENS  
(TEI OF ATHENS)  
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## 5. TOPICS OF CONFERENCE

Quantitative Methods in Finance  
Statistical Inference  
Linear and non-linear models in Statistics  
Analysis of Time Series  
Factor Analysis  
MANOVA  
Principal Component Analysis  
Latent Roots  
Profile Analysis  
Nonparametric Techniques  
Computer Intensive Methods in Statistics (BOOTSTRAP, JACKKNIFE, CROSS VALIDATION)  
Econometric Models  
Techniques of Operational Research  
Index Numbers  
Demographic Methods  
Sampling Techniques in Business  
Quality Control Techniques  
Managerial Decision Making (Decision Trees)  
Risk Analysis  
Neural Networks  
Statistical Computing  
Optimization and Modeling  
Inventory Control and Management  
Program Evaluation and Review Technique (PERT)  
Forecasting  
Simulation  
Queuing Systems  
Gini index and Lorenz Curves  
Gibbs Sampling Methods  
Panel Methods  
Stochastic Models in Business  
Capital Budgeting  
Use of Quantitative Methods in Feasibility Studies  
Use of Quantitative Methods in Operational Planning  
Use of Quantitative Methods in Public Finance  
Use of Quantitative Methods in Stock Exchange and the Analysis of Derivatives  
Systems for Planning and Evaluation of Large Projects (PERT, CPM)  
Quantitative Methods in Personnel Management (SPAN OF CONTROL)  
Information Systems for Management  
E-learning and e-Business  
Customer Relations Management  
Managerial controlling Methods  
Quantitative Methods in Local Government  
Quantitative Methods in Courts  
International Accounting Models  
Management Accounting  
Quantitative Methods in Tourism  
Quantitative Methods in the Environment  
Biostatistical Methods  
Quantitative Methods in Education  
Quantitative Methods in Marketing  
Quantitative Methods in Medicine  
Quantitative Methods in Maritime Business  
Quantitative Methods in Transportation  
Quantitative Methods in Civil Engineering

Quantitative Methods in Food Business  
Quantitative Methods in Archaeology  
Quantitative Methods in Agricultural Business

## **TOPICS OF QUALITATIVE METHODS IN ECONOMIC AND ADMINISTRATIVE SCIENCES**

1. Focus Groups research
2. Group Dynamics and Group interviewing
3. Individual depth interviews (IDIs)
4. Web-based qualitative research
5. On-line focus groups
6. Hermeneutic Research
7. Projective Tests techniques
8. On-line Individual Depth Interviewing
9. Marketing research by interviews
10. Consumer behaviour research by interviews
11. Qualitative research in Psychology
12. Sociological research by interviews
13. Decision models in qualitative research
14. Software packages for Qualitative research
15. Comparison between Qualitative and Quantitative methods
16. Experimental designs and qualitative research

## 6. INVITATION FOR SUBMISSION OF PAPERS

The Scientific Committee of the Conference welcomes Oral presentations (15 minutes each) and Poster Presentations using MS POWERPOINT. All submitted papers will be refereed and their authors will be informed. Each participant who would like to present a paper at the Conference must submit a two –page abstract in MS WORD 2003 (500 words maximum), to the Organizing Committee at the following address:

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The abstract will be written according to the following instructions:

- a.1. width of page: 12.5 cm.
- a.2. length of page: 18cm.
- a.3. font: Times New Roman, size 12.
- a.4. Title will be in capital letters, centered . Font in title: Times New Roman, size 14, bold.
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The form of References will be the same as the form of References in the Journal: *Communications in Statistics, Theory and Methods, VOL. 31, 2002.*

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**The complete paper (Abstract, Main text, References) will be written according to the following instructions:**

- 1.1 . Length of paper: 8-10 pages.
- 1.2 . Language: English or Greek(with English abstract)
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- 1.5 . Diagrams, Pictures: Black and white.
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The submission will BE IN TWO COPIES include a diskette 3.5 Inch or a CD in which the paper will have been stored in MS WORD 2003. The abstracts will be published in the Conference Proceedings.

#### **6a. REGISTRATION FEES: 80€\***

Students: 40

(\*) the proceedings of the conference are included

In the proceedings of the Conference, the full papers of participants will be included.

#### **6b. PUBLICATION OF PAPERS, AFTER PEER REVIEW, IN JOURNALS**

The Scientific Journals:

1. International Journal of Economic Science and Applied Research
2. Archives of Economic History
3. Tourism Issues

will publish selected papers, after peer review.

#### **7. IMPORTANT DATES**

- |  |
|--|
| <ol style="list-style-type: none"><li>1. 1 February 2009. Submission of abstracts (final deadline).</li><li>2. 20 February 2009. Reply from the Scientific Committee regarding acceptance or not of paper.</li><li>3. 20 March 2009. Submission of complete paper.</li></ol> |
|--|

#### **8. PARTICIPATION TO THE CONFERENCE**

Official Attendance Certificates to the Conference will be given to all participants.

#### **9. EXCURSIONS**

An excursion to Delphi, Sounion or Hydra is planned for 28 May 2009.

The details of this excursion will be given in subsequent announcements.

A Greek dinner will be given on the second date of the Conference at low prices in the magnificent suburb of Athens, Plaka.

#### **10. CERTIFICATE OF PARTICIPATION TO THE CONFERENCE**

There will be given a Certificate to all participants to the Conference.

#### **11. INVITATION LETTER FOR PARTICIPATION TO THE CONFERENCE**

Participants who would like to obtain an invitation letter from the Conference organizers in order to submit it to their Institutions or Companies, should contact:

Prof. Christos Frangos (e-mail: [cfragos@teiath.gr](mailto:cfragos@teiath.gr)), in order to obtain this letter. However, this invitation does not imply any financial assistance from the Conference Organizing Committee.

#### **12. ACCOMODATION**

Hotel prices for one night's accommodation with breakfast in the neighborhood of the Technological Educational Institution of Athens (5km from it) and in the Center of Athens are in the region of 50-60 Euro/single room and 80-90 Euro/double room, at very good hotels. The organizing Committee is in the process of obtaining better deals with the hotels and there will be future announcements on this.

**13. REGISTRATION FORM**

I wish to participate to the Conference  
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QUANTITATIVE AND QUALITATIVE METHODOLOGIES IN THE ECONOMIC AND ADMINISTRATIVE SCIENCES.  
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which shall take place at  
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SUBMISSION OF ABSTRACT ACCORDING TO THE INSTRUCTIONS a.1-a.9.



# Papers

# LEADERSHIP EFFECTIVENESS. THE CASE OF ATHENS MUNICIPALITY

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## Abstract

*During the last decades there is an emerging issue concerning the effectiveness of bureaucracy at the public sector organizations in the context of the continuous changes of the business environment. The cornerstones of the contemporary management science such as ERP, DSS, TQM, Reengineering, MbO, Transformational Leadership, Total Civil Satisfaction etc, are a challenge for the public sector. At the same time the pressure for effective and efficient local government, bring in question the traditional management of the public sector.*

*In this paper we examine the leadership characteristics and style followed by the managers at the Municipality of Athens and its implications on employee's satisfaction and performance.*

*The basic research questions of the research are related to the role of leadership in a governmental organization and especially: a) how a leader can inspire and motivate employees in a bureaucratic environment, b) which is the appropriate leadership style to increase effectiveness and performance of public servants.*

*An updated literature review was conducted additionally to the legal and administrative framework of the Athens Municipality.*

*The final results of this research support the basic hypothesis and raise the prominence of leadership as a prerequisite of organizational survival in the contemporary continuous changing environment. Some of the emerging leadership characteristics are the team builder, the positive discipline, the commitment to the vision, the change agent with trust and justice.*

## Περίληψη

Τις τελευταίες δεκαετίες λαμβάνει χώρα ένας έντονος προβληματισμός σχετικά με την ικανότητα της γραφειοκρατικής δομής να προσαρμοστεί στο ασταθές και ταραγμένο περιβάλλον που διαμορφώνουν οι σύγχρονες οικονομικές, κοινωνικές και πολιτικές εξελίξεις. Η ανάπτυξη καινοτόμων μεθόδων και τεχνικών μανάτζμεντ του ιδιωτικού τομέα (ERP, DSS, Διοίκηση Ολικής Ποιότητας, Ηγεσία, MbO, Αναδιοργάνωση Διαδικασιών, Στρατηγικό Μάνατζμεντ, Ολική Ικανοποίηση του Πολίτη) αποτελούν πρόκληση για μία πιο αποδοτική, αποτελεσματική και ενεργή τοπική αυτοδιοίκηση ενώ παράλληλα αμφισβητούν τις παραδοσιακές μεθόδους διοίκησης του δημοσίου τομέα.

Στην παρούσα εργασία διερευνάται εάν τα συγκεκριμένα χαρακτηριστικά και στιλ ηγεσίας που εφαρμόζεται στο Δήμο Αθηναίων οδηγούν τους εργαζόμενους σε υψηλή απόδοση και αποτελεσματικότητα.

Τα βασικά ερωτήματα που χρησιμοποιήθηκαν για τη διερεύνηση της παραπάνω υποθέσεως συνδέονται με το ρόλο του ηγέτη στο πλαίσιο του Δήμου Αθηναίων. Συγκεκριμένα: α) πως ο ηγέτης μπορεί να εμπνεύσει και να παρακινήσει τους εργαζόμενους σε ένα γραφειοκρατικό περιβάλλον, β) ποιο είναι το κατάλληλο στιλ ηγεσίας για την αύξηση της αποτελεσματικότητας και της αποδοτικότητας των δημοσίων υπαλλήλων.

Για τη θεωρητική τεκμηρίωση της παρούσας έρευνας έγινε ανασκόπηση της βιβλιογραφίας και χρησιμοποιήθηκε το ισχύον νομικό πλαίσιο και κυρίως το διοικητικό δίκαιο που καθορίζει τις σχέσεις των υπαλλήλων στο Δήμο Αθηναίων.

Οι τελικές διαπιστώσεις της παρούσας μελέτης επιβεβαιώνουν την κύρια ερευνητική υπόθεση και αναδεικνύουν τον ηγέτη ως πολύ σημαντικό παράγοντα για την επιβίωση και ανάπτυξη του οργανισμού στο σύγχρονο συνεχώς μεταβαλλόμενο περιβάλλον. Ορισμένα από τα ηγετικά χαρακτηριστικά που αναδείχθηκαν είναι το κτίσιμο ομάδων, η θετική πειθαρχία, η δέσμευση στο όραμα, η εισαγωγή αλλαγών, η εμπιστοσύνη και η δικαιοσύνη.

**Key Words:** Leadership, Public Management, Motivation, Athens Municipality

## Introduction

Public organizations which are organized under stable and predicted environment face the problem of inability to adapt to the continuous changes of their environment. The lack of capability to satisfy the modern needs of productivity improvement e.g. the requirements of the act 3230/2004 and the continuous quality improvements in order to satisfy citizens needs (Michalopoulos, 2002). Especially local government the crisis is more evident due to the bureaucracy and the generic pathogenesis of the administrative system (Makridimitris, 1995).

In this framework the appropriate leadership can result to dramatic improvements that would lead to the adoption of change and public servants empowerment (Denhardt, Denhardt, 2006). The local government leader must first of all motivate and energize all employees in order to accept and implement organizational changes that would change the public organizational culture (Valie, 1999, Denhardt, Denhardt, 2001, 2007).

## **Literature Review**

Leadership in generally is considered as a very important parameter in organizational effectiveness and employees performance (Wang *et al.*, 2005). The early years scholars tried to define the effectiveness of the leadership (Blake & Mouton, 1964, Lewin, 1939).

The leader in the local government (Alimo *et al.*, 2006) must incorporate in his traditional bureaucratic role the contemporary managerial role combined with the institutional and legal conformity which is designated for the public organization operation. Terry (1995) discriminates three basic roles as the cornerstones of the managerial – leader role:

1. The mission fulfillment as the local leaders act as agents of the political leaders (of the local and the national government) and according to the laws and the magisterial decisions. The local leaders must use their discretion to implement a specific decision which is not evident as the politician may send controversial messages to them.
2. The core agency values protection as the middle and high level managers must keep a positive image of the governmental organization to the public. They must not become corrupted or altered as they disseminate the ethical standards to the society. The protection of principles and values (Kouzes, Posner, 1992) require knowledge of the human capital of the organization to which the manager is the leader and ensures its autonomy and enhance its loyalty to the core values.
3. To ensure the well being of the internal bureaucracy in order to achieve organizational objectives which are far and beyond of the individuals and the groups which consists the organization. Organizations are full of formal and informal teams which look for to satisfy their aims and objectives which sometime diverge from those of the leaders of the public organization which lead to degradation of the image of the whole organization. The leader must infuse a feeling of trust and identification among the members of the organization so as to share common objectives and work together for the same purpose.

It is obvious that the leader must respect the institutional and legal part of the managerial role and at the same time to inspire employees to trust him so as to create a common organizational vision which must be aligned to the vision of each individual and group of the organization (Bartram, Casimir, 2007).

## **Research Methodology**

The aim of this research was to investigate the leadership characteristics from the point of view of the public managers and from the point of view of the public servants.

This paper was based on a field primary investigative research using a sample of 42 employees at Athens Municipality. Two structured questionnaires were used the one for the managers (five persons) and the other for the employees (37 persons). A pilot research was conducted during July 2008 and the final research during September 2008. The questionnaires structure was similar to a big extent of course with different point of view. The questions were divided into three categories. First were the demographic data second the leader behavior and third the leader characteristics. The research tried to depict the current situation by describing how leader believe they behave and how followers perceive their leadership.

## **Results**

The demographics of the sample were as follows:

- Sex: men 31% and women 69%, while for the employees the percentage was 27% men and 73% women and for the managers was 60% men and 40% women.
- Education level: 24% Bachelor, 14% TEI and 62% Lyceum, while for the employees the percentage was 19% Bachelor, 11% TEI and 70% Lyceum
- Professional experience: Minimum six months and maximum 29 years with standard deviation 8.23 years.

It is obvious that there are more women as employees and fewer women as managers. The education level of employees is lower comparing to this of managers. Of course the seniority is a prerequisite in the public sector and thus managers have longer experience from those of employees.

The characteristics of the leaders in Athens Municipality according to the managers are the following on a hierarchical basis:

1. Planning and Organization
2. Cooperation and Teamwork
3. Initiation
4. Communication
5. Effectiveness
6. Self Motivation
7. Conflict Handling
8. Adaptability

The characteristics of the leaders in Athens Municipality according to the employees are the following on a hierarchical basis:

1. Conflict handling
2. Cooperation and Teamwork
3. Communication
4. Effectiveness
5. Initiation
6. Integrity
7. Adaptability
8. Planning and Organization
9. Self Motivation
10. Staff development

There a lot of differences and similarities between the two points of view. The managers consider that they are able in planning and organization while employees believe that this is not their strong characteristic. Employees believe that the strong point of the managers is the way they handle conflicts whether for the managers this is not an important point. There is a convergence in characteristics such as communication, cooperation and teamwork and effectiveness.

The differences are the result of what each party considers as important and gives value to this.

## **Conclusions**

The need for change of the bureaucratic model to the calls of the modern management in the public organizations such as the Athens Municipality is evident. This need is stronger especially after the recent economical and social crisis of the 2008 and the new citizen profile with the consequent demands. At the same time for this transition it is important to take into consideration the deep assumptions and values that are been infused in the public servants which form the public organization culture in order to use a successful method to transfer these innovative management tools from the private to the public sector (Sotirakou, Zeppou, 2005, Parry, Proctor-Thompson, 2003).

The challenge for the new public servant – leader is to overcome the obstacles of the organizational long term patterns, attitudes and behaviors in order to achieve productivity improvements and staff empowerment. At the same time these public leaders are coming from the body of the bureaucratic old fashioned public structure which has the power to design the leader and not the leader to design the organizational behavior and the structure (Bass, 1985, Valle, Perrewé, 2000).

In the case of Local Government and especially the Athens Municipality the malfunctions of the public bureaucracy such as the lack of flexibility, the legalism, the ceremonialism and the limited staff development lead to a poor organization performance which becomes worst due to the interventions of the politicians both from the local and the national government (House, Aditya, 1997). Additionally characteristic of the civil servants is the resistance to any change as the protected value in the public organizations is stability and the need for safety.

The above characteristics of the contemporary public sector emerge the need of leadership as a necessity for survival and development.

Based on the results of the current research one and most important tool for a manager to become a leader in a public organization is the establishment of a communication which leads to the development of trust between the leader and his followers (Laschinger *et al*, 2001).

In order to achieve this trustiness the leader must establish the following principles in his organization:

- Transparency
- Equity
- Freedom of feelings
- Consistency and stability
- Keep promises
- Truth
- Keep confidential data
- Self-improvement

The development of a high level of trust must follow the next three steps (figure 1):

1. Scanning the organizational environment in order to adapt the appropriate leadership style.
2. Developing of trust using the above principles.
3. Achieving trust through continuous efforts of the leader to monitor and adjust his behavior to the reactions of the followers

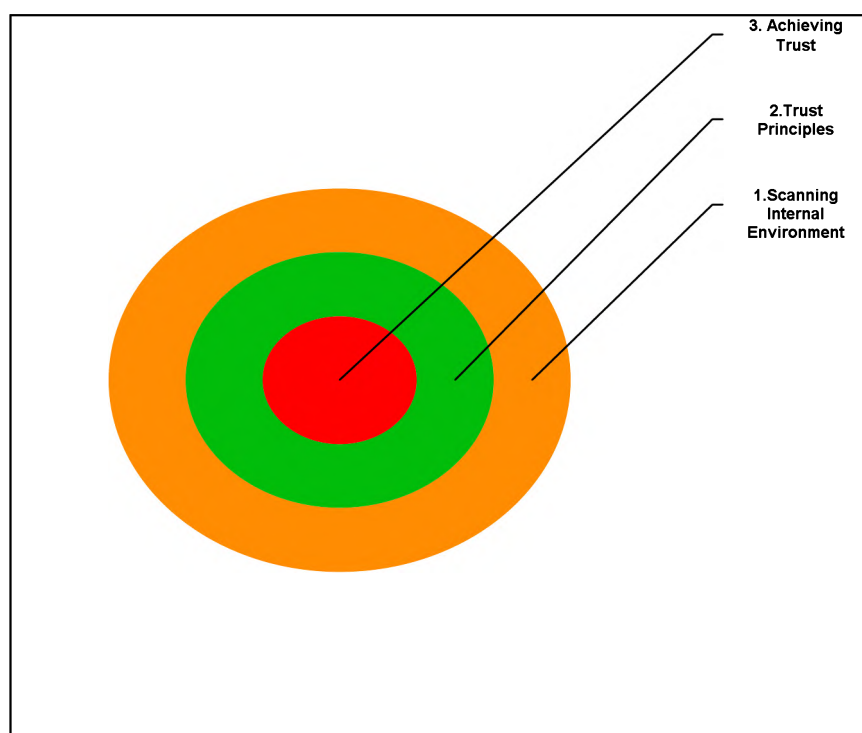


Figure 1: Stages of Trust Development

Additionally it seems that the number of women is increasing rapidly in the public sector which means that it would be necessary for them to transcend the barriers of stereotyping against woman and to develop a leadership behavior that will improve organizational effectiveness and stimulate performance.

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# APPROACHES TO LEARNING OF GREEK BUSINESS STUDENTS

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## Abstract

*Accounting education research indicates that the approach to learning is a significant factor affecting the quality of learning. This is the first study undertaken in Greece examining the approaches to learning adopted by accounting and management students in their study of financial accounting. Data regarding deep and surface approaches to learning were collected from business students studying at two Greek ATEIs using the Revised Two Factor Study Process Questionnaire (R-SPQ-2F). At the same time various attitudinal variables were taken into account. Finally, factors such as gender, educators and departments are specifically considered in this study.*

## Περίληψη

*Η έρευνα στη Λογιστική εκπαίδευση έδειξε ότι η προσέγγιση στη μάθηση είναι ένας σημαντικός παράγοντας που επηρεάζει το ποιοτικό αποτέλεσμα της μάθησης. Αυτή είναι η πρώτη μελέτη που πραγματοποιήθηκε στην Ελλάδα εξετάζοντας τις προσεγγίσεις στη μάθηση που υιοθετούνται από τους σπουδαστές τμημάτων Λογιστικής και Διοίκησης επιχειρήσεων κατά τη διάρκεια της μελέτης της Χρηματοοικονομικής Λογιστικής. Στοιχεία σχετικά με τη βαθιά και επιφανειακή προσέγγιση στη μάθηση συγκεντρώθηκαν από σπουδαστές που φοιτούν σε δύο Ελληνικά Τεχνολογικά Ιδρύματα, χρησιμοποιώντας το Revised Two Factor Study Process Questionnaire (R-SPQ-2F). Επίσης, ποικίλες μεταβλητές της συμπεριφοράς καθώς και παράγοντες όπως το γένος, οι καθηγητές, το τμήμα σπουδών συμπεριλήφθηκαν στη εξέταση των διαδικασιών μάθησης της Χρηματοοικονομικής Λογιστικής.*

*Keywords: Learning approaches, first accounting course, business students, R-SPQ-2F.*

## 1 Introduction

Many academics have highlighted that students learn in different ways (Beattie, Collins and McInnes, 1997; Davidson, 2002). Furthermore, several studies have indicated how important is for academics to understand how students learn. The importance of approaches to learning in Higher education has been emphasized by many researchers. The concept of approach to learning is “a key concept in teaching and learning” (Ramsden, 1992, p.39).

Davidson (2002) argued that the quality and quantity of learning outcomes is influenced by students learning approaches. Approaches to learning have been investigated more than fifty years (Ryle, 1949; Entwistle and Ramsden, 1983; Biggs, 1987a, 1987b). Marton and Sajlo (1976a, 1976b) were the first to introduce the concept of learning approaches by studying how students perceived and learned a particular reading task. They came up with the powerful idea of approach to learning, which became the point of departure for the emerging conceptual framework known generically as “student approaches to learning (SAL) theory” (Biggs et al, 2001)/

This is the first study to investigate approaches to learning of Greek business students and to identify differences between accounting and management students using a well established theory. The Revised Two Factor Study Process Questionnaire (R-SPQ-2F) introduced by Biggs et al.(2001) was used by comparing R-SPQ-2F scores of accounting and management students who were following an introductory accounting course.

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This paper, involving Greek accounting and management students, has the following specific objectives:

- to explore management and accounting students' approaches to learning in the first accounting course;
- to identify similarities and differences in the approaches to learning between management and accounting students;
- to identify similarities and differences in the approaches to learning between male and female students
- to examine the relationships between students' learning style and their approaches to learning
- to investigate the relationship of prior academic achievement and approaches to learning

The remainder of this work is structured as follows. The next section presents prior research on accounting and business students' approaches to learning and introduces the theoretical framework for the study. This is followed by the research methods used; then the results of the statistical analysis are analyzed and discussed. Finally, the implications of the research study and practice are presented and scope of further work identified.

## **2 Literature Review**

One of the basic concepts which have arisen from accounting literature the last decades on accounting education is the need to move towards a conceptual form of learning (AAA, 1986; Arthur Andersen et al, 1989; IMA, 1999; Mathews, 2001; Tippett, 1992; Adler & Milne, 1997; Kelly et al, 1999; Parker, 2002, 2007; Howieson, 2003; Carr & Mathews, 2004). Accounting graduates should develop skills and competencies necessary to become independent, lifelong learners. Marton and Saljo (1976) were the first to distinguish two approaches to learning, deep and surface. Deep learning approach is associated with a personal desire by the student to understand the subject and relate it to previous knowledge and experiences. Students with deep approach internalize learning and try to understand how knowledge represents reality. They relate evidence to conclusions, integrate ideas and examine the logic of the conclusions. In contrast, when a surface approach is adopted, students memorize and reproduce knowledge for the sake of the examinations. Learning is externalized. Students passively accept ideas and information and have no learning plan or strategy. Assessment requirements drive their learning route and desire (Sharma, 1997; Hassall and Joyce, 2001).

Approaches to learning constitute an absolutely critical concept for teachers to understand, since it affects how teachers teach. As Ramsden states (1992, p.45) an approach describes a relation between the student and the learning he or she is doing. When we try to change approaches, we are not trying to change students, but to change the students' experiences, perceptions or conceptions of something.

Numerous studies have indicated that instructors are able to influence students' approaches towards "deep" rather than "surface" learning by changing the learning environment and the educational and pedagogical context. Irrespectively of methodology undertaken, questionnaires or interviews, research studies have shown that the outcomes of students' learning are associated with the approaches they use. Approaches are related also to how much satisfaction students experience in their learning. Deep approaches are related to higher quality outcomes and better grades. They are also more enjoyable. Surface approaches are dissatisfying and associated with poorer outcomes (Ramsden, 1992).

The positive correlation between deep approaches to learning and academic performance has been stated by Entwistle and Ramsden (1983), Watkins and Hattie (1981), Biggs (1987). Studies by Duff (2004), Booth et al. (1999), Byrne et al. (2002) Ramburuth and Mladenovic (2004) have revealed also the positive association between deep approach and improved performance. Duff (2004) findings categorized students as "effective learners" with high scores on deep approach, academic self-confidence and high rate of progression (75%) and "ineffective learners" with high scores in surface approach and a very low rate of progression (11.7%). A set of interventions in the learning context in order to enhance deep learning of accounting students was examined by English et al. (2004). Intervention included writing skills development, use of case studies and examinations reinforcing critical thinking and analysis. The findings confirmed the effectiveness of the interventions in encouraging a deep approach and in improving overall course results. Hall et al. (2004), Adler et al. (2004), Boyce et al. (2001) elaborated on the strategic use of case studies in order to enhance generic skills development. Authors used SPQ (Biggs, 1987b) questionnaire to assess students' approaches change after the introduction of group learning activities. Results indicated that accounting students showed a small but statistically significant increase in their deep learning approach and a small but statistically significant reduction in their surface learning approach.

Study findings indicated that age is positively related to a preference for deep approach, suggesting mature students of more than 21 years old demonstrate a desire for academic learning and a positive influence on the course (Duff, 1999; Richardson, 1994; Richardson et al, 1999; Harper and Kember, 1986).

Gender differences have also been considered in the studies (Byrne et al. 2002; De Lange and Mavondo, 2004). Findings showed a different pattern on the learning approaches for male and female students. While females supported the proposition that there is a positive relation between deep and strategic approach and high performance, there was no significant evidence for male students. Hassall and Joyce (2001) found the opposite results with females scoring higher on the surface approach.

Lucas and Meyer (2004) used the RoLI (Reflections on Learning Inventory) questionnaire and their findings indicated that there are variations in conception and approach to learning between students who specialize in accounting and those who do not specialize in accounting and between male and female students.

Accounting students tend to decline the use of deep processing approaches as they progress in their studies with an increasing preference of convergent learning style (Gow et al, 1994; Brown and Burke, 1987). As Kolb (1995, p.54) explains “the converger seeks to apply acquired knowledge to specific problems for the purpose of problem solving and decision making. Convergents seek single, correct answers or solutions to a question or problem” Other researchers (Hall et al, 2004; Lucas and Mladenovic, 2004) showed in their studies that intervention in the learning environment, although increased the deep strategies did not significantly reduce the use of surface strategies. In accounting, students must “learn terminology, basic concepts, and procedures before being able to apply knowledge to novel problems and reflect/evaluate on the appropriateness of various treatments and methods” (Hall et al, 2004, p.502.)

### 3 Theoretical Framework

The concept of “learning approaches” was examined in the 1970s and the 1980s independently by the following research groups: the Lancaster Group led by Entwistle, the Australian Group led by Biggs, the Swedish Group led by Marton, and the Richmond Group led by Pask.

#### The Australian Group – Biggs

This group developed a model (the “3P” model of teaching and learning) (Figure 1) in which the study process is an intermediate stage between presage factors and product factors. Presage factors are identified as personal and institutional characteristics and exist before student starts studying. Examples of personal characteristics are the cognitive style, IQ, personality and home background of each student. Institutional characteristics are the subject area, teaching method, assessment method and course structure, institutional climate and procedures. Product factors can be either objective (i.e. examination marks) or subjective (satisfaction with performance attained).

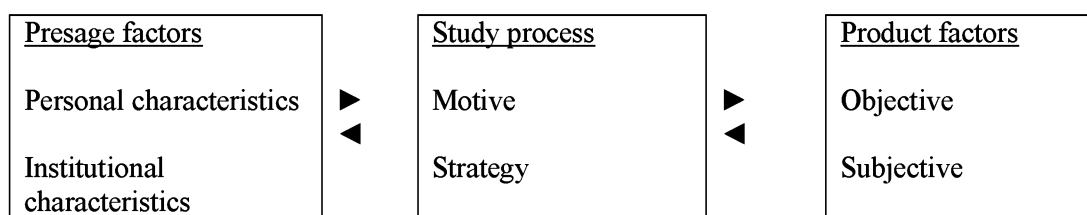


Fig.1. Biggs' (1978) learning model adapted from Beattie et al, 1997

In the 3P model, student factors, teaching context, on-task approaches, and the learning outcomes, mutually interact, forming a dynamic system. Presage factors can affect product factors by affecting the study process. The academic performance of students can be affected by the motives that students have or by the strategy students adopt in their approach to learning. Motives and strategy of students are affected by personal and institutional characteristics. Each factor depends on every other factor, so that for example the student's preferred approach will adjust to the specific context and course being taught and to the success or not of the outcome.

According to Biggs different types of motives and strategies can produce different types of learner but possibly with similar success in their studies. In the following table the study process is presented through

the motives of learning a task and the strategies undertaken to accomplish the task The learner type of student comes as a result of the motive-strategy combination (deep, surface, achieving).

Table 1 Impact of motive and strategy on approach to learning.

Study process		Approach to learning
Motive	Strategy	
Main purpose is to meet minimum requirements: need to achieve balance between working too hard and failing	Reproductive: limit target to bare essentials and reproduce through rote learning	Surface
Studies to realise interest and competence in particular academic subjects	Reads widely with previous relevant knowledge	Deep
Competitive: tries to obtain highest grades whether or not the material being studied is interesting	This is the “model” student: organises time and working space	Achieving

Deep and surface approach identify the ways which students undertake in order to realize a task whereas the achieving approach describes the way in which students organize their time and working environment. Mixed approaches to learning can sometimes be adopted. For example:

Surface-achieving strategy (rote learning in a highly organized way),

Deep-achieving strategy (reading for meaning in an organized way),

According to Biggs (2001) there are possible interactions between student perceptions and teaching demands. A student that engages in rote learning may find that this strategy will not work under portfolio assessment, so will have to undertake deep studying. A student, who usually engages in deep learning, may decide to go surface in a course that is overloaded with content and assessed by Multiple Choice Questions. (Biggs et al, 2001, p5).

#### R-SPQ-2F questionnaire

Biggs developed the Study Process Questionnaire (SPQ) to test 3P model on higher education students in the late 1970s. Later appeared the need for a shorter two-factor version of the SPQ. Biggs, Kember and Leung (2001) produced The Revised Two Factor Study Process Questionnaire (R-SPQ-2F) using a process of testing and refinement and arrived in deep and surface motive and strategy scales each with 5 items, 10 items per approach score. The final version was tested using reliability procedures and confirmatory factor analysis. The sample for the final version consisted of 494 undergraduate students from a variety of departments in the same university.

### 4. Research Method

#### 4.1 Sample and data collection

Greek post-secondary education is divided into university-level and non-university (but still tertiary-level) education and this is offered by the Higher Technological Educational Institutions (ATEIs). The degrees in Accounting and Business Administration awarded by ATEIs have four-year duration, divided into eight independent semesters. During the first semesters of their studies, students take general business science courses such as Economics, Financial Accounting, Management Accounting, Maths, Statistics, Law and Information Technology, as well as introductory courses on business administration and management. The data for this study were collected via questionnaires that were administered to two different groups of Greek business students attending the first accounting course (hereafter FAC). The data collection was anonymous. The students participating in the study completed the questionnaires during class time and questionnaires were collected immediately upon completion. The first group consisted of full time accounting students attending the ATEI-Piraeus attending classes contacted by two different accounting educators (educator A and educator B). The questionnaire was also administered to another group of full time management students

attending the ATEI-Athens and ATEI-Piraeus, attending classes conducted by two different accounting educators (educator C and educator D). After checking for internal consistency and verification, of the 416 questionnaires received, 368 were deemed usable, with 204 from accounting students and 164 from management students. This gave a participation rate of 85%. The unusable questionnaires were incomplete. Approximately 28% of the students were 19 years old, 26% 20 years old, 21% 21 years old 22% older than 21 and 2% younger than 19 years old. From the students 35% was at the first academic semester, 24% was at the second academic semester, 20% was at the third and fourth semester and 21% was at the last four semesters of their studies. The sample consisted of 52% students from Athens, 42% students from other parts of Greece and 6% students from a diverse range of countries. From the sample 41% declare sensing learners, 21% declare intuitive learners and 38% declare in between sensing and intuitive learners.

The department, gender, and age structure of the sample population is shown in the following tabulation.

Table 2 Structure of Department, Gender, and Age of Sample

	Accounting Students	Management Students	Total
Number	204	163	367
Male	87	75	162
Female	117	88	205
Average Age (Min-Max)	18-40	18-36	

#### 4.2 The instrument

The instrument used in this study to measure the students' approaches to learning is divided into two sections as follows:

Part I of the questionnaire gathered students' demographic information, i.e., gender, age, origin, transfer degrees, learning style, department and typical semester of their studies.

Part II of the questionnaire consisted of the R-SPQ-2F developed by Biggs (2001). The R-SPQ-2F contains 20 items and was answered on a 5-point Likert scale as follows: (1) this item is never or only rarely true of me (2) this item is sometimes true of me (3) this item is true of me about half the time (4) this item is frequently true of me (5) this item is always or almost always true of me.

In this research, the R-SPQ-2F was used to investigate both students' approaches to learning at the first accounting course and to examine differences between accounting and management students as these can serve as indicators in a number of research contexts (English et al., 2004).

Students' responses to the R-SPQ-2F were aggregated following the procedure in Biggs (2001). The reliability of the R-SPQ-2F in this research was assessed using Cronbach alpha with values calculated for each learning approach subscale (motive and strategy) and each learning approach scale (deep and surface).

Responses were initially aggregated into the deep motive and deep strategy subscales of learning approaches. The matched deep motive (the deep motive subscale consists of 5 items and the range of possible scores was from 5 to 25, midpoint 15) and deep strategy (the deep strategy subscale consists of 5 items and the range of possible scores was from 5 to 25, midpoint 15) subscales were further aggregated resulting in an overall deep approach scale. The deep approach scale consists of 10 items. The range of possible scores was 10 to 50, midpoint 30. Cronbach  $\alpha$  for the present sample was 0.71.

The same procedure was used for surface motive and surface strategy subscales of learning approaches. The matched surface motive (the surface motive subscale consists of 5 items and the range of possible scores was 5 to 25, midpoint 15) and surface strategy (the surface strategy subscale consists of 5 items and the range of possible scores was 5 to 25, midpoint 15) subscales were further aggregated resulting in an overall surface approach scale. The surface approach scale consists of 10 items. The range of possible scores was 10 to 50, midpoint 30. Cronbach  $\alpha$  for the present sample was 0.70.

## 5. Analysis and Results

### 5.1 Descriptive analysis of questionnaires

The purpose of using the R-SPQ-2F questionnaire was to measure Greek Accounting and Management students' approaches to learning (accounting). The analysis of questionnaires (Table 4) suggests that overall Business students (Accounting and Management students) have a deep approach to learning in the FAC although the result is not statistically significant (Mean= 30.01). Further analysis revealed that the Accounting department has a mean for the deep approach scale of 30.44 indicating deep learners while the Management department has a mean of 29.79 in the surface approach scale indicating surface learners. In order to test the significance of the scores one sample t-tests were carried out. The mean scores for the sample of Accounting students (30.44 deep learners) and the mean score for the sample of Management students (29.79 surface learners) are not significantly different than 30 which is the mean score of the scale ( $p=.246$  and  $p=.673$  respectively)

The analysis indicates that accounting and management students in Greece are neither deep nor surface learners. In order to further explore this result for the accounting students further tests were carried out regarding the subscales that define deep motive and deep strategy. The mean for the deep motive subscale (16.02) is higher than the mean score of the scale and it is significantly different ( $p<0.000$ ). However the mean for deep strategy subscale (14.38) is lower than the mean score of the scale and it is significantly different ( $p=0.002$ ). This implies that accounting students have deep motives to learn accounting but they indicate that they have a surface strategy. Accounting educators in order to engage student in a deep learning approach should employ appropriate techniques to improve the learning strategy of students.

In order to further investigate this result for the management students tests were carried out regarding the subscales that define surface motive and surface strategy. The mean for the surface motive subscale (13.45) is lower than the mean score of the scale (15) and it is significantly different ( $p<0.000$ ). However, the mean for surface strategy subscale (16.38) is higher than the mean score of the scale and it is significantly different ( $p<0.000$ ). This implies that management students while they employ a surface strategy they do not have a surface motive to learn accounting.

Table 3 R-SPQ-2F summary statistics

Variables	Total sample		Accounting students			Management students		
	Mean	Std. Deviation	Mean	Std. Dev.	Sig (2-tailed)	Mean	Std. Dev.	Sig (2-tailed)
Deep Motive	15.63	3.26	16.02	3.19	0.000	15.13	3.29	0.628
Deep Strategy	14.41	2.94	14.38	2.83	0.002	14.46	3.09	0.028
Surface Motive	12.96	3.67	12.57	3.63	0.000	13.45	3.69	0.000
Surface Strategy	16.08	3.28	15.82	3.12	0.000	16.38	3.46	0.000
Deep Approach	30.01	5.33	30.44	5.28	0.246	29.49	5.34	0.237
Surface Approach	29.00	6.03	28.36	5.92	0.000	29.79	6.10	0.673

### 5.2 Similarities and differences between departments

To examine whether these differences between the two groups are statistically significant for all subscales, a series of t-tests was performed. The results (Table 4) show no statistically significant differences in deep strategy and surface strategy and in deep approach to learning between accounting and management students. However, there is a statistically significant difference in the score of the deep motive surface motive and surface approach to learning.

Table 4 Differences between Departments

Variables	Department	Mean	Std. Deviation	Sig. (2-tailed)
Deep Motive	Accounting	16.02	3.19	0.009*
	Management	15.13	3.29	
Deep Strategy	Accounting	14.38	2.83	0.806
	Management	14.46	3.09	
Surface Motive	Accounting	12.57	3.63	0.024*
	Management	13.45	3.69	
Surface Strategy	Accounting	15.82	3.12	0.108
	Management	16.38	3.46	
Deep Approach	Accounting	30.44	5.28	0.097
	Management	29.49	5.34	
Surface Approach	Accounting	28.36	5.92	0.028*
	Management	29.79	6.10	

### 5.3 Differences between accounting educators

Educators have a positive or negative influence on students' learning and performance. Statistically significant differences were found only on the subscale of deep and surface motive subscales between two educators one teaching in a management class (educator C) and the other in accounting class (educator A).

### 5.4 Differences between other demographic characteristics

#### Gender

A comparison of the scores for the scales and subscales (see Table 5) shows that female students have a higher score on the deep approach to learning scale than males. The difference is statistically significant ( $p=0.027$ ) as shown by an independent samples t-test. This difference can be explained by the female scores on deep motive subscale and the deep strategy subscale. The difference is statistically significant on the deep motive subscale ( $p=0.016$ ) as shown by an independent samples t-test. It should be pointed out that the male business student have a surface approach in studying accounting but this difference is not statistically significant ( $p=0.568$ ).

Table 5 Differences between males and females

Variables	Gender	Mean	Std. Deviation	Sig. (2-tailed)
Deep Motive	Female	15.9950	3.17253	0.016*
	Male	15.1625	3.31925	
Deep Strategy	Female	14.5882	2.74841	0.186
	Male	14.1761	3.17533	
Surface Motive	Female	12.6667	3.42685	0.084
	Male	13.3418	3.94351	
Surface Strategy	Female	16.1931	3.25643	0.441
	Male	15.9236	3.31187	
Deep Approach	Female	30.5578	4.93446	0.027*
	Male	29.3057	5.72070	
Surface Approach	Female	28.8384	5.91429	0.568
	Male	29.2092	6.18216	



## Learning Style

To help measure students' learning style and its relationship with the learning approaches, they were asked to indicate their learning style (sensing, intuitive and mixed). No differences were observed between the different learning styles as those were declared by the students and the learning approaches. For that analysis the one way ANOVA test was employed.

## Transferred and non transferred students

Students in Greece can transfer their degree and studies from one university to another. This is allowed mostly to students of low income and those that belong to families that have three or more children. Although this seems a reasonable policy, it results in a large number of students being transferred from departments where the admission scores are low to departments with high admission scores. Low admission departments are mostly located away from Athens. In some cases the number of students been transferred exceeds the number of students that initially were admitted in the department.

The transferred students have lower entrance grades since they were admitted to educational institutes in the province. For the sample populations the transferred students exceed the non-transferred by almost 38% (153 students were originally admitted while 211 were transferred). Statistics collected from the files of transferred students show that the prior academic achievement scores in the secondary school range from 10.0 to 12.0 (with 20 maximum) while for the non-transferred student the same scores range from 14.0 to 16.5.

In order to further investigate differences between transferred and non transferred students, i.e. between high and low performance students, comparison tests were carried out regarding the scales and subscales that define the learning style. The mean score for deep motive and deep strategy subscales for the non-transferred students is higher than the same scores for transferred students (but not statistically significant). Also the mean score for the deep approach scale is higher for the non-transferred students than the same scores for transferred students (but not statistically significant).

However the opposite is true for the subscales and scale that define surface learning. The mean score for surface motive and surface strategy subscales for the transferred students is higher than the same scores for non-transferred students. The difference is close to statistically significant for the surface motive subscales ( $p=0.050$ ). Also the mean score for the deep approach scale is higher for the transferred students than the same score for non transferred students. The difference now is statistically significant ( $p=0.029$ ).

This is an indication that the learning approach of students that have low prior academic performance is surface motive while high performing students have a preference for deep motive and deep approach.

Table 6 Differences between transferred and non-transferred students

Variables	Transferred	N	Mean	Std. Deviation	Sig. (2-tailed)
Deep Motive	Yes	205	15.46	3.31	0.272
	No	152	15.84	3.21	
Deep Strategy	Yes	209	14.26	2.85	0.368
	No	150	14.55	3.06	
Surface Motive	Yes	205	13.27	3.40	0.050*
	No	150	12.51	4.02	
Surface Strategy	Yes	208	16.28	3.13	0.145
	No	147	15.76	3.49	
Deep Approach	Yes	203	29.67	5.21	0.210
	No	149	30.40	5.48	
Surface Approach	Yes	203	29.57	5.52	0.029*
	No	144	28.13	6.65	

## **6. Conclusions and further research**

The aim of the current study was twofold: firstly to identify the learning approaches undertaken by undergraduate students in Greece during their study of introductory accounting course and secondly to investigate relationships between approaches to learning, gender, students' learning style, and prior academic achievement. Our sample included two cohorts of students coming from two different departments: accounting department students and management department students from two different Institutions (ATEI Piraeus and ATEI Athens).

Results based on R-SPQ-2F questionnaire indicated that overall sample of students is oriented towards deep learning approach though this is not statistically significant. This result reveals a mixed preference of students for both approaches which is consistent with other studies' results (Birkett and Mladenovic, 2002; Hall et al. 2004). In some learning contexts, like accounting, lower level strategies are required in order to progress to higher level of comprehension. In accounting courses, students need primarily to learn terminology, basic concepts and procedures which they will be able to apply in a later stage in order to evaluate and critically reflect on various problems and treatments as they arise (Hall et al. 2004). In a comparison between the two departments, accounting students showed an overall deep approach. They scored high on deep motive but simultaneously they scored high on surface strategy. Management students employed surface approach though not statistically important. They scored high on surface motive and high on surface strategy too. It is obvious from results that accounting students have the motivation to learn but they fail to use the proper learning methods and this is a statistically significant result. Management students have neither the motive nor the strategy to study accounting. Surface strategy is engaged also by the total sample of students.

Overall results confirm employment of low level strategies by all students. Thus becomes apparent the need for teachers to reflect on how they will introduce students to new teaching context (teaching methods, assessments) which will support them to shift towards higher learning levels. There are no differences on the scores of the main variables in relation to the educators and the students' learning styles.

Examination of a typical Greek situation was performed for the transferred students which revealed the expected findings concerning their preferred learning approach in relation to their prior academic achievement. The present study revealed that non transferred students (with higher entrance qualifications) engage in a deep learning approach and their scores are all better in the subscales (deep motive and deep strategy) though not statistically significant. On the contrary transferred students (with lower entrance qualifications) show preference for surface approach and their scores are higher for both surface motive and surface strategy.

Analysis for gender showed that females have preference for deep learning approach and they score higher on deep motive scale and on deep strategy scale. There is no consistent evidence from studies which tested for gender differences in approaches to learning (Richardson and King, 1991; Hassall and Joyce, 1997; Byrne et al, 1999; Michael and Marriott, 2008; Duff, 2004).

The present study has two limitations which are suggestive for future research. First, it uses a sample which comes from two different Educational Institutions, each one of them creating its own educational environment and carrying its own ethos. Theory suggests that, educational context, ethos and institution climate are factors affecting learning approaches. A second limitation could be the possibility that sample included students who attended the specific course for a second or third time or more, since there is no regulation prohibiting students to attend a class or take exams as many times as they wish, given they have failed in previous attempts. There are indications from previous studies that the approaches to learning change over time

Definitely a wide range of future research issues could contribute to our knowledge regarding Greek students' learning approaches and consequently support teachers in our effort to promote high level outcomes. Among them we would suggest the investigation of the relation between learning approaches and performance, the exploration of teaching interventions on learning engagements in relation to outcomes, comparison of ATEI and University students' learning approaches, approaches to learning and students' perceptions about accountants.

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# QUALITATIVE METHODOLOGIES OR MEASURES TAKEN FROM FINANCIAL INSTITUTIONS REGARDING THE MANAGEMENT OF THEIR REPUTATION

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## Abstract

*Paper scope:*

- a) *The meaning of reputation*
- b) *The worth of reputation*
- c) *Qualitative methodologies regarding its management*

*Method:*

- a) *References to relative literature on the subject.*
- b) *Description of the day by day practice of the institution of Millennium Bank in Greece, garnering information with the method of interviews to the upper level staff*

*Results:*

- a) *Comprehension on basic elements and tools on the significance of corporate reputation*
- b) *Introduction on day by day practices for reputation management from a financial institution*

**Keywords:** *Constituent elements of the reputation, The worth of a good reputation, the stakeholders theory, Crisis management, models of measure of the reputation, Chief Reputation Officer and the CEO's role for the reputation of the institution*

## 1. The Meaning of Corporate Reputation

By general confession, when encountering the theory that reputation is important, the executives of a company pose the inevitable question: "so, what reputation is actually worth?". Everybody, from the communications' executives to the heads of Marketing and Finances, seeks an answer. Dr. Fombrun (3) used the following example in order to give us an idea regarding the meaning of reputation.

"Do you recall the last time you hired a contractor to make improvements to your house or apartment? Or the last time you called on travel agent assistance in planning a trip? Or those less than happy times when you required the advice of a lawyer, accountant, dentist, or doctor? Think about how you came to choose that particular contractor, travel agent, lawyer, accountant, dentist, or doctor. If you are like most people, chances are, you didn't just pick up their names out of a phone book. You probably went to them because they were recommended to you by a family member, friend, or someone else you trust. If so, they are hired based on their reputation. A company's prestige, its good reputation, as well as the brand's added value will be determined by the quality of the relationship with the consumer. The sales and market share will continue to be important (8) but will always constitute historical ratings. The company's value will be determined by the future return that is based, on the one hand, on the company's prestige and good reputation –constituting the most intangible asset- and, on the other hand, on the quality of the relationship between the brand and the customers.

The value of reputation and thus of its proper management for every company becomes even more imperative, if one takes into account that the generation of surplus value for the company requires the effective management of image and reputation not only at the consumer-customer level, but overall and towards all stakeholder groups, in order for the firm to create a competitive advantage, converting stakeholders to advocates-ambassadors of the company and the products. Corporate reputation constitutes hence an intangible asset with cumulative power and is thus difficult to measure. Its measurement is mainly conducted on the basis of surveys examining characteristic qualities of the company, their effect on the various stakeholder groups, as well as the overall performance of the company in its field of activity.

## 2. What Makes a Good Reputation

Basic components of corporate reputation are corporate identity and corporate image. Good corporate identity can have two possible effects on corporate image (Dr. Dowling) (2). First, people can make the correct association between the company and its identity symbols (i.e. golden arches of Mac Donald's). Then hopefully these identity symbols help people recall their image of the company – which may include a mental picture and/or sensory feelings about it (we had a good time there when we last visited). However, much of this image may be the result of rote learning. For example, through years of advertising and widespread availability, most people now recognize Mac Donald's and associate it with fast food and family restaurant atmosphere. Some corporate identity symbols may also automatically enhance the organization image. The definition of corporate image above suggests that this construct has two components: a “logical” (cognitive belief) component and an emotional (feeling) component. Both of these are necessary and both are usually experienced simultaneously in the person's mind. They fit together to form an overall corporate image. The role of the emotional component is to energize the individual to respond to the company – such as a customer buying a product or an employee working harder. Beliefs without emotions are not effective – someone or something else has to stimulate action. In effect, a good corporate reputation represents a tight “fit” between the image of the company and the individual's free-standing value system. According to Dr. Fombrun (4), corporate identity describes the set of values and principles employees and managers associate with a company. A corporate identity captures the commonly understood features that employees themselves use to characterize how a company approaches the work it does, the product it makes, and the customers and investors it serves. Corporate identity derives from a company's experience since its founding, its cumulative record of successes and failures. It describes the future of the company that appear to be central and enduring the employees. On a day –to–day basis, corporate identity appears in the managerial practices managers employ in their dealings internally with employees and externally with other constituents. Every one of us, however, regularly recognizes a company by its name and by the many presentations it makes to describe its actions, its plans and intentions. Those self-presentations can be interpreted more or less favorably and form mental images of the company. More often than not, the image is distorted (a) as the company tries to manipulate its public through advertising and other forms of self-presentation or (b) as rumors develop from the unofficial statements of employees to peers, analyst and reporters. Dr. J. Larking (4) appose the constituents of corporate reputation by setting down fields like Product & Services, Workplace environment, Social responsibility, Vision & Leadership, and Financial Performance. All these are leading to the mobilization of the emotional appeal as first step to the triptych of admire, feel and trust of the internal and external stakeholder group which leads to the topology of reputation. Further to the above is now well understood that an organization does not have a single image or reputation-it has many of them. In fact, (Dr Dowling) (2) each person will form a (slightly) different evaluation of an organization! (Figure What is needed is a way of clustering people in to groups who are likely to hold similar evaluations of the organization, dissimilar from those of other groups. This grouping is based on one of the fundamental organizing principles of modern marketing, namely market segmentation. In a broader sense, stakeholder relationships can be characterized into various emotional types. The type of (desired) relationship a company has with its stakeholders is important because it can have a big impact on the beliefs and feeling (i.e., images) people hold of the organization, and on the fit between these and the free-standing values of the person (and thus their reputation). The different functional relationships people have with an organization will also influence the amount and types of information they want about its activities. Managers need to understand which groups of stakeholders are important to the organization, what type of relationship they have with it, and how these relationships affect their beliefs and feelings about the organization. Research can also be used to profile the different mix of freestanding values each group holds.

## 3. Leadership (CEO)

According to the research “Building CEO CAPITAL 2003” (Advocate / Burson-Marsteller) (5) arise that the relationship between corporate reputation and CEO is straightly involved. The CEO's reputation and prestige affect gravely the actions with which the company is recommended as potential partner, good employer, and good and promising investment as well. Furthermore the CEO's reputation affects strongly the trustworthiness and reliability of the company and consist a holdback to rumors and pressures. A CEO can integrate his/her organization's internal activities and co-ordinate these with its external communications to project a desired image. The models “Pathfinder”, “Commander”, “Change” and “Vision” can be summarized in a table. Nevertheless Dr. Dowling (2) says that promoting the CEO as major attribute of the

organization may, how-ever, be a high risk strategy, especially at the time of succession to the leadership. To avoid the problem of the CEO's style and values dominating the organization, many organizations create a Vision Statement which is independent of any individual.

#### 4. New Executive Role (CRO)

According to Dr. Fombrun, (3) much as companies appoint a chief financial officer to safeguard financial capital, a chief operating officer to monitor operations, and a chief information officer to control and manipulate corporate databases, so might they benefit from appointing a chief reputation officer (CRO) to watch over the company's intangible assets. So he proposes companies to create a new executive role. The CRO's tactical responsibilities would include oversight of pricing, advertising, quality, environmental compliance, investor relations, public affairs, corporate contributions, and employee, customer and media relation. The CRO would act as a corporate guide, working with specialists in each area to help them see the reputation consequences of their decisions. If necessary, the CRO could impose an opinion.

#### 5. Reputation Risk Matters - Crisis Management

Considering reputation risk is not dissimilar to looking at operational or financial risk. Conventional risk management can increase value in different ways –it can reduce a company's regulatory and tax burden, minimize potential for financial volatility, increase debt capacity and help to maintain a particular risk profile that enables investors to assess performance. Traditionally, risk management has not been undertaken in a co-coordinated way across a business. While managers have always been involved in some form of risk management, risk has tended to be dealt with separately. (J. Larkin)(4). An organization in order to manage effectively reputation risk has to put in to practice the following described steps. 1. Establish early warning and monitoring systems–the reputation risk radar, 2. Identify and prioritize risks (and opportunities), 3. Analyze the gaps, 4. Develop strategies and action plans, 5. Implement 6. Keep the radar tuned

#### 6. Qualitative Methodologies Regarding Its Management

(G. Davies et al.)(1) Many companies are reluctant to provide specific examples of what they did to success and track their reputation. Some of them argued that it was too ethereal to measure. Most used one or more proprietary measures of media exposures. (i.e. number of mentions of specific issues related to the business). Few had used any of the market research tools (positioning analysis, multidimensional scaling etc) that could be used to assess and track actual consumer opinion. Measurement appeared to be more *ad hoc*, and issue based. Asking about measurement did reveal much about the origins and function of the responders and their roles. Dr. Dowling (2) stress that the simple truth of the matter is that the only way accurately to gauge what people think of an organization is to ask them. This is easy to say, but often difficult to do, because it takes valuable time, it costs money that has not direct contribution to generating bottom line profit in the period in which it is spent; most organizations will need to employ the services of an outside market research firm to help; and it is not intuitively obvious how one measures elusive concepts such as corporate image and corporate reputation especially year after years. Any of these reasons is generally sufficient to kill the idea of measuring corporate reputation. Fortune measures corporate image across eight attributes such as quality, investment value, community and environmental friendliness. Over the years researchers have discovered that all eight attributes are highly correlated with each other (>0.60) and when factor analyzed, the produce only one factor. The second reason for not using these publicity syndicated measures is that most do not discriminate among the images of different stakeholder groups. Hence they need to be measured separately. The third reason is that they do not distinguish between a measure of corporate image and corporate reputation. The components of image are what a manager can seek to change, while a stakeholder's values act as the benchmark to calibrate the corporate image. Hence, measuring how a company rates on a set of image attributes does not really provide a measure of the reputation, or super brand value of the company. Therein after Dr. Dawling (2) suggests that is necessary to collect as much of the following information as the budget allows. 1) a detailed measure of the images and reputations held by various stakeholder groups, 2) similar although often less detailed, measures of competitive organizations and 3) an indication of the characteristics of an 'ideal' organization in the specific industry. These measures must be designed for diagnostic purposes, not just as a scorecard. So Dr. Dowling gives a measurement process with the following three-stage research approach. First use qualitative research techniques to discover the attributes of corporate image and reputation (free-standing values) and the outcomes relevant for various stakeholders

groups. Second design a survey to have stakeholders rates the company and its competitors. Third, do some statistical number crunching to quantify the corporate images and reputations, and calibrate strengths and weaknesses. The Harris-Fombrun reputation quotient, mentioned by G. Davies et al (1), is a relatively new alternative to the most admired lists. The quotient is calculated from a list of twenty attributes representing six dimensions. In an analysis of the six dimensions, the originators suggest that ratings for products and services, workplace environment, social responsibility, vision and leadership and financial performance each contribute to emotional appeal which in turn creates reputation. Thereinafter the Rotterdam Organizational Identification Test (ROIT) has to be mentioned. The ROIT questionnaire (1) consists of a number of elements divided into six groups. (Van Riel and Balmer, 1997) The key measure is that of the employees identification with the organization, for example their feeling of belonging, acceptance and security. However the ROIT scale does not reveal the nature of corporate identity itself, more the inputs to and the consequences of that identity. G. Davies et al. 2002 appose the Aaker scale (1997). It has to be mentioned as well. Aaker derived a generic scale to measure brand image. She used the personification metaphor and her scale for brand personality consists of forty-two items. These describe the personality of a brand along five dimensions, labeled: sincerity (11 items), competence (9 items), sophistication (6 items), excitement (11 items) and ruggedness (5 items). In her questionnaire respondents were asked to imagine that the product, service or corporate brand being assessed had come alive and to assess its personality on a five points scale from strongly disagrees to strongly agree. In the Greek context, we have the "Reputation Balance" survey for companies and businessmen by Tradelink Reputation Management (8) (journal 2002, 2003), which is based on the same method as that of Harris Interactive. It is an empirical survey that has also been conducted in Greece in the last five years in cooperation with the Reputation Institute of New York and Professor Charles Fombrun. The methodology followed is initially qualitative with personal interviews with opinion leaders, separate group discussions with investing public and public opinion representatives, and then quantitative telephone survey with structured questionnaire to the same categories of public. According to the survey, the structure of corporate reputation is based on six interdependent pillars. Corporate reputation and prestige depend on the good products and services, trustworthiness, social responsibility, financial vigor, good work environment, vision and leadership of the company.

## **7. Study of Millennium Bank Day By Day Practices In Greece Qualitative Methods**

As it has already been mentioned, the purpose of the present survey is principally an effort to show through international literature, articles and the internet, the theoretical approaches with regard to the management of Corporate Reputation. In the second part, we attempted to record the way in which Millennium Bank implements (if it does so), and to what degree, what was recorded as international practices with regard to the management of its reputation capital. It is a qualitative survey that aims, on the one hand, at penetrating into the operation of reputation management, as implemented Millennium Bank, and on the other hand, at comparing these practices to the ones included in international literature. The main advantage and, at the same time, disadvantage of this case study method is the emphasis placed on the detailed study of a limited number of persons, organizations, events or circumstances and the relations between them, which is too restricted to provide sufficient trustworthiness or generalization possibility of findings (Robert K. Yin 1981). As regards the Millennium Bank section, they were performed through open interviews with senior executives on the basis of the questionnaire provided to them to fill out. Moreover, various slides of corporate presentations, photographic material and interviews of the CEO relevant to the matters for development, were provided to us. The questionnaire was developed based on the main modules of the literature review and was divided into four parts including: a) General questions on Corporate Reputation, b) Questions regarding its management by Millennium Bank, c) The role of the leader in the management of Reputation and d) Demographic information. This grouping served to facilitate respondents to fill it out through a logical flow. As for its form, it includes both open- and close-ended questions and used Likert scaling ("Strongly disagree" – "Strongly agree" with five levels), rating scales ("not important" – "extremely important"), even number of answers (balanced) and odd (in order to be given the neutrality option) Finally, according to pre-check, the questionnaire completion time was calculated at ten minutes, while it was in parallel confirmed that it can fulfill the purposes of the study.

## **8. Survey Results**

*Description in what ways reputation affects the day-to-day operation and evolution of your company.* The Bank acknowledges the contribution of reputation both in day-to-day operation and its evolution



diachronically. All responding executives took a clear position with regard to the importance of reputation, as well as the necessity of its management. In line with their particularly converging views, they stated that, thanks to reputation, Millennium Bank enjoys a number of benefits, such as: 1) possibility to hire competent executives, 2) build long-term relations with its customers, 3) create “ambassadors”, which results in increase of its market share, 4) enhance trust relations with the customers/ investors, 5) enjoy positive atmosphere of public opinion, 6) achieve positive publicity as far as the Mass Media are concerned. For all the above, effort is put to reinforce the administration's and the overall personnel's commitment in achieving the highest level of honesty and trustworthiness. In addition, however, to these two elements, one more element constitutes a principal goal of the Bank's communication policy: it is its effort to communicate its ability to provide high standard service and products in all its fields of activity. By adopting the phrase “Millennium Bank, the Bank you have wanted”, it exalts it to its main philosophy, addressing to both retail banking and private or business banking customers, practically embracing the viewpoint of C.J.FOMBRUN (3) (2003) that “the range of works/ services provided by each Bank in the major fields of the sector is an important index of its reputation”.

Grade each of the following measurement criteria of corporate success per their importance degree in your opinion. Use a scale from 1 through 7, where “1=not important criterion and 7=very important criterion, by crossing the respective boxes.

(PROFITABILITY, RETURN ON INVESTMENT (ROI), MARKET SHARE, CORPORATE REPUTATION, SOCIAL RESPONSIBILITY, SUSTAINABILITY, CORPORATE GOVERNANCE, QUALITY OF PRODUCTS / SERVICES)

Elements, such as corporate reputation, return on investment (ROI), market share and quality of products and services have also been ranked at the top importance scale. Of course, this may also be explained if we take into account that the examined company is a Bank and, additionally, a fairly new one in the domestic market. As it is evident, more economic criteria precede, since, for the Bank, success or failure is measured on the basis of the goals set, and the goals of credit institutions refer to and principally pursue the achievement of profitability and claim of the biggest possible market share, based on the offered products/ services.

In addition to the criteria mentioned above, one observes that criteria, such as corporate social responsibility, sustainability and, finally, corporate governance, are considered of lower importance (still above average). *What is the position held by reputation in the company's strategy?* The viewpoint of all three Millennium Bank executives, who responded to this question, coincided. Justifying the contribution of reputation to the day-to-day operation of the company, they consider that reputation management should hold a very important position. And this was supported by choosing from a 5-level scale including Not Important \* Slightly Important \* Important \* Very Important \* Extremely Important. Such a thing, certainly, involves the development of a special Corporate Reputation Management Program, provision and disposal of a relevant appropriation and the existence of an executive charged with the duty of reputation management. In reality, this is partly provided for. Reputation management in the broader sense is exercised by the CEO and Managing Director, assisted mainly by the Communication and Public Relations Manager, as well as by certain members of the Board of Directors. It is thus obvious that there is no provision for a respective program, appropriation and executive. In other words, except for the actions of the CEO and Managing Director, the procedure mainly passes through the activities of public relations. Another element that should be mentioned at this point is the establishment and operation of an autonomous Bank Compliance office. If one wants to define the operation field of the specific department, one would use the definition included in the official handbook of the Bank, which notes that “the mission of the department is to monitor any service and product, prevent and encourage compliance of any action (transaction and/or customer relation) of both the clientele and personnel at all levels, which may cause financial risk or afflict the Bank's reputation”. The aforementioned department, in parallel operation with the Internal Audit department, is directly accountable to the CEO and Managing Director of the Bank, as well as to the respective agency of the parent company in Portugal. Characteristic is the fact that prevention and reputation management measures are established through many international organizations of the financial sector, such as, for example, the FATF (Financial Action Task Force), the United Nations, etc., and are adopted by the Greek institutional bank system, which fully embraces their professions through measures, such as modification of legislation, as well as issuance of circulars and directives by the Bank of Greece. All these measures aim at the Bank's effort to put an end to illegal actions of employees or customers, which may afflict its reputation and stigmatize it to an extent that possibly entails penalties by the local audit authorities. (e.g. BoG, the body under article 7, consumer

organizations, etc.) Taking into account its main mission, which is synonymous to top level bank services, Millennium Bank tries to guarantee and provide services with the maximum level of trustworthiness and honesty. Studying the Regulatory Compliance handbook of the group, we notice that, in addition to the instructions on prevention of reputation loss, it also includes handling instructions, in case reputation is at risk from high rank public figures (politicians), natural or legal entities, with case-by-case analysis of the natural persons' legal personality (e.g. S.A., limited liability company, foreign companies, off-shore companies, etc.) The Regulatory Compliance department constitutes another reputation management tool, which is practically led by the CEO. In this context, we could say that the Bank, without integrating into its formal strategy the organization of a mere Corporate Reputation department in the broader sense, by maintaining the Regulatory Compliance department, it draws up a specific budget in order to have one more reputation loss prevention agency in place. Particular attention is given through the establishment of special policy regarding recruitment and training of executives in order to achieve the relevant theory that assesses personnel as one of the major stakeholder groups. The application of this policy concerns a) separation of professional growth from work position, b) Association of hierarchical level with a skills' profile and c) reward of employees who have successful experience in various fields of the bank. The job rotation policy is implemented. Special induction courses are provided to new partners with a view to have them integrated into the same culture, but special attention is also given to continued training through conduct of seminars and financing of post-graduate courses. Special importance is also given to mentoring as a tool mobilizing not only the employees' mind but also their emotions. The communications directorate, through a third-party company conducts particularly analytical surveys with regard to competition, awareness and recall of the bank in the customers' memory, repercussion of the slogan, as well as other components of corporate image, but also to the customers' life style. Special attention is given by the communication directorate to the promotion of "corporate citizen" through a series of humanitarian events and sponsorships. A systematic effort by the quality department to measure and assess data stemming from questionnaires of both customer public and the internal customer, i.e. the personnel, has been observed. These questionnaires are dispatched through a specific policy and are distinguished in those concerning Retail Banking, Business Banking & Private Banking. Each of these is further distinguished as to the period of dispatch and the object they wish to explore. To the answer what factors affect the formulation of corporate reputation, the executives place at the highest scale criteria such as honesty towards stakeholders, ethical behavior, work environment. The second scale included the criteria of social responsibility and support of causes of welfare. The following criteria group placed the greatest importance on financial vigor, innovation, technology, excellent services' provision and charismatic leadership. The respondents coincided as to the stakeholders' common features and the extent to which these can affect the bank's reputation. The most important ones are personnel, leadership, shareholders and customers, followed by NGO's, the government, competitors, mass media, local community and pressure groups, while the last position was held by suppliers. As a corporate reputation management procedure, it is clear that excursive efforts are made by the department involved each time under supervision of the head of the specific directorate each time. The building of corporate image and identity towards the public is mainly performed by the communication directorate mainly on the axes of advertisement (30%), interviews / articles / mass media (25%), sponsorships (20%), contacts with opinion leaders / economic analysts (10%), participation in business conferences (10%) and organization of events (5%). With reference to the internal public, a main role is played by the HR department in cooperation with the Quality department. Main actions include open informational discussions at the workplace (35%), personnel events (30%), the publication of a journal and the provision of a corporate internet television channel (Millennium Bank TV) (30%), internal direct mails (5%) and discussion with trade union representatives (0%) -since there isn't any Union-. With regard to the impact of leadership on the shaping of corporate reputation, the executives see in the face of their CEO a person that inspires, shapes, actively and unfailingly influences the bank's reputation with regard to both the external and internal public. Assisted by the Board's members and the Communication Manager, he is directly involved also in the treatment and management of eventual crises. The following criteria, that a leader should possess, were mentioned by executives as the most important: 1) Crises management ability, 2) Trustworthiness, 3) To have and impart vision, 4) Prudent resources' management, 5) Character, 6) Interest in the customers, 7) Maximization of profitability, 8) His salary should be commensurate to his achievements. At a second level, the criteria stated were as follows: 1) Ability to attract top quality executives, 2) Respectful behavior towards employees, 3) Ability to balance the stakeholders' needs and 4) humanitarian action.

## 9. Conclusions

Although the concept of Corporate Reputation Management is a relatively new concept that has not been yet integrated into the vocabulary and practice of most Greek companies, in Millennium Bank it constitutes a field of intense examination and search. The contribution of good reputation to the day-to-day operation and growth of the company (in operational and financial terms) is great, but hard to express in quantitative terms and, thus, the use of reputation as a measurement criterion of corporate success is used less often. However, organized efforts are observed, which are, nevertheless, distributed in individual responsibility departments, which, in their turn, process data, such as customer satisfaction, awareness or penetration of the Bank communication, etc. In this way, departments, such as the HR Directorate, Quality, Communication, Regulatory Compliance, Internal Audit, etc. are involved in the collection and process of data relative to corporate reputation, the CEO and Managing Director of the credit institution being the final recipient. A corporate image shaping and cultivation and enhancement of corporate identity program are followed, as well as measurement and evaluation thereof, although on an individual basis. A reputation management program is implemented with continuous and systematic study of the external and internal environment, setting of goals, strategy and programs addressed to each stakeholder group, if deemed necessary. As far as the role of leader is concerned, in Millennium Bank it is considered of great importance – and for a reason – if one considers that, especially in the Greek business sector, the faces are widely known and are often publicly criticized. Moreover, through study of the literature, we concluded to the following typology of companies in terms of the theoretical and practical management of corporate reputation: a) Active supporters of Reputation Management (who have developed and implemented a CRM, hold a position of CRM responsible in the organization chart and provide for a special appropriation in the budget), b) Potential supporters of Reputation Management (recognize or thus support the meaning of CRM, but remain idle. They usually adjust to the actions of the environment, rather than exercise active CRM), c) Unconscious supporters of Reputation Management (invest in actions favoring reputation, without realizing it. This happens randomly and excursively), and d) Indifferent (consider that reputation is anyway produced by other factors, e.g. economic performance) and assume no initiatives concerning CRM. On the basis of the above typology, Millennium Bank is listed in the first group. It can be characterized as a company that has developed and implemented a Corporate Reputation Management program. Nevertheless, it has not included in its organization chart a CRM responsible, in the sense of the examined literature and no appropriation is provided for the said position and the respective duties, but only for the individual departments that are excursively involved in the reputation issue.

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# UTILIZING CONSENSUS MODELS IN DECISION MAKING. A PROCESS FOR DESIGN AND DEVELOPMENT OF A PUBLIC ADMINISTRATION REFORM SYSTEM: METHODOLOGY, ASSESSMENT, CONCLUSIONS AND PROPOSALS

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## Abstract

*The increasing complexity in structures and operations of the Greek Public Administration Reform (G.P.A.R). system with "deterministic " and stochastic characteristics demands the application of model that would portray the dynamic elements and interpretive relationships of this system.*

*In this article, we introduce a new approach to the description, analysis and synthesis of a public administration reform system. Through consensus models of decision making we try to develop methods for idea generation and classification in order to eliminate barriers that could impede the system success in relation to his vision, mission and objectives.*

*Given, the increasing complexity in the system structure and functions the consensus methodology that we develop in the article constitutes an essential problem-solving approach as far as design, control, co-ordination and reengineering concern. As systems become increasingly complex, the need for such techniques of analysis becomes more intense. In response to this need, system thinking theory through consensus models has developed to incorporate both the deterministic and probabilistic characteristics of a social organization.*

## Περίληψη

Στο άρθρο αυτό, αναπτύσσεται η μεθοδολογία αντιμετώπισης πολύπλοκων προβλημάτων μέσω συναινετικών προτύπων (consensus models) γένεσης, κατηγοριοποίησης, και πολυεπίπεδης δόμησης ιδεών και θέσεων για την άρση παθογόνων καταστάσεων που δυναμιτίζουν την δομή και λειτουργία των κοινωνικών συστημάτων. Εφαρμόζεται, ένα πρότυπο συμμετοχικής μεθοδολογίας λήψης αποφάσεων που στοχεύει στην υπέρβαση των εμποδίων για την υλοποίηση του οράματος, της αποστολής και των στόχων της κοινωνικής οργάνωσης .

Δεδομένης, της αυξανόμενης πολυπλοκότητας τόσο στα συστατικά μέρη του συστήματος όσο και στην δυναμική αλληλεπίδραση τους, το συμμετοχικό πρότυπο λήψης αποφάσεων του άρθρου μας, αποτελεί απαραίτητη μεθοδολογική προσέγγιση για τους εμπλεκόμενους κοινωνικούς φορείς με τομείς ευθύνης τη σχεδίαση, τον έλεγχο, το συντονισμό και την αναμηχάνευση (reengineering) οργανώσεων του δημόσιου και ιδιωτικού τομέα.

**Keywords:** Decision-making, nominal group technique, interpretive structural modeling

JEL: C92;C93;L38

## 1. Introduction

The increasing complexity in structures and operations of the Greek Public Administration Reform (G.P.A.R). system with "deterministic " and stochastic characteristics demands the application of model that would portray the dynamic elements and interpretive relationships of this system.

In this article, we introduce a new approach to the description, analysis and synthesis of a social system. Through consensus models of decision making we try to develop methods for idea generation and classification in order to eliminate barriers that could impede the system success in relation to its vision, mission and objectives.

A hallmark of the methodology is the formulation of its scientific foundations, its use of structure and its constant empirical testing in the arena of practice.

The study presents guiding principles , for conducting dialogue in complex situations and their implications in terms of:

- Ashby's Law of Requisite Variety;
- Miller's Law of Requisite Parsimony;
- Boulding's Law of Requisite Saliency;
- Peirce'n Law of Requisite Meaning;

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- Tsivacou’s Law of Requisite Autonomy in Distinction Making;
- Dye’s Law of the Requisite Evolution of Observation

The embodiment of these six laws within a designing methodology which aim to reform and improve the Public Administration in Greece, supports a disciplined approach to dialogue, called “*dialogue-ware*”.

It enables collaborative interaction among participants.

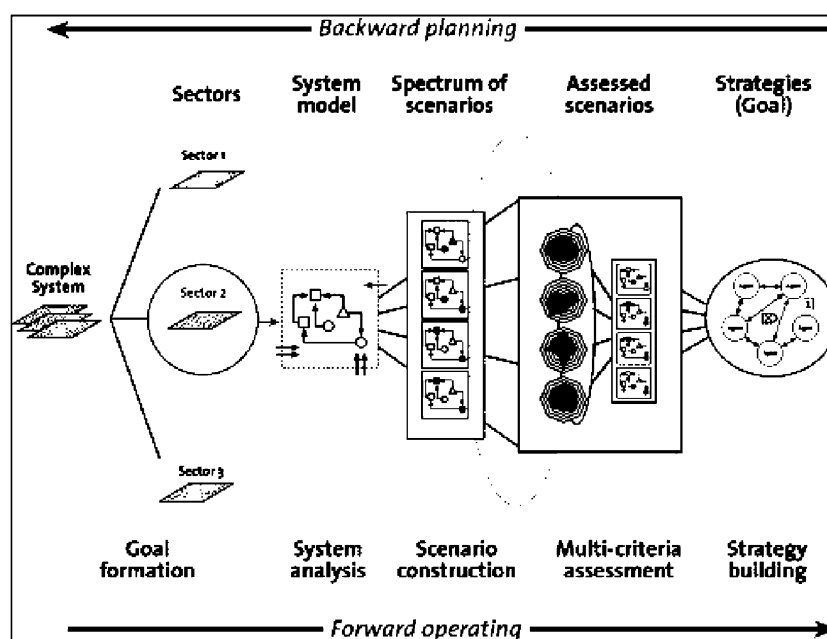
It enables participants to generate and clarify a large number of ideas in relation to the emergence of a situation in highly complexity-we call *problematique* . On the *problematique* , which is the Public Administration Reform system , the participants have designed an action plan, which is co- owned by them because it has been co-created be them.

Our **Greek Public Administration Reform (G.P.A.R)**. system originates proposals and design concepts aimed at changing existing methods and procedures or reforming the system itself. It articulates objectives of the system, to furnish the rationale for action and guidance for implementation.

By making a maximum effort to anticipate key performance results, it seeks to make present actions meet both present and long-range system goals grouped into three clusters: a) employee results b) citizen results and c) society results

The consensus methodology we have incorporated, enables constructive dialogue among participants, encourages the huge amount ideas generation in the context of designing both alternatives and action plan in response to a complicated situation.

It seeks to embody a vision into the Greek Public Administration through a spectrum of proposals, strategies and action plan within specific time , cost and quality dimensions..



The complicated situation which is the article main theme , refers to constructing a methodology which will be the cornerstone for reforming and improving public administration in Greece.

In lieu of designing a methodology as a device for **Greek Public Administration Reform (G.P.A.R)**. system, we developed the following four stage approach

## 1. STAGE ONE : ELUCIDATION

1.1. Generation and clarification of terms in response to the triggering question :

‘... .. what are the critical current and anticipated issues(= obstacles, barriers) to be shortcomings and weaknesses in achieving civil service vision, mission, goals, strategies ?.....’

A list of 268 proposed issues is shown in TABLE 1 : Unstructured List of issues to be addressed for achieving civil service vision, mission, goals, strategies

1.2. Classification of issues into affinity clusters

As a result of the dialogue the participants produced a pattern showing the classification of the issues into five affinity clusters.

- CLUSTER #1 : Leadership
- CLUSTER #2: Strategy & Planning ( Primary Design-Planning-Analytical Design)
- CLUSTER #3 : People ( Human Resource)
- CLUSTER #4 : Partnerships & resource ( citizens relationships, innovations, best practices utilaztions)
- CLUSTER #5 :Process (service performance, change management)

The generic question used for implementing step #2:

*‘.....in the context of civil service vision, mission, goals, strategies does:  
[issue-x]  
have significant attributes in common with  
[issue-y].....’*

The issues classification into five affinity clusters are shown in TABLE 2

These five clusters are considered as *enablers* (#1,#2,#3,#4,#5) in producing *results* also classified into four clusters (#6,#7,#8,#9) as depicted graphically in Figure 1 and 2

**Figure 1 : A diagnosis and improvement actions against nine clusters of issues.**

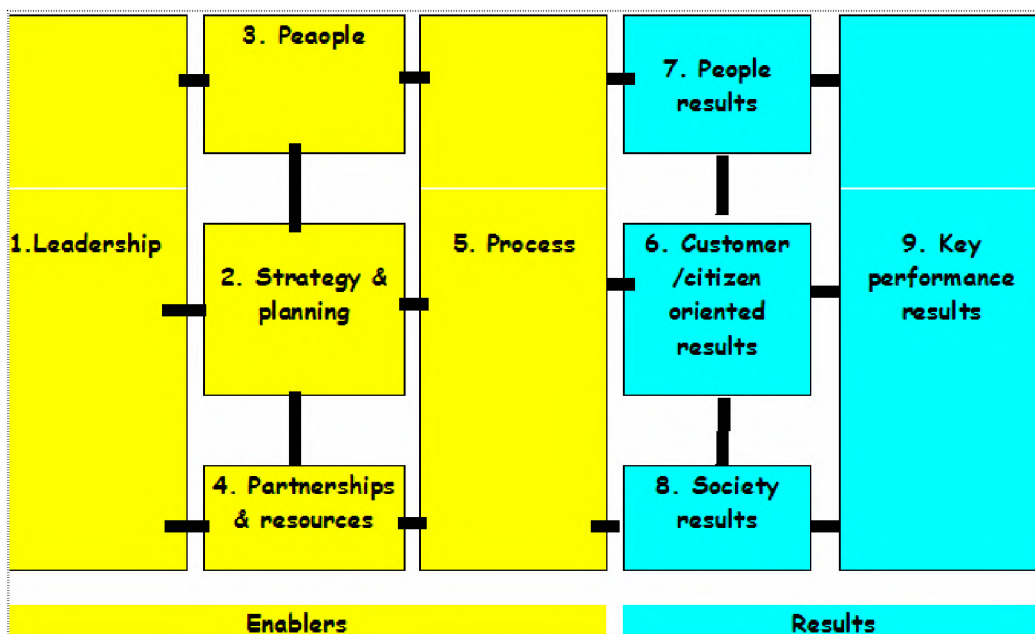
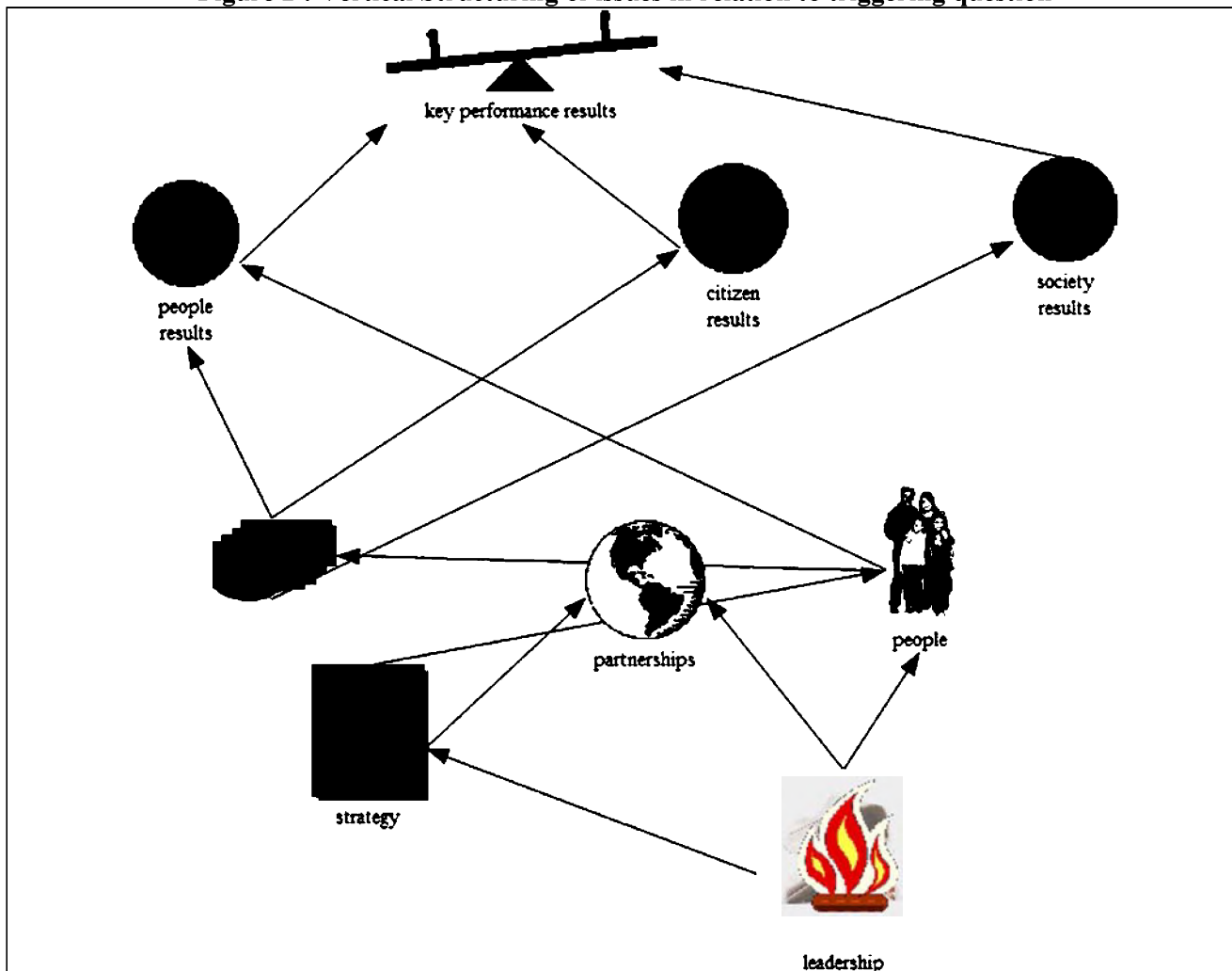


Figure 2 : Vertical Structuring of issues in relation to triggering question



## 2. STAGE TWO : DESIGNING ALTERNATIVES

In the design stage, the participants constructs alternative scenarios for the resolution of the *problematique* described in our carefully framed '*triggering question*'

### 2.1. Generation and Clarification of Options (=proposals)

The 100 options proposed by the participants are shown in Table 4: Unstructured List of Options for Resolving the *civil service vision, mission, goals, strategies* problematique

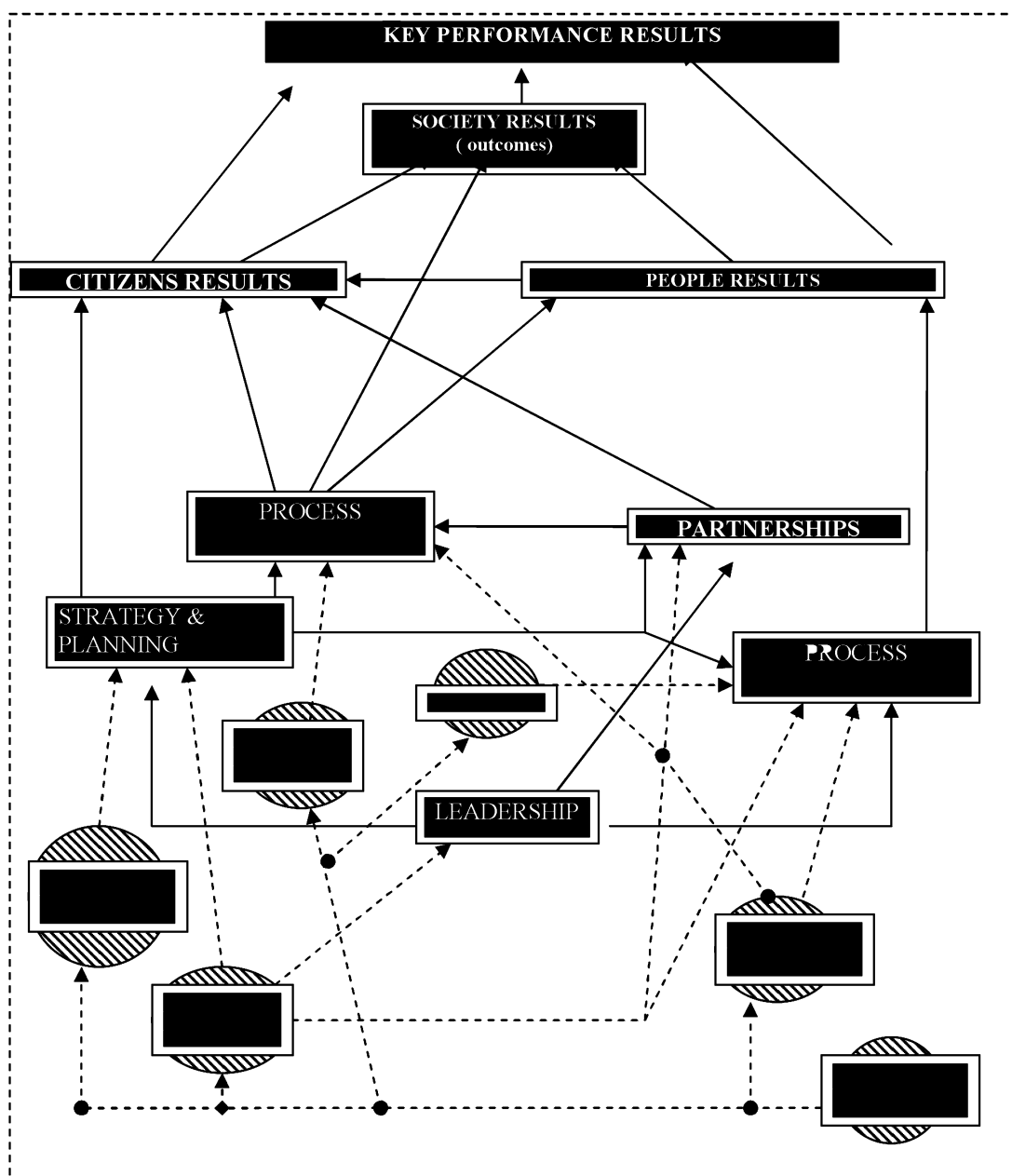
### 2.2 Classification of Options through Option Field Method (O.F.M.)

The six clusters of Options(=proposals) for Resolving the *problematique* are shown in Table 5: Options Classification for Resolving the *problematique*.

Table 5: Options ( proposals) Classification for Resolving the problematique.

- 
- CLUSTER #1 : 'Value' system
  - CLUSTER #2: Structure
  - CLUSTER #3 : Staffing
  - CLUSTER #4 : Resource Utilization
  - CLUSTER #5 : Methods and Procedures
  - CLUSTER #6 : Monitoring & Performance evaluation
- 

In Figure 6 we depict the Proposals for Resolving Barriers in relation to the *problematique* which is to achieve civil service vision, mission, goals, strategies



### 3. STAGE THREE : CHOICE

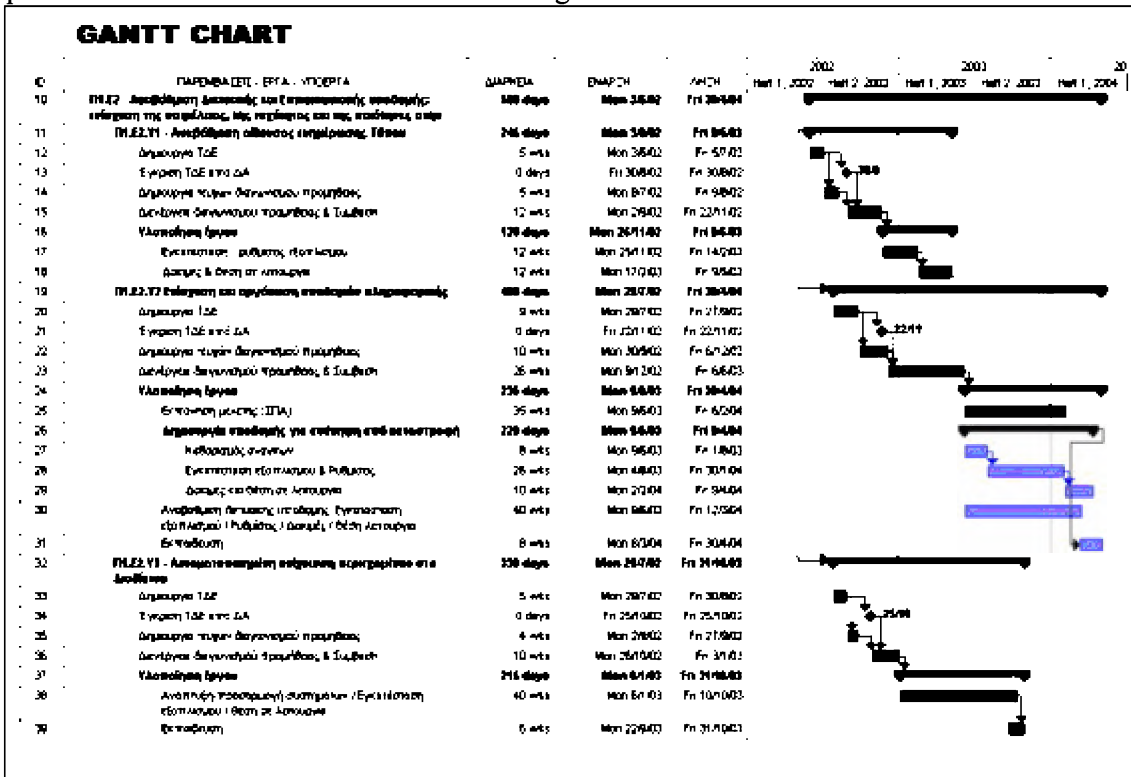
During this stage we evaluate the proposed alternatives based on the following criteria:

- Participation
- Transparency
- Consensus orientation
- Responsiveness
- Equitability and inclusiveness
- Effectiveness and efficiency
- Government effectiveness
- Regulatory quality
- Rule of law
- Control of corruption
- Voice and accountability
- Long-term pay-off
- Competitive advantage
- Productivity gain
- Cost saving



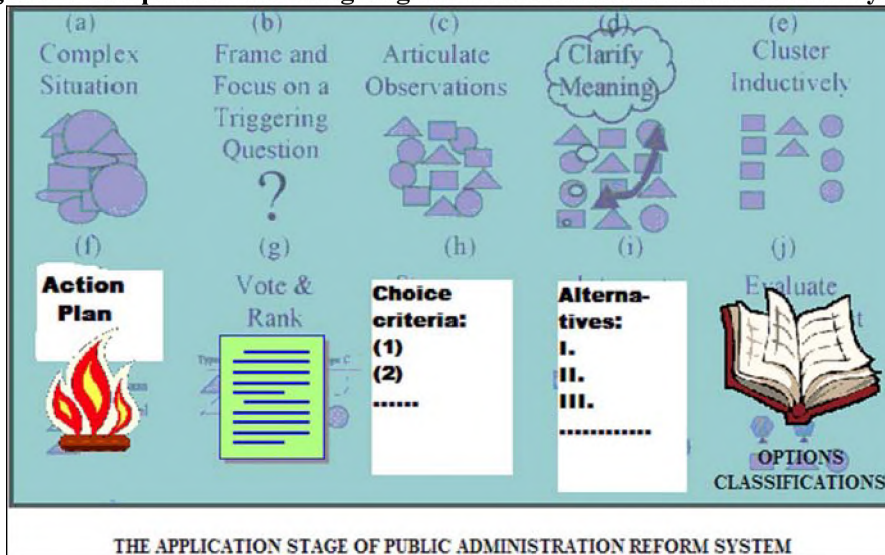
### 3. STAGE THREE : ACTION PLAN

Having selected the preferred alternatives, we transform the alternatives into project management task sequence for actions. The detailed blueprint for action is depicted by employing project management techniques such as : GANTT charts for time scheduling and PERT/CPM for resource utilization.



Our process in Designing the Public Administration Reform system is briefly depicted in Figure 7

Figure 7: The process for Designing the Public Administration Reform system



Given, the increasing complexity in the system structure and functions the consensus methodology that we develop in the article constitutes an essential problem-solving approach as far as design, control, co-ordination and reengineering concern. As systems become increasingly complex, the need for such techniques of analysis becomes more intense. In response to this need, system thinking theory through consensus models has developed to incorporate both the deterministic and probabilistic characteristics of a social organization.

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# ANALYZING THE RELATIONSHIPS AMONG INNOVATION ACTIVITIES AND ORGANIZATION INNOVATION

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## Abstract

*In this paper the effects of one of the most important innovation activity, the Idea Management, to the innovation performance are analyzed. These effects are quantified in specific business sectors. While it is obvious that organizations should be able to gather and evaluate ideas from all employees and in a systematic and flexible way, the exact influence in company innovation and performance cannot be easily be modeled and measured. Different organization parameters and data related to idea management and organization innovation are analyzed. The output of this analysis is the relationship between the managing of the ideas of employees and the relevant Innovation Key Performance Indicators (KPIs).*

**Key words:** Innovation; Knowledge; Key Performance Indicators (KPIs); Knowledge Management; Innovation Management; Idea Management.

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## 1. Introduction

Our society in 21st century has been transformed from Knowledge to Innovation society. According to the definition of innovation of OECD in the Frascati handbook (OECD, 2002), it is “the transformation of idea in marketable product or service, functional method of production or distribution - new or improved or still in new method of benefit of social service”. Innovation concerns the use of knowledge for the creation of new ideas that leads to products and services that can be successfully sold in the market or in new enterprising activities that improve the operation, the flexibility and the adaptability of enterprise to the continuously changing conditions of market. According to Intel’s CEO Paul Otellini, “innovation is to give customers new reasons to buy.”

Since products’ life cycle decreases progressively, enterprises are forced to constantly innovate. Nowadays, production is not characterized any more by mass production but by flexibility, while the innovation becomes the more important parameter (Afuah A, 2003). Increasingly, the new core competences are creativity, imagination, and, above all, innovation. Innovation Management is emerging as a new discipline for managing the creation of innovative products and services and introduce them to market. It involves forming organizational structures and systems that encourage creative solutions to difficult problems. Furthermore, innovation appears to be the only way for survival and growth of a company (Cooper, 1999). Innovative companies can achieve bigger market share, higher productivity, higher growth rates and of course profits (Geroski, P. and Machin S, 1992, Griliches 1990).

Innovation and Creativity should constitute the basic enterprise processes that can combine different activities, from research to customer support, for a common objective, a successful commercial product. The company executives’ capabilities and experiences, the innovation and creativity possibilities, the most optimal enterprising practices, the patents, the knowledge that the enterprise has accumulated from its suppliers and its customers and the knowledge gained by the competitors, constitute its most precious resource. The innovation should constitute the key component of the strategy of a modern enterprise, the

DNA of its daily operation and culture. Almost 30% of total sales of innovative 3M derive from relative new products, i.e. from products that were introduced in the market during the last 4 years.

According to R. Solow, (Solow, 2004) recipient of the 1987 Nobel Prize in Economic Sciences, innovation is the *X Factor* and the aim of corporations should be to create innovations that give them a sizeable and long-term competitive advantage. That advantage is produced through the creation and development of more complex innovations that embrace more than a single **dimension of innovation** i.e. more than just a new design, package, or marketing technique. To achieve this, and to maximize the innovation market impact, each opportunity should be “expanded” to several different innovation dimensions to create something that is harder for the competition to copy and attack.

Innovation does not only concern companies of high technology and the introduction of new products/services that satisfy real customers’ needs is a more important innovation factor itself than the hi-technology, the research and the growth. It is not necessarily synonymous with (high) technology but concerns all stages of new product development, including Opportunity Identification and Selection, Concept / Idea Generation, Concept / Idea Project Evaluation, Research & Development and Market launch. Organizations are competing based on the speed at which they can create, develop and implement ideas for new products and services.

Due to the importance of innovation, they are executing a number of innovation activities supported by IT systems like *Creativity Support Systems*, *Brainstorming Support Systems*, *Inventive Problem Solving Systems*, etc. The analysis of relationships between innovation activities and innovation performance and organization performance is an open research issue. In this paper the effects of one of the most important innovation activities, the Idea Management, to the innovation performance are analyzed. The focus is on specific business sectors and it analyzes different organization parameters and data from questionnaires related to idea management and organization innovation. It uses different approaches including statistical methods and data mining techniques. The output of this analysis is the relationship between the managing of the ideas of employees and the innovation KPIs. The factors that can have an impact to this relationship, like organization structure and culture are evaluated.

The rest of this paper is organized as follows: In section 2 we describe the major Innovation Activities and the related Information Systems. In section 3 we provide the major Innovation Key Performance Indicators (KPIs) that will be used in our analysis. In section 4 we describe in more detail the Idea Management Innovation Activities since their impact on Innovation KPIs will be explored. In section 5 we analyze the effects of Idea Management Systems to Innovation KPIs. Finally in section 6, we provide certain conclusions and directions for future work.

## 2. Innovation Activities Support Systems

Due to the importance of innovation in our era, organizations should execute innovation activities including knowledge management, and generation, collection, organization, distribution and evaluation of ideas. Innovation Activities can support all the phases of innovation cycle: *Idea Generation*, *Research on the technology used to develop the idea*, *Development*, *Technology Transfer* and *Commercialization*. Particular emphasis should be given to the management information systems that support Innovation activities and help companies create more and improved ideas.

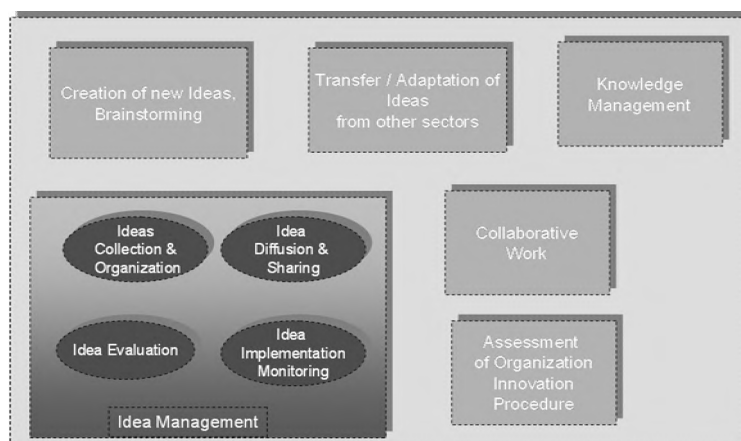


Figure 1: Important Innovation Activities

The main categories of innovation activities are (Figure 1):

- Creativity Support and Brainstorming
- Discovery, transfer and customization of Ideas from other sectors
- Idea Management
- Knowledge Management & Collaborative Work

These activities can be supported by Information systems:

1. *Creativity and Brainstorming software support tools*, help companies create more and better ideas. They operate as catalysts, allowing human brain to “externalize” its creativity. Some of these tools ask questions, while others are based on the use of a variety of relevant as well as parallel thinking techniques. Additionally to the creation of new ideas, they can support definition of company’s priorities as well as organisation of the best ideas. A classical Brainstorming technique is the *Mind Mapping* that allows the visual representation and arrangement of ideas and their inter- relations.

2. *Systems supporting the Discovery, transfer and customization of Ideas from other sectors*: They consider that somebody, in another place of the planet has already resolved your problem or another one similar with yours, likely in other field. Creativity means you find that solution and you adapt it in your running problem. This approach is used widely today for the development/improvement of existing products, services and processes, while it saves time in order to create and develop new innovations and inventions. *TRIZ theory* is based on the analysis of the creative solutions via older problems and is applied for the continuous improvement as well as for the development of new products and services, (Smith L. 2001). The research for TRIZ method was implemented in the former USSR from 1946 until 1985 and is continued in world level from then (Raskin A. 2003, Slocum et al, 2003, Fortune, May 16, 2005, Kellner T. 2005) .

3. *Idea Management Systems* support the process of gathering and evaluating ideas from all employees in a structured way, with a goal of selecting the best ideas with the greatest potential for implementation. Companies are competing on the speed they discover, develop and materialize ideas on new products and services.

4. *Knowledge Management Systems* organize the unstructured enterprise data and information into knowledge that is actionable and provides business value. They help organizations to capture, share and leverage their collective knowledge, expertise and wisdom and consist of the following components: Collaboration, Content Management, Search, Taxonomy management, Business Process Management, Business Intelligence and Portal.

### 3. Key Performance Indicators for Innovation

You cannot manage what you do not measure, as the old management adage clearly states. The difficulty, when it comes to innovation, is that its nature and innovations complexity, does not allow direct measurements (like cost per hour etc) so it is approached in an indirect way. *Key Performance Indicators (KPIs)* represent a set of measures focusing on those aspects of organizational performance that are the most critical for the current and future success. They tell what to do in order to increase performance dramatically (Parmenter, 2007). Companies are dynamic organizations interacting with their environment, which has a great complexity to analyze and manage. Never the less, all companies and production system on a standard input must have a standard output, so during sort term periods we could say that all systems are deterministic (with a standard deviation +/- X%). So, actually, we can have a “picture” of an organization for a specific time frame (year when talking about balance sheet, second when we monitor the changes of a stock value).

In order to measure innovation performance we use *Innovation Key Performance Indicators (Innovation KPI)*. Table 1 presents a series of well-tested and established Innovation KPIs, along with our comments and improvements. These KPIs are used in our work to evaluate the importance of innovation activities to the innovation performance.

No	Innovation KPI	Description
1	Revenue growth due to new products or services	The revenue growth due to new products and services is a strong indicator by which we can assume that an organizations new products and services have been approved by the organizations market and the organization has outpaced its competitors.
2	Customer satisfaction with new products or services	Customer satisfaction is a very important key indicator. Nevertheless, it should be supported by a sub-indicator, the customer reference percentage, meaning the ratio of the satisfied customers that suggested our products or services to new customers
3	Number of ideas or concepts in the pipeline	The new ideas soon to be evaluated and realized. The average time before realization or rejection should be also taken under consideration
4	R&D spending as a percentage of sales	How much strongly an organization believes that innovation is the key.
5	Percentage of sales from new products/services in given time period	Would the new products or services make the majority of the total sales? How important are the new products or services. Pretty much an ABC analysis for our innovations.
6	Number of new products or services launched	In combination with indicator number 3, this can also be negative, meaning that if from an organization only one idea occurred, the idea's realization was the organization's only choice.
7	Return on investment (ROI) in new products or services	How fast did the organization get the money back from its innovations.
8	Number of R&D projects	Can show organisations' will to innovate.
9	Number of people actively devoted to innovation	Number of creative employers devoted to innovation, working in any department of the organization
10	Profit growth due to new products or services	More focused indicator than the first one, meaning that new products and services have really gave advantage to the organization along with money for R&D.
11	Potential of entire new product/service portfolio to meet growth targets	The potentiality is always estimation. Nevertheless, when there is a possibility that the entire portfolio will meet growth target, that means that in the portfolio there are some "star" products or services that can meet growth sales for a very long period of time.
12	Changes in market share resulting from new products/services	The diffusion of organization's innovation in the market. Actually, the diffusion of an innovation within the organizations boundaries should also be a factor
13	Net present value (NPV) of entire new product/service portfolio	The NPV of the entire portfolio shows the total present value (PV) of a time series of cash flows. It is a standard method for using the time value of money to appraise long-term projects.

Table 1: Important Innovation KPI

#### 4. Idea Management

In the 1990s a number of approaches were developed for better collection and management of ideas, including "innovation councils" (cross-functional bodies enabling cross-business / function / geography decision making and coordination.) and innovation "cross-functional teams". With these developments, the modern Idea Management System was born. In recent past many large companies relied upon suggestion box systems to gather ideas from employees. Suggestion box was originally a physical box, with a slot in the top, that sat in a suitable location in a building and people dropped their written idea suggestions into it. The ideas periodically reviewed by a designated person, typically a member of the administrative staff or the owner of the business or manager of a business unit. But these systems because they weren't usually focused on specific business goals, they tend to attract a small volume of low-quality ideas. Moreover, once an employee submitted an idea, s/he usually never learned what became of it. As a result, employees often would no longer contribute their ideas. Moreover these systems made it hard to ensure that all ideas were evaluated on a timely basis and a consistent manner.

In parallel with the use the Suggestions Box for idea management, companies such as Imaginatik (1994) and General Ideas Software (now BrightIdea) (1999) entered the market of Idea Management

Information Systems, allowing companies to capture and process ideas through dedicated software packages that allowed managers to organize and run 'idea campaigns.'

**Idea Management** currently can be supported by **Idea Management Technology**, which is a new type of enterprise software tool that can support the effectiveness of the innovation strategy. These applications are often Web-based and help companies discover focused ideas from the all employees (despite their geographic place) and gather them on a central online database. Idea management systems provide also structured activities for the evaluation, sharing and dissemination of ideas and support the recognition and remuneration of employees that offer the best ideas. They can include knowledge management components that help employees have quick access in knowledge and experience that are diversified in the whole organization to help them solve an emerging problem.

The new product development process suggests 7 stages of development of a new product (or service): (1) Idea Generation, (2) Idea Screening, (3) Concept Development and Testing, (4) Business Analysis, (5) Beta Testing and Market Testing, (6) Technical Implementation and (7) Commercialization. Idea Management software products typically focus on at least the first two stages, with some products extending into the third and fourth stages. Typically the fourth through seventh stages are handled by other organisational systems outside the Idea Management System.

### 5. Analyzing Organization Innovation through Idea Management Systems

Organizations should use Idea Management Technology and Systems in order to efficiently exploit the creativity of employees. While it is obvious that organizations should be able to gather and evaluate ideas from all employees and in a systematic and flexible through Idea Management System, the exact influence in company innovation and performance cannot be easily modeled and measured.

**Idea Management Systems** can help organizations to focus the creativity and ideas of employees on specific business issues. This tends to result in a larger quantity of very high quality ideas. Also, because today's idea management systems are powered by databases, setting up and managing a closed-loop evaluation process -- which automatically reminds evaluators of upcoming deadlines and unevaluated ideas -- is much easier to set up and administer. They also share some common roots with knowledge management systems. But many companies that have implemented knowledge management systems are finding it hard to measure their bottom-line impact. Since they track ideas from inception to implementation, idea management systems make it much easier to track key metrics as the ones defined in section 3.

Idea management tools offer a number of compelling benefits to companies of all sizes, and collect ideas from all areas of the organization, not just specialized departments like R&D and marketing. They focus employees' creative efforts around specific organizational goals and objectives. Research by two leading suppliers of idea management systems (*Imaginatik* and *General Ideas*) shows that when employees are asked to generate ideas or suggestions for a specific business problem or objective, the quantity and quality of ideas tends to increase significantly. They encourage employees to capture all of their ideas. In most types of businesses, employees rarely capture their ideas, and most of them are lost forever. Idea management systems help employees to share ideas, comment on, add to and further improve each others ideas, and acquire knowledge by viewing others' ideas.

By placing ideas in a shared repository, idea management systems promote greater transparency. Employees can see the outcome of all of the ideas they have submitted, which increases their enthusiasm for participation in idea campaigns. Also, these database-driven tools make it easier to measure how much each implemented idea has contributed to the firm's bottom line. This makes it easier, in turn, to reward employees who have contributed winning ideas. Idea management systems help companies to share best practices. For companies that have multiple offices or locations, idea management systems enable them to quickly and cost-effectively share ideas and best practices that have been used successfully at one location with other locations. This allows them to multiply the bottom-line benefit of a single cost-saving idea many times over. Web-based idea management systems can be accessed via any computer with an Internet connection, from anywhere in the world, vastly simplifying the transfer of valuable ideas and best practices across geographical and organizational barriers (*Idea Management Resource Center*).

They help companies to take advantage of the best ideas and increase their time to market. They do so by providing a structured process for evaluating ideas and selecting the best for implementation, and by providing mechanisms to make sure that all ideas are promptly reviewed and evaluated. They not only

provide a toolset for developing new product and service ideas, but can also have greater results from cost-reduction. Outside partners, such as suppliers and partners can also contribute ideas.

In our initial research we analyze the effects of one of Idea Management to the innovation performance.

We focused on private and public organizations in Greece from the service sector. As a first step we have tried to identify the level of idea management performed in the organizations. The following parameters were examined:

- Whether organizations have formal procedures to collect the ideas of their employees
- The effects of organization structure to idea management. How different groups, departments and divisions communicate and change ideas. There is a practice the departments or divisions of the organizations (that can be located in different areas) to operate like silos, rarely sharing information and ideas.
- If the climate of the organization facilitates employees to discuss and share their ideas (informal exchange of ideas)
- From whom and how new ideas are created, screened and evaluated.
- If there is a culture in the organization for idea sharing and if there are incentives for the employees with the best ideas
- The effects of the *suggestion box systems* or the *suggestion e-mail* used by some companies to gather ideas from their employees.
- The companies that are using Idea Management Information Systems and how they are trying to exploit these systems.
- How the companies that are trying to gather ideas from outside partners, such as customers, suppliers, dealers and joint venture partners.

The second step was to collect data in order to calculate the most important Innovation Key Performance Indicators (KPI) of these organizations as described in section 3. After selecting information about the level of Idea Management performed in the organization and calculating the most important Innovation Key Performance Indicators we tried to link the organization Idea Management approach to these indicators.



<b>Decision</b> (mandatory)	<input type="radio"/> Implement - firm plans <input type="radio"/> Implement - with modifications <input type="radio"/> Implement - some plans <input checked="" type="radio"/> Implement - under certain conditions <input type="radio"/> Not Implement - except under conditions <input type="radio"/> Not Implement <input type="radio"/> Thank you for the Contribution
<b>Message to the Idea Author</b>	Your idea will have a strategic input to our competitive situation. The Innovation Council will work out a reward for your achievement
<b>Benefit Type</b> (mandatory)	What is the main type of Benefit of this idea: <input checked="" type="radio"/> Revenue Increase <input type="radio"/> Cost Saving <input type="radio"/> Intangible Benefits
<b>Revenue Increase</b> (please include \$000)	Increase in Revenue \$ <input type="text" value="1200000"/>
<b>Net Benefit</b>	Implementation Cost \$ <input type="text" value="450000"/>
<b>Multiplier</b>	Net Revenue Increase \$ <input type="text" value="750000"/>
<b>Overall Potential</b>	How many times can these benefits be incurred <input type="text" value="1"/>
<b>Comment on Benefits</b>	Total Net Revenue Increase \$ <input type="text" value="750000"/>
<b>Implementing the Idea</b>	Rough estimation - need to prepare a thorough analysis.
<b>Comments / Next steps</b>	Choose a person to take care of the implementation Ian Jones
	Devise project plan. Add to the agenda of R&D Innovation Committee meeting.

Figure 2 : Idea Management Tool "Idea Central" by Imaginatic: Part of page with the conclusions of the idea evaluation

Major outcomes of our work that was performed through questionnaires and personal interviews with personnel in all levels within the organizations, were:

- None of the examined companies invests on Idea Management Information Systems. Only some subsidiaries of multinational companies use such systems. This is not the case in other countries where at least the big organizations like *Coca Cola*, *IBM*, *Bayer*, *Nokia* and *Zerox* use these systems and have structured idea management processes. Some researches (Turrell, 2003) show a *Return on Investment (ROI)* of 10X or higher with the adoption of Idea Management Tools.
- In most companies there are no formal processes to collect and evaluate the ideas of their employees. In some of them the employees can send a message with suggestions to a specific company e-mail address (suggestion e-mail) but the e-mail content is provided unstructured and cannot electronically processed. In some companies a number of ideas are collected through the e-mail but there are no skilled persons responsible to check, evaluate and approve the ideas.
- Through *suggestion e-mail*, companies are receiving a number of ideas that have nothing to do with the business objectives.
- In most companies the structure and the culture does not help the idea sharing
- In the majority of companies the ideas for new products and services or for new processes start from the high level management
- The employees cannot follow what happened with their ideas. This results in negative climate and in damaging any additional idea generation campaigns.
- In general in all companies that have some kind of idea management, the related Innovation KPIs, have better values (for example the "New Product Turn Around Time" and the "Number of Collected Ideas that were implemented" are at least 25% better).

## 6. Conclusions - The Present and the Future of Innovation through Idea Management

Facilitating innovation is increasingly acknowledged as a key factor for competitive advantage. Existing Information Systems support planning, scheduling and executing tasks. However, in order to achieve

continuous innovation and persistent competitive advantage, they should also support non-linear knowledge-based tasks with the broad participation of employees. This must be supported by new paradigms of Information Systems for generation, organization and dissemination of ideas and knowledge.

Idea Management is one of the most important innovation activities. The Idea Management Systems, enable organizations to gather, share and evaluate ideas with quality, speed and flexibility. They enable managers to measure the impact of ideas collected and implemented, and determine the "return on ideas". Moreover, it is a cost effective approach because it allows management tap into its own employees rather than hiring of consultants. However, in order to be successful, the idea management system needs to be implemented in an appropriate organization structure and culture in order to lead to highly profitable innovations. Our future work include (a) the long-term analysis of the innovation KPIs after the introduction of innovation management systems to a large number of European companies and (b) the analysis of the innovation performance with the adoption of other innovation activities described in this paper.

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# THE EVOLUTION OF ROMANIA'S SOCIAL INSURANCE REDISTRIBUTION SYSTEM

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## Abstract

*The social insurance systems have emerged and developed as redistribution systems. The demographic phenomena's trend and the free circulation of citizens towards free labor force markets have imposed the redistribution systems' resetting and the initiation of reforms in all the countries dependent on the only existing system of social insurances, the redistribution one. The social insurance systems cover a transition period in which there is a coexistence between redistribution and accumulative systems, based on investments. Basing oneself on fundamental universal principles, the redistribution systems remodel themselves on scientific basis. The balance between contributors and beneficiaries bends permanently by reducing the population's employment rate, imposing therefore the necessity of reshaping the system also in the situation of economic growth.*

*In this article, we present the results of the evolutionary analysis of the redistribution system in Romania's legislative and economic outlines. Within the initiated reform, Romania has introduced the principle of contribution. This principle is analyzed in a distinct chapter and considered a fundamental principle of the reform by Romania. In our study, we illustrate the functionality and the distortions of functionality to the Romanian principle, in the way it is implemented and applied in Romania.*

*The authors suggest that only the actuarial reshaping, on its components of accumulation and redistribution of resources, offers solutions to the integral functionality of the contribution principle into a redistribution system. The study results are presented in the article.*

*The authors conclude that the sustainability of a redistribution system is determined by the system's stimulating and anticipating character, coexisting with the principles of contribution and social cohesion.*

*Key words: social insurances; contribution principle; redistribution system; actuarial reshaping; social cohesion*

## 1. Introduction

In the context of citizens' free movement, a community labor force market has developed.

On the path of its active lives, Europe's citizens offer their abilities and professional performances, their work capacity, to the countries of origin or the ones in which they carry out their activity.

**Between the citizen and the society, a contract cuts in** for the exchange of the remuneration. In the act of labor force selling, **it offers** to the society also the social insurances' contributions, staking on the guarantee of a **further interest of allocation**.

The European Union's regulations imposed to the member states the implementation of reforms for establishing an adequate level of the national pension and for ensuring the conversion of the contributions paid in other states as a community pension.

Ensuring the sustainability of the social insurances' systems is today the responsibility of each national state, but also of the European Union, which has forwarded the phenomenon of flexicurity on the global labor force market.

At the basis of the social insurances there are universally underlain principles, on which foundation the reallocation systems have emerged and developed.

There are **two vital problems** to the beneficiaries:

- To have the guarantee that the pension interests' allocation is equitable

- The remuneration's replacement in the moment of assigning the pension interest is in direct correspondence to the social insurances' system's own share.

**We define the principle of contribution** as a permanent obligation of each insured person to pay contributions for ensuring the interest to the resources' allocation that will accumulate in the future from the working people.

The principle of contribution in the reallocating systems works as a principle along the other fundamental principles. The efficiency of the principle of cohesion and social solidarity is necessary among generations.

The authors consider that the dependency measured by the dependency rate, as statistical indicator, produces to the beneficiary **the need of demarcating his contributions**.

**The allocation principle** utilized in the social insurances' systems is based upon the remunerations realized in a period of work assigned by specific law and also upon the working seniority, with particularities from one country to another.

**The capital allocation criteria are:**

- The contributions, as an expression of the realized remuneration earnings
- Quotization stage, equivalent to the working seniority
- Working conditions

**The reallocating systems base themselves on** the principle of allocation of the active population's accumulated incomes, by the social insurances' contributions owed on the individual remuneration earnings, to the population that have entirely or partially lost their working capacity or that are forced to go into retirement by effect of law.

Between accumulation (A) and allocation (D) there is a fundamental equation specific to the social insurances' domain:

$$A = \alpha * W * C \quad (1)$$

Where  $\alpha$  is the average amount of the contributions, W is the nominal average wages, C is the total number of contributors (the employed population).

$$D = \beta * W * B \quad (2)$$

Where  $\beta$  is the rate of wages' replacement by pension,  $\beta = P/W$ , P = average amount of pension, B = number of beneficiaries.

**In the social conception**,  $\beta = (P/W) * 100$  is the pensions' adequation rate in the definition proposed by the authors.

In balance,  $A = D$ , that is:

$$\alpha * W * C = \beta * W * B \quad (3)$$

In relation (3), we replace  $\beta = P/W$  and it results:

$$\alpha * W * C = P * B \quad (4)$$

The reallocating systems have as objective the adequation rate's maximization and we utilize the relation (3), like this:

$$MAX(\beta) = MAX\{\alpha * (C/B)\} \quad (5)$$

MAX( $\beta$ ) is realized when C is maximum,  $\alpha$  is maximum and B is minimum.

**Factorial analysis:**

a) C is the number of contributors. The magnitude of this indicator can increase by 4 methods:

- Maintaining in activity the population that reached the standard age of going into retirement; we define this contribution period using the phrase "after-age contribution"
- Encouraging youth hiring; the attraction of the pre-active population
- Voluntary contributions of the beneficiaries
- Voluntary contributions of the contributors

The proposed methods do not always lead to a value increase of the indicator C, but lead to the value increase of the contributions. In Romania there is the situation  $B_K = C_K$ , that is a person finds oneself in double situation.

b)  $\alpha$  is the average amount of contributions. Because economic agents are rational agents,  $\alpha$ 's amount can be increased up to a maximum level that can permit to the economic agent, as employer and actual payer of contributions, to realize profit and to find itself in an economic growth trend. It results that  $\alpha$  is a variable depending to C.

c) B is the number of beneficiaries.

The maximization problem narrows down to the optimal realization by the influence of the demographic and economic factors.

Among the demographic factors of influence we specify the economic migration of the labor force and population aging. Statistical data show that the general balance of the social insurances is strongly influenced by the two factors.

**The level of the indicator  $\alpha$** , the average amount of contributions, bears:

- The economic analysis of the profitableness rate of engaged capital
- The social analysis of appreciating the degree of solidarity and social cohesion

The fundamental equation of the social insurances implies a relation of balance between the economic and social components of the system.

**The calculation of the indicator C/B**, as indicator of statistical analysis that characterizes a reallocating system, generates different perceptions and interpretations:

- The rate of dependency beneficiary-contributor (as ratio  $100 \cdot B/C$ )
- The number of contributors that "backs up" a beneficiary by the level of paid contributions (C/B)

The indicator C/B has depreciated in time, therefore the system finds itself in a relative balance.

**The second evolution phase** of the reallocation system is the phase of transition from the Defined – benefit plan system to the Defined – contribution plan system.

In this phase, the actuary's part steps in.

Actuarial science appeared starting with XVII<sup>th</sup> century, even by the combination of mortality tables with the rate of interest. First studies belong to De Witt (1671) and Haller (1693). Abraham de Moivre published "Annuities treaty" in 1725. The profession of actuary appeared with the creation of mutual societies of life insurances ("The Equitable").

In Romania, actuarial analysis is approached in association to general insurances and life insurances (C.Anghelache) and in health insurances' analysis (Dan Anghel Constantinescu).

In private systems of insurances, actuarial methods offer analyses for risk evaluation, risk management, the capitalization of insurance funds. Actuarial analysis is based on demographic tables (mortality and shifting) realized using the statistic data and the theory of probability as basis, capitalization and actualization tables obtained from financial tables of actualization.

As we move to systems based on accumulation, the principle of contribution becomes prevalent against the principle of cohesion and social solidarity.

## 2. The evolution of Romania's Social Insurance System

Romania's Social Insurance System comprised a series of phases during its evolution. According to the applied insurance pattern, the phases covered by the social insurances in Romania are:

1. **The formation of the social insurances** funds by contributions paid by the employees and the employers. The period is marked out by the law of unification of the social insurances from all provinces of our country – 1933. The paid contributions are of 6% applied to the wages, and of 8% starting with 1938.

2. **The foundation of the Pensions General House** and the determination of the mode of calculation and also of the public employment pensions' system of administration (Law no. 446 / 10.07.1943). It introduces the first formula of calculation of the pension. The elements on which basis the pension quantum was determined are: the calculable time, the rate, the last wage. The variation of the pension amount is between 22.5% (for 10 calculable years) and 90% (for 35 years and more). The contributions are established as a rate of 10% to the earnings.

3. **The creation of additional pensions'** fund and the determination of the pension quantum based on the wages average of 5 consecutive years worked in the last 10 years (Law no. 27 / 28.12.1996). The appearance of special laws for lawyers and farmers.

4. **The differentiation of contributions'** rates on the criteria of labor conditions (The Decree 389/1972; Law no. 49/1992) and the pension quantum differentiated on groups and labor conditions (Law no. 3/1977).

5. **The diversification of insurance systems** (farmers, lawyers, handicraft cooperatives) and the differentiated determination of the pension interest by specific law for military staff.

6. **Phase predecessor to the reform initiation** (1990-2000)

Starting with 1990, there can be remarked remuneration increases owed to the inflation effect. The criterion of determining the pension quantum based on the wages average of 5 consecutive years worked in the last 10 years becomes inefficient and incorrect, since for this period there were situations in which the assigned pension, as replacing revenue to the salary, was in fact higher than the last salary recorded on the Work Card.

On the background of the contributor – beneficiary ratio's depreciation and the situations generated by the remunerations increases owed to the inflation effect, the legislator turned to the emission and application of the Government Decision 565/1996. According to this, the pension interest was determined on the basis of an average of revenues to which it was applied the effective "decorrelation" procedure starting with 01.04.1991, the application date of the first measure of employees' social protection. By the "decorrelation" procedure, the wages average was set to the equivalent wages from 01.10.1990.

To the equivalent wage, called deducted average wage, social protection measures were applied, which were also applied to the pensions. After the chronological application of the social protection measures, it was determined the pension quantum which should have been given to a person that went into retirement until 2001.

This procedure was complicated. Disfunctionalities of application have emerged in the situations in which an employee traversed an activity period in the interspaces submitted to the "decorrelation", if the activity period was registered to a private employer that wasn't bound to apply the wages' indexations in the amounts assigned by the Government, but who gave remunerations increases. Since 1998, a process of recorrelation was initiated, which had as an effect the equalization of the pension amounts, ignoring the contribution principle in favor of the social solidarity principle.

7. **The reform initiation in the Social Insurance System of Romania** (Law no. 19/2000)

Starting with 01.04.2001, the law based on the contribution principle was applied and consists in assigning the pension amounts based on an average annual synopsis. This indicator is conceived as being the employee's share to the social insurance system in Romania regarding system contributions. Therefore it is the main criterion of redistributing the resources accumulated by the employees in each period.

The redistribution does not imply the distribution of every person's accumulated contributions, but it does imply the allocation of present accumulated contributions, therefore it is a redistribution process.

8. **Recalculating the pensions assigned** on the basis of the previous legislation by the new procedure of calculation.

The application of the principle contribution and the pensions' assignment based on the average annual synopsis, lead to the appearance of new situations. These refer to the comparability between persons with the same path of obtained earnings and the same quotization duration, who went into retirement previous to the current legislation with the pensions that retired based on the new law.

It was initiated and is to be finalized the procedure of recalculation, which consists in the assignation of the average annual synopsis also to the persons that went into retirement based on the previous legislation.

This procedure is derogatory to the persons that retired until 2001, who concentrated their contributions to the career ending, because that period was taken into account. These persons found themselves in the situation of not being able to adjust the pension amount reassigned on the basis of the average annual synopsis. A great amount of the retired persons have thereby recommenced their activity.

Distortions are registered in the manner of applying the recalculation procedure, owing to the work conditions. The persons that evolved their activity in different and special conditions found themselves in the situation of losing the advantages obtained by bigger pension amounts. The legislator is preoccupied at present to find solutions referring to these categories, triggering a new recalculation procedure.

9. **In the current phase**, there are shaping:

- The diversification of the social insurance systems, by the appearance of special laws for different categories (seagoing staff, diplomats, magistrates, artists) and by applying specific laws (for policemen, militaries). The social insurance systems' diversification is to the detriment of applying the contribution and resources' administration principles.
- The relocation of a part of the individual contribution made by the persons up to 35 years of age to the pensions' private funds for their development.

### 3. The principle of contribution. Algorithm of calculation

The authors present in this article their own conclusions on the mode of implementation and application of the contribution principle. That is about the formulation of opinions on the resources distribution's equitability considering the contribution of each insured person.

We specify that the algorithm is created and developed by the authors on the basis of the legislation text applied to Romania. For exemplifying the contribution principle, we define the following notations, terms and indicators:

$(P_{ij})_k$  = synopsis realized by a person in the month  $j$  of the year  $i$ , where  $i$  belongs to  $(15, S_k)$

$S_k$  = quotization stage, period in which the person has contributed to the social insurance system

$$(P_{ij})_k = \frac{(W_{ij})_k}{W_{ij}} \quad (6)$$

$S_t$  = standard stage of quotization

$P_i$  = synopsis realized by a person in the year  $i$

$(W_{ij})_k$  = gross earnings realized by the person  $k$  in the month  $j$  of the year  $i$

$W_{ij}$  = gross average remunerations (gross earnings) on the economy in the month  $j$  year  $i$

$P_k$  = average annual synopsis realized by the person  $k$

$P_k$  is the indicator which stands at the basis of allocating by the person  $k$  of the assigned resources to the social insurance system in Romania, likeness the pension interest.

**Statistically**,  $P_k$  shows how many times the average annual earnings of a person are situated over the level of the average earnings realized in Romania upon all period of quotization to the social insurance system.

In the application of the contribution principle, in Romania the following algorithm of calculation is utilized:

#### Step 1

Calculating  $(P_{ij})_k$  and  $P_i = \frac{\sum (P_{ij})_k}{12}$ ,  $j = \overline{1,12}$

#### Step 2

For  $i$  between 1967 and 01.04.2001,  $(P_{ij})_k$  increases with a rate between 13% and 22%, considering the contribution to the additional pensions' fund.

$$P_s = \sum (P_{ij} * \lambda_{ij}), \text{ where } \lambda_{ij} = \text{rate of increasing the } P_{ij}$$

#### Step 3

Calculating  $P_k = (\sum P_i + P_s) / S_t$ , where  $i = \overline{1, S_k}$ ,  $S_t = 25$  years for women, 30 years for men

#### Comment

$S_t$  is variable and increases monthly up to 2014.  $S_t$  is different for the persons who performed activities in remarkable and special work conditions.

#### Remark 1

$$P_k = (\sum (\sum P_{ij}) + P_s) / (12 * S_t), i = \overline{1, S_k}, j = \overline{1, 12}$$

Because  $P_{ij}$  does not depend on the contribution rate, it results that  $P_k$  does not depend on the contribution rate. There is at least one person  $y$  so that  $P_k = P_y$  and  $(C_{ij})_k * (W_{ij})_k / W_{ij}$  different from  $(C_{ij})_y * (W_{ij})_y / W_{ij}$ .

#### Remark 2

Saying  $\alpha$  is the average dimension of  $(C_{ij})_k$  and the average dimension of  $(C_{ij})_y$  and the conditions:  $S_k = 30$ ,  $S_t = 30$ ,  $S_y = 30$ , identical as periods

There is at least one person  $y$ , so that  $\alpha \sum \sum (W_{ij})_k / W_{ij} = \alpha \sum \sum (W_{ij})_y / W_{ij}$  and a term  $(W_{ij})_k = (W_{ij})_y$ , both of different degrees.

It results that in the case of allocating the terms  $W_{ij}$  on the range  $i * j$ ,  $j = \overline{1,12}$ ,  $i = \overline{1,30}$ ,  $P_k = P_y$  does not show the contribution because the formula does not comprise the actualization element. It results that the current  $P_k$  is different to the current  $P_y$ .

### Remark 3

Saying  $\sum (\sum P_{ij})_k = \sum (\sum P_{ij})_y$ , with all the identical terms allocated in the period  $S_k = S_y$ .

Because  $S_t$  is differentiated after the sex criterion and  $S_t$  is different for  $k$  and  $y$ , it results that  $P_k$  is different from  $P_y$ , the contributions being ignored from the calculation formula.

### Remark 4

Saying  $\sum (\sum P_{ij})_k = \sum (\sum P_{ij})_y$ , with all the identical terms allocated in the period  $S_k = S_y$ .

Because  $S_t$  is differentiated after the work conditions criterion and  $S_t$  is different for  $k$  and  $y$ , it results that  $P_k$  is different from  $P_y$ , the contributions being ignored from the calculation formula.

The contribution principle does not comprise the contribution rate and the actualization element of the contributions. At equal annual synopsis does not always correspond equal contributions.

## 4. Conclusions and recommendations

**The authors conclude** that the contribution principle does not correspond to the level of contributions paid by employees and employers, but to an average level resulted from the entire period of activity and contribution.

From the case of study, taking into account the influence element – the rate level of the social insurances' contributions and its evolution, at contributions considered equal at present – it differs the total value of contributions between people with the same contribution indicator level, also utilized in reallocation.

The authors recommend taking into account the coefficients – sum of contributions and the element of actualization and capitalization and the determination of the contribution indicator.

In the social insurance systems' analysis, the authors propose this model of calculation of the accumulations and the closing in to the idea of a virtual accumulation fund, as contribution indicator, like in Australia and Sweden.

**The actuary** has the role of actualizing the contributions considering the virtually individually accumulated fund and offering solutions for alternative allocation, so that the principle of contribution should comprise not only the obligation, but also the option of choosing the reallocation strategy.

Because more than 20 generations are interested in the equitability of benefits' allocation and in the sustainability of current system of social insurances, we authors propose for Romania:

- The creation of an anticipative system based on the models of Sweden and Australia
- The harmonization of insurance systems on the model of Austria
- Political consensus in reforms' application (Luxembourg model)
- Guaranteeing the interest of equitable allocation and the level of the living standard
- Transparency in the application of EU regulations
- Real manner application of the contribution principle

**In conclusion, the authors recommend taking into account** the real sum of contributions and the factor of actualization and capitalization and the determination of the real contribution indicator.

## 5. Practical example of applying the contribution principle

### a) Current version applied in Romania

Saying  $K$  and  $Y$  are two women that go into retirement in 2009. For the exemplification, we use the quotization effective stage equal to 25 years. Both persons have graduated 5 years at the university, before 1984 and accomplished in the same period. For exemplifying, we utilize the average remuneration on all



economy as reporting basis for the period after 1990, with the addition that starting with 01.01.1991 the monthly gross average remunerations are utilized for the determination of  $P_{ij}$ .

In the current version the person k achieves a number of 40,50000 points from the work activity. Also, the person y achieves a number of 40,50000 points.

The remunerations achieved by the person k are presented in column  $(\sum W_{ij})_k$ , while the remunerations of the person y are shown in column  $(\sum W_{ij})_y$ .

For the years in which the social insurances contributions' rate has changed, the remunerations realized in the two periods are separated.

**The contribution indicator and the repartitions in the current version Table 1**

Year	Average wage	$\sum (W_{ij})_k$	$\sum (W_{ij})_y$	$P_i$ for K	$P_i$ for Y	$\sum P_K$	$\sum P_y$
1	3,224	47,586	42,557	1.23000	1.10000	1.23000	1.10000
2	3,285	48,526	47,304	1.23100	1.20000	2.46100	2.30000
3	3,317	49,039	67,667	1.23200	1.70000	3.69300	4.00000
4	3,337	39,243	52,057	0.98000	1.30000	4.67300	5.30000
5	3,422	40,284	34,904	0.98100	0.85000	5.65400	6.15000
6	3,538	41,692	36,937	0.98200	0.87000	6.63600	7.02000
...							
11	181,694	6,759,017	2,834,426	3.10000	1.30000	17.60900	15.45100
17	2,876,645	93,203,298	62,135,532	2.70000	1.80000	26.88900	24.96100
18	4,282,622	7,066,326	8,351,113	0.55000	0.65000	27.43900	25.61100
18	4,282,622	50,106,677	46,252,318	1.30000	1.20000	28.73900	26.81100
19	5,452,987	91,610,182	104,697,350	1.40000	1.60000	30.13900	28.41100
20	6,741,152	121,340,736	137,519,501	1.50000	1.70000	31.63900	30.11100
21	8,261,491	168,534,416	178,448,206	1.70000	1.80000	33.33900	31.91100
22	9,668,279	208,834,826	220,436,761	1.80000	1.90000	35.13900	33.81100
23	11,500,000	262,200,000	276,000,000	1.90000	2.00000	37.03900	35.81100
24	14,100,000	380,700,000	355,320,000	2.25000	2.10000	39.28900	37.91100
25	17,421,700	253,172,144	541,257,376	1.21100	2.58900	40.50000	40.50000
<b>Total</b>		<b>1,705,009,682</b>	<b>2,015,857,561</b>	<b>40.50000</b>	<b>40.50000</b>		

Contribution calculated to the effective wage (St=25 years)	40.50000
$P_k = P_i$ for K/ St	1.62000
$P_y = P_i$ for Y/St	1.62000

In the current version, the average annual synopsis of the person y is equal to the average annual synopsis of the person k.

**b) Proposed version. Calculating the contributions and determining the indicators  $P_y$  and  $P_k$**

Let's say  $C_{ij}$  is the contributions rate paid over by the two persons K and Y.

We calculate the contributions of persons K and Y, like this:

K's contribution =  $C_{ij} * (\sum W_{ij})_k$

Y's contribution =  $C_{ij} * (\sum W_{ij})_y$

Year = 1984, ..., 2008

**The value of nonactualized contributions and the average contribution Table 2**

Year	C <sub>ij</sub>	Average wage	$\sum (W_{ij})_k$	$\sum (W_{ij})_y$	K's contr.	Y's contr.	Average contribution
1	15%	3,224	47,586	42,557	7,138	6,384	5,803
2	15%	3,285	48,526	47,304	7,279	7,096	5,913
3	15%	3,317	49,039	67,667	7,356	10,150	5,971
4	15%	3,337	39,243	52,057	5,886	7,809	6,007
5	15%	3,422	40,284	34,904	6,043	5,236	6,160
6	15%	3,538	41,692	36,937	6,254	5,541	6,368
7	15%	4,010	39,418	60,150	4,908	7,489	5,991
...							
18	35%	4,282,622	50,106,677	46,252,318	13,153,003	12,141,233	13,490,259
19	35%	5,452,987	91,610,182	104,697,350	32,063,564	36,644,073	22,902,545
20	34%	6,741,152	121,340,736	137,519,501	41,255,850	46,756,630	27,503,900
21	31.5%	8,261,491	168,534,416	178,448,206	53,088,341	56,211,185	31,228,436
22	31.5%	9,668,279	208,834,826	220,436,761	65,782,970	69,437,580	36,546,095
23	31.5%	11,500,000	262,200,000	276,000,000	82,593,000	86,940,000	43,470,000
24	31.5%	14,100,000	380,700,000	355,320,000	119,920,500	111,925,800	53,298,000
25	29%	17,421,700	253,172,144	541,257,376	73,419,922	156,964,639	60,627,516
Total					525,993,471	616,613,836	319,075,820

Contribution calculated for the average wage	319,075,820
P <sub>k</sub> = K's contribution/ Average wage	1.64849
P <sub>y</sub> = Y's contribution/ Average wage	1.93250

K's contribution = 616.613.836

Y's contribution = 525.993.471

It results that the contributions level is different for the 2 persons.

As the calculation shows, **P<sub>k</sub> = 1.64849** and **P<sub>y</sub> = 1.93250**.

In the case of study, we did not take into account the actualization element, as the tables of capitalization of the actuarial analysis show. The contributions' values are determined as historical nonactualized values.

In the phase of resources' reallocation, the ratio  $\mu$  would correspond to a relative actualization element.

P<sub>average</sub> represents the average value assigned by the **social insurances budget law**.

The parameter  $\lambda$  is annually established and is comprised between 37,5 % and 45%.

**c) The redistribution principle**

**P<sub>std</sub> (standard) = value of standard point**

**Wa = Average current wage**

P <sub>std</sub>	P <sub>k_old</sub>	P <sub>y_old</sub>	P <sub>k_new</sub>	P <sub>y_new</sub>
697	1.62000	1.62000	1.64849	1.93250

Where:  $P_{std} = \lambda * Wa$  (7)

$Val_k = P_k * P_{std} = P_k * \lambda * Wa$  (8)

For S<sub>t</sub> = 25 years and  $\lambda = 45\%$ :

$$Val\_k = (45\% / St) * Wa * \sum_i \sum_j [(Wij(k) / Wij) / 12] \quad (9)$$

- d) **Analysing the formulas** used in the reallocation phase (model elaborated by the authors according to the current legislation), we notice that the reallocated annual value depends on the total earnings **and not on the contributions.**

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# ANALYSIS AND FORECASTING OF THE NUMBER OF TRACTORS IN ITALY WITH TIME-SERIES METHODS

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## Abstract

*In this paper we analyze and forecast the number of tractors in Italy. The particular method consists of 4 stages: identification, estimation, diagnostic checking and forecasting. It proves that the most suitable model is the General Modified Exponential (G.M.E.) with 1<sup>st</sup> order autocorrelation correction. So we expect that the forecasts of this model will be the best.*

## Περίληψη

*Στην εργασία αυτή χρησιμοποιείται μία μέθοδος χρονοσειρών για την ανάλυση και πρόβλεψη του αριθμού των τρακτέρ της Ιταλίας. Η συγκεκριμένη μέθοδος αποτελείται από 4 στάδια: αναγνώριση, εκτίμηση, διαγνωστικός έλεγχος και σύγκριση των προβλέψεων. Συμπερασματικά προκύπτει ότι η Γενική Τροποποιημένη Εκθετική (Γ.Τ.Ε.) έχει την καλύτερη προσαρμογή στα δεδομένα, άρα αναμένεται να δώσει και τις ακριβέστερες προβλέψεις.*

*Key words: time series; forecasting; number of tractors.*

## 1. Introduction

Mar - Molinero (1980) used the Logistic curve to model the number (stock) of agricultural tractors in Spain and introduced an autoregressive error term to model the effect of economic influences and government policies. They followed many other papers with different methods with the same data.

In this paper we follow the same process for the number of tractors in Italy. First we present the General Modified Exponential (G.M.E.) and its special cases i.e. the Logistic, the Gompertz and the Simple Modified Exponential. Also the close related Bass model. Then we describe the identification methods, the estimation method, the model parameters and various measures of fit like the  $R^2$ , the S.S.R. and the Durbin - Watson statistic. Next we test the residuals for autocorrelation and correct the models. Finally we take the forecasts from these models and measure their accuracy with the usual measures and the model identification method of Gregg et al. (1964). Then we review the estimation, model checking and forecasts produced from these models. The data - 43 obs. (1961-2003) were taken from the data basis: <http://devdata.worldbank.org/> (All the calculations and diagrams were made with the use of the statistical - econometric package E-views 4.1).

## 2. The General Modified Exponential (G.M.E.)

The General Modified Exponential (generalized Logistic), Gregg et al. (1964), is given by:

$$y_t = a / (1 + \varphi \times \exp(-b(t-m)))^{1/\varphi} \quad (1)$$

were  $a$  = upper asymptote,  $b$  = slope parameter,  $t = m$  = point of inflexion and  $\varphi$  is  $\alpha$  power low parameter.

### Special Cases

i)  $\phi = 1$  Logistic  $y_t = a / (1 + \exp(-b(t-m)))$  (2)

ii)  $\phi = 0$  Gompertz  $y_t = a \times \exp(-\exp(-b)(t-m))$  (3)

iii)  $\phi = -1$  Simple Modified Exponential  $y_t = a (1 - \exp(t-m))$  (4)

were  $t = 1, 2, \dots, T = \text{time}$ .

Note that the Bass model:  $y_t = (a - b \times \exp(-ct)) / (1 + d \times \exp(-ct))$  (5)

when  $b = 0$  gives the Logistic curve, while when  $d = 0$  we have the Simple Modified Exponential.

### 3. Identification methods

The more elementary methods are the examination of the diagrams of the data, their 1<sup>st</sup>, 2<sup>nd</sup>, etc differences, the transformed data (e.g. their logs) and their differences etc. Among the more accurate methods is the method of Gregg et al. (1964) which we describe shortly next:

#### Greggs method.

A) Calculation of the Moving Average (MA) and the Slope(S) from:

MA = (Moving Average at year t) =  $(y_{t-2} + y_{t-1} + y_t + y_{t+1} + y_{t+2}) / 5$  (6)

S = (Slope at year t) =  $(-2 \times y_{t-2} - y_{t-1} + y_{t+1} + 2 \times y_{t+2}) / 10$  (7)

B) Examination of the scatter plots:

Compute and plot against time	If the result oscillates about a straight line which is:	Then the curve suggested is:
Slope	Horizontal	Straight line
Slope	At an angle to horizontal	Parabola
Slope/(Moving Average)	Horizontal	Simple Exponential
Slope/(Moving Average) <sup>2</sup>	At an angle to horizontal	Logarithmic Parabola
Logarithm of Slope	Sloping down to the right	Simple Modified Exponential
Logarithm of {Slope/(Moving Average)}	Sloping down to the right	Gompertz
Logarithm of {Slope/(Moving Average) <sup>2</sup> }	Sloping down to the right	Logistic
Log(S) - $(\phi - 1) / \phi \times \log(\text{MA})$	Sloping down to the right	GME

where  $(\phi - 1) / \phi$  is estimated from the regression:  $\log(S) = a + b \times t + ((\phi - 1) / \phi) \times \log(\text{MA})$

### 4. Model estimation

The model parameters were estimated with the non linear least squares algorithm, which requires initial parameter values. The estimated parameters of the various models are shown in Table 1 together with the usual econometric measures of fit i.e. R<sup>2</sup>, SSR, and the Durbin – Watson statistic.

Table 1. Estimated parameters of various models

model	a	b	c	d	f	R <sup>2</sup>	SSR	DW
Logistic	1778,50	0,1010	16,5000	-	-	0,9985	12860,270	0,6314
Gompertz	1982,60	0,0600	12,0000	-	-	0,9989	9683,1410	0,8109
GME	1895,00	0,3067	-	14,0579	0,0728	0,9990	8620,8420	0,9078
Bass	1857,6	799,33	0,08322	3,33267	-	0,9990	8388,7880	0,9275

From the inspection of this Table we notice the presence of high 1<sup>st</sup> order autocorrelation in the residuals, so we move to the next stage.

### 5. Diagnostic checking

In this stage we test the fitted models for autocorrelation in the residuals and re-estimate them. The results are shown in the next table:

Table 2. Estimated parameters of various models (with 1st order autocorrelation correction)

model	a	b	c	d	f	AR(1)	R <sup>2</sup>	SSR
Logistic	1800,90	0,097	16,73	-	-	0,654	0,999195	6317,2
Gompertz	1972,09	0,061	12,40	-	-	0,6	0,999201	6271,4
GME	1876,33	0,077	14,61	-	0,42	0,54	0,999238	5980,4
Bass	1853,26	0,084	-	(d <sub>1</sub> =743,84)	(d <sub>4</sub> =3,4476)	0,54	0,999240	5965,4

### 6. Forecasting

The forecasting accuracy of the models is given by various statistical measures like those described below in Tables 3 and 4.

Table 3.

model	Logistic	Gompertz	GME	Bass
RMSE	17,29	15,01	14,16	13,97
MAE	14,36	12,89	11,85	11,41
MAPE	1,84	1,27	1,23	1,11
Theil In. Cr.	0,0074	0,0065	0,0061	0,0060
Bias Prop.	0,0011	0,0001	0,0000	0,0000
Var. Prop.	0,0101	0,0001	0,0005	0,00025
Cov. Pr.	0,9888	0,9988	0,9996	0,9998

Table 4.

model	Logistic	Gompertz	GME	Bass
RMSE	14,82	15,14	14,04	14,07
MAE	11,57	13,02	11,49	11,47
MAPE	1,18	1,27	1,12	1,09
Theil In. Cr.	0,0063	0,0065	0,006	0,006
Bias Prop.	0,0019	0,0009	0,0000	0,0000
Var. Prop.	0,0012	0,0004	0,0004	0,0002
Cov. Pr.	0,9968	0,9987	0,9996	0,9998

From their inspection we conclude again that the G.M.E with 1<sup>st</sup> order autocorrelation correction has the best fitting to the data.

## 7. Conclusions

In this paper we use a time series method for the analysis and forecasting of the number of tractors in Italy. The particular method consists of 4 stages: identification, estimation, diagnostic checking and comparison of forecasts. In conclusion it follows that the General Modified Exponential (G.M.E) – with 1<sup>st</sup> order autocorrelation correction - has the best fitting to the data, so we expect that its forecasts are also the best.

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## Appendix

Figure 1: Original data

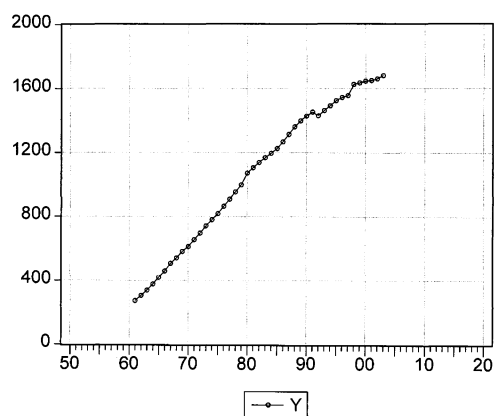


Figure 2: Identification test-1

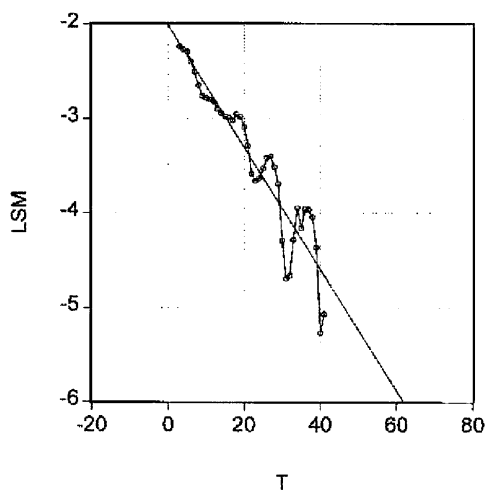


Figure 3: Identification test-2

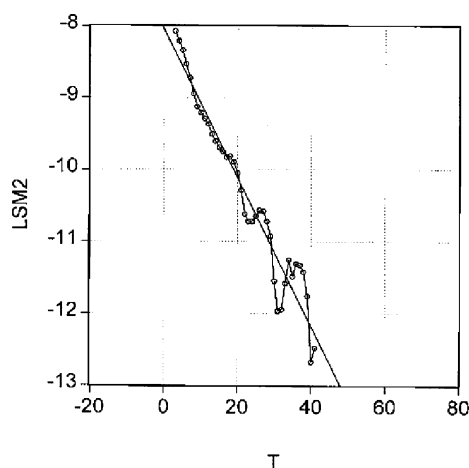


Figure 4: Correlogram of Y

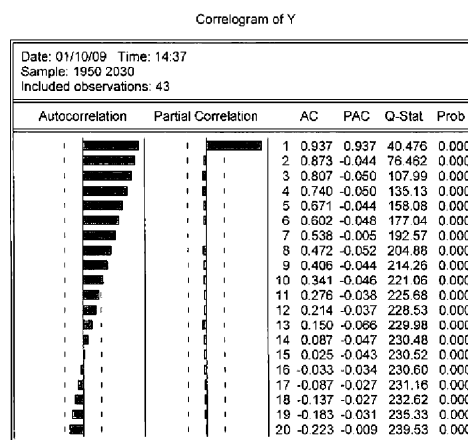


Figure 5: Correlogram of D(Y)

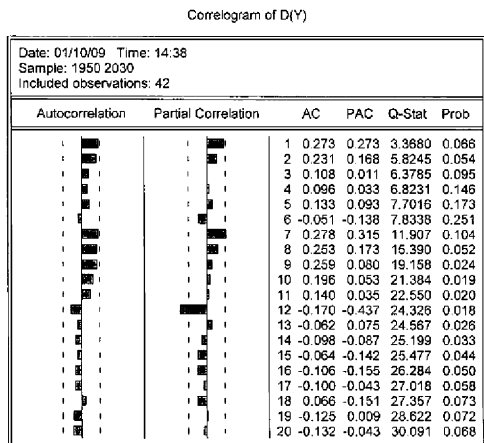


Figure 7: Forecasting the models with autocorrelation correction

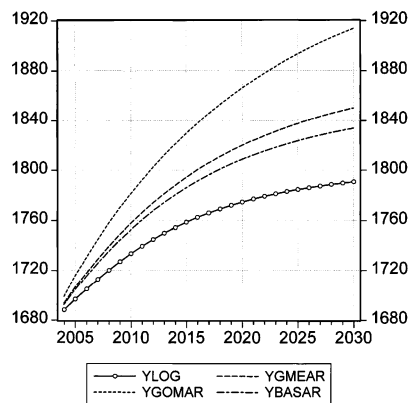
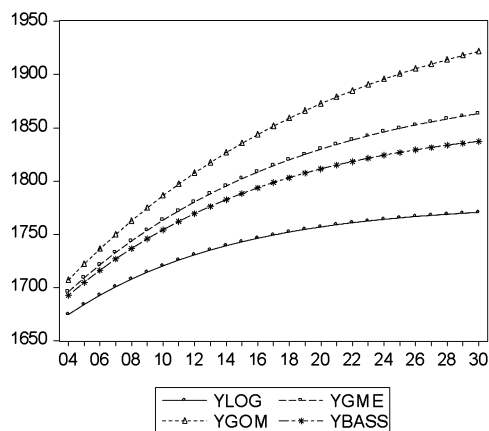


Figure 6: Forecasting the models





# ESTIMATION OF $P(X>Y)$ IN CASE OF BIVARIATE NORMAL DISTRIBUTION USING RANKED SET SAMPLING WITH CONCOMITANT VARIABLE

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## Abstract

Nonparametric-type estimation of  $\theta = P(X > Y)$ , based on ranked set sampling technique with concomitant random variable, is considered. The maximum likelihood estimation of  $\theta$  is also considered using RSS (ranked set sampling) and MRSS (median ranked set sampling) techniques with concomitant random variable. The estimators obtained are compared to their counterparts based on simple random sampling (SRS) using bias and MSE (mean square error). It appears that the suggested nonparametric estimator based on RSS is more efficient than that based on SRS and the MLE estimator based on MRSS is more efficient than the MLE based on RSS which is in turn more efficient than the MLE based on SRS.

**Key Words:** Simple Random Sampling, Ranked Set Sampling, Median Ranked Set Sampling, Concomitant Variable, Nonparametric Estimation; Maximum Likelihood Estimation, Bias, Mean Square Error.

## 1. Introduction

The ranked set sampling (RSS) technique was first suggested by McIntyre in a paper in 1952. It consists of choosing randomly  $m$  sets of size  $m$  each from the population of interest; the elements in each set are ranked by judgment with respect to the variable of interest. Then, the  $i^{\text{th}}$  judgment ranked unit from the  $i^{\text{th}}$  set is chosen for actual quantifications. In practice, the set size  $m$  should be small to avoid ranking errors; a larger sample size can be obtained by iterating the procedure. The RSS procedure and its variations can be applied in many areas such as forestry, agriculture, animal science, medicine, etc. For details about these applications, see Halls and Dell (1966), Martin et al. (1980), Al-Saleh and Al-Shrafat (2001). Takahasi and Wakimoto (1968) established a rigorous statistical foundation of the theory of ranked set sampling. Other related work on RSS can be found in Patil et al. (1999); Kaur et al. (1995); Al-Saleh and Zheng (2002) and Barabesi and Pisani (2004).

Stokes (1980) introduced a modified ranked set sampling procedure in which only the largest or the smallest judgment ranked unit is chosen for quantification. The method was investigated further by Samawi et al. (1996).

In this paper, first we propose to use the RSS with concomitant variable for nonparametric estimation of  $\theta = P(X > Y)$ . Then the MLEs of  $\theta$  and modifications of them based on RSS and median ranked set sampling (MRSS) with a concomitant variable are considered. Their properties are studied. The efficiency of the estimators is compared with those obtained from SRS.

## 2. RSS and MRSS with concomitant variable

Assume that  $(X, Y)$  is a bivariate random vector such that variable  $Y$  is difficult to measure or to order by judgment, but the concomitant variable  $X$ , which is correlated with  $Y$ , is easier to measure or to order by judgment. The variable  $X$  may be used to acquire the rank of  $Y$  as follows:

- Select  $m$  units from the jpdf of  $X$  and  $Y$  using  $m$  SRS's of size  $m$  each. Identify by judgment the  $i^{th}$  ranked observation of the  $i^{th}$  sample to the variable  $X$ .
  - Repeat the above two steps  $r$  times, if necessary, until the desired sample size,  $n = r m$  is obtained.
  - Measure accurately the selected  $n$  judgment identified units for both variables.
- The set of the  $n$  pairs obtained using the above procedure, is called a RSS with concomitant variable.

If  $m$  is odd, the MRSS can be obtained as in the steps above, but in step (a) we measure always the  $(\frac{m+1}{2})^{th}$  ranked observation and if  $m$  is even then  $\frac{m}{2}$  times we measure the  $(\frac{m}{2})^{th}$  ranked observation and  $\frac{m}{2}$  times we measure the  $(\frac{m}{2} + 1)^{th}$  ranked observation. Repeat this process  $r$  times until the desired sample size is obtained.

Let  $\{(X_{(i:m)j}, Y_{[i:m]j}), i = 1, 2, \dots, m, j = 1, 2, \dots, r\}$  be a RSS from  $f_{X,Y}(x, y)$  based on the concomitant variable  $X$ . If judgment ranking is perfect then,  $X_{(i:m)j}$  and  $Y_{[i:m]j}$  are, respectively, the  $i^{th}$  smallest value of  $X$  from the  $i^{th}$  sample of the  $j^{th}$  cycle and the corresponding value of  $Y$ , where  $i = 1, 2, \dots, m$  and  $j = 1, 2, \dots, r$ . Note that the pairs of this sample are independent but not identically distributed. The jpdf of  $(X_{(i:m)j}, Y_{[i:m]j})$  is denoted by  $f_{(i:m)j}(x, y)$  and given by:

$$f_{(i:m)j}(x, y) = f_{x_{(i:m)}}(x) f_{Y|X}(y|x)$$

where  $f_{x_{(i:m)}}$  is the pdf of the  $i^{th}$  order statistic of a SRS of size  $m$  from the marginal distribution of  $X$  and  $f_{Y|X}(y|x)$  is the conditional density of  $Y$  given  $X$ , (see Yang, 1977 and Stokes, 1980).

## 3. Nonparametric Estimation of $\theta = P(X > Y)$

We will consider the estimation of  $\theta = P(X > Y)$  nonparametrically. The nonparametric estimator of  $\theta$  based on the SRS  $(X_1, Y_1), \dots, (X_n, Y_n)$  is given by:

$$\hat{\theta}_{SRS} = \frac{1}{n} \sum_{i=1}^n I(X_i > Y_i)$$

Note that  $\hat{\theta}_{SRS}$  is an unbiased estimator of  $\theta$  with variance  $\frac{\theta(1-\theta)}{n}$ . We propose the following nonparametric estimator of  $\theta$  based on the RSS with concomitant variable  $\{(X_{(i:m)j}, Y_{[i:m]j}), i = 1, 2, \dots, m, j = 1, 2, \dots, r\}$ :

$$\hat{\theta}_{RSS} = \frac{1}{rm} \sum_{j=1}^r \sum_{i=1}^m I(X_{(i:m)j} > Y_{[i:m]j})$$

where  $n = r m$ . Then we have the following result where the proofs of (a) and (c) will be given.

**Theorem 1:**

(a)  $\hat{\theta}_{RSS}$  is an unbiased estimator of  $\theta$ .

$$(b) \text{Var}(\hat{\theta}_{RSS}) = \frac{1}{n^2} \sum_{j=1}^r \sum_{i=1}^m \theta_{ij} (1 - \theta_{ij})$$

$$(c) e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS}) = \frac{\text{var}(\hat{\theta}_{SRS})}{\text{var}(\hat{\theta}_{RSS})} = \frac{m\theta(1-\theta)}{\sum_{i=1}^m \theta_{i1}(1-\theta_{i1})} \geq 1$$

where  $\theta_{ij} = P(X_{(i:m)j} > Y_{[i:m]j})$ ,  $i = 1, 2, \dots, m$ ,  $j = 1, 2, \dots, r$ .

**Proof:**

$$\begin{aligned} (a) E(\hat{\theta}_{RSS}) &= \frac{1}{n} \sum_{j=1}^r \sum_{i=1}^m P(X_{(i:m)j} > Y_{[i:m]j}) \\ &= \frac{1}{n} \sum_{j=1}^r \sum_{i=1}^m \int_{-\infty}^{\infty} \int_y^{\infty} f_{X_{(i:m)j}}(x) f_{Y|X}(y|x) dx dy \\ &= \int_{-\infty}^{\infty} \int_y^{\infty} \left\{ \frac{\sum_{j=1}^r \sum_{i=1}^m f_{X_{(i:m)j}}(x)}{n} \right\} f_{Y|X}(y|x) dx dy \end{aligned}$$

$$= \int_{-\infty}^{\infty} \int_y^{\infty} f(x) f_{Y|X}(y|x) dx dy$$

(by Takahasi and Wakimoto (1968))

$$= \int_{-\infty}^{\infty} \int_y^{\infty} f(x, y) dx dy = \theta$$

(c) By Cauchy Schwarz inequality, we have

$$\sum_{j=1}^r \sum_{i=1}^m \theta_{ij} \leq \sqrt{\sum_{j=1}^r \sum_{i=1}^m 1} \sqrt{\sum_{j=1}^r \sum_{i=1}^m \theta_{ij}^2}$$

which implies that

$$n\theta \leq \sqrt{n} \sqrt{\sum_{j=1}^r \sum_{i=1}^m \theta_{ij}^2}$$

which in turn implies

$$\begin{aligned} \text{Var}(\hat{\theta}_{RSS}) &= \frac{1}{n^2} \sum_{j=1}^r \sum_{i=1}^m \theta_{ij} (1 - \theta_{ij}) = \frac{1}{n^2} \left[ \sum_{j=1}^r \sum_{i=1}^m \theta_{ij} - \sum_{j=1}^r \sum_{i=1}^m \theta_{ij}^2 \right] \\ &\leq \frac{1}{n^2} [n\theta - n\theta^2] = \frac{\theta(1-\theta)}{n} \\ &= \text{Var}(\hat{\theta}_{SRS}) \end{aligned}$$

which ends the proof of (c).

Note that from Theorem (1),  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  does not depend on  $r$ . Therefore in this section, we will assume that  $r=1$ . Also, note that  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  depends on the joint distribution of  $X$  and  $Y$ . We will assume that  $X$  and  $Y$  have a bivariate normal distribution  $BVN(\mu_x, \mu_y, \sigma_x^2, \sigma_y^2, \rho)$  where  $\sigma_x^2, \sigma_y^2$  and  $\rho$  are

known. We may assume without loss of generality that  $\sigma_x^2 = \sigma_y^2 = 1$ . Note that  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  depends on  $\mu_x$  and  $\mu_y$  through  $\mu_x - \mu_y$ . Table 1 gives  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  for  $m=2, 3, 4, 5$ ,  $\rho = -.8, -.5, -.3, .3, .5, .8$  and  $\mu_x - \mu_y = -1.00, -0.75, -0.62, -0.3, 0.3, 0.47, 0.85, 1.57$ . FORTRAN is used for the calculations in this paper.

The following can be deduced from Table 1 :

- (a) The efficiency  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  is always greater than one.
- (b) The efficiency  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  increases in  $m$  for negative  $\rho$  for fixed  $\rho$  and fixed  $\mu_x - \mu_y$  but not for positive  $\rho$ .
- (c) The efficiency  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  in case  $\rho$  is negative is better than when  $\rho$  is positive.
- (d) For fixed  $m$  and fixed  $\mu_x - \mu_y$ , the efficiency  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  increases as  $|\rho|$  increases for negative  $\rho$  and decreases as  $\rho$  increases for positive  $\rho$ .
- (e) For fixed  $\rho$  and fixed  $\mu_x - \mu_y$ , the efficiency  $e(\hat{\theta}_{RSS}, \hat{\theta}_{SRS})$  increases as  $|\mu_x - \mu_y|$  decreases for negative  $\rho$ .
- (f) Based on Table 1, we may conclude that  $\hat{\theta}_{RSS}$  is a good competitor of  $\hat{\theta}_{SRS}$ .

#### 4. MLE of $\theta = P(X > Y)$

We will consider the MLE  $\theta = P(X > Y)$  using SRS and RSS and MRSS with concomitant random variable in case of the bivariate normal distribution  $BVN(\mu_x, \mu_y, 1, 1, \rho)$  where  $\rho$  is known. Denote the density and the cumulative density of the standard normal distribution by  $\phi$  and  $\Phi$  respectively. Note that

$$\theta = P(X > Y) = \Phi\left[\frac{\mu_x - \mu_y}{\sqrt{2(1 - \rho)}}\right]$$

which implies that the MLE of  $\theta$  will be  $\hat{\theta} = \Phi\left[\frac{\hat{\mu}_x - \hat{\mu}_y}{\sqrt{2(1 - \rho)}}\right]$  where  $\hat{\mu}_x$  and  $\hat{\mu}_y$  are MLEs of  $\mu_x$  and  $\mu_y$  respectively.

It is easy to show that based on the SRS  $(X_1, Y_1), \dots, (X_n, Y_n)$ , the MLEs of  $\mu_x$  and  $\mu_y$  are  $\bar{X}$  and  $\bar{Y}$  respectively where  $\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$  and  $\bar{Y} = \frac{\sum_{i=1}^n Y_i}{n}$ . This implies that the MLE of  $\theta$  using the SRS is:

$$\hat{\theta}_{SRS} = \Phi\left[\frac{\bar{X} - \bar{Y}}{\sqrt{2(1 - \rho)}}\right] \tag{4.1}$$

If  $\{(X_{[i:m]_j}, Y_{[i:m]_j}), i = 1, 2, \dots, m, j = 1, 2, \dots, r\}$  is a RSS from  $BVN(\mu_x, \mu_y, 1, 1, \rho)$  based on the concomitant variable  $X$ , then it can be shown as in Stokes, S. (1980) and Al-Saleh and Al-Ananbeh (2007) that the maximum likelihood estimators of  $\mu_x$  and  $\mu_y$  exist and are unique, say  $\hat{\mu}_{x,RSS}$  and  $\hat{\mu}_{y,RSS}$  and they are given as the solutions of the following two equations:

$$\mu_x - \bar{x}_{RSS} + \frac{1}{n} \sum_{j=1}^r \sum_{i=1}^m (i-1) \left\{ \frac{\varphi(x_{(i:m)j} - \mu_x)}{\Phi(x_{(i:m)j} - \mu_x)} - \frac{\varphi(x_{(i:m)j} - \mu_x)}{[1 - \Phi(x_{(i:m)j} - \mu_x)]} \right\} = 0 \quad (4.2)$$

$$\mu_y = \bar{y}_{RSS} - \rho (\bar{x}_{RSS} - \mu_x). \quad (4.3)$$

Hence an estimator of  $\theta$  based on  $\{(X_{(i:m)j}, Y_{[i:m]j}), i = 1, 2, \dots, m, j = 1, 2, \dots, r\}$  is given by

$$\hat{\theta}_{RSS} = \Phi\left[\frac{\hat{\mu}_{x,RSS} - \hat{\mu}_{y,RSS}}{\sqrt{2(1-\rho)}}\right] \quad (4.4)$$

Similarly, the maximum likelihood estimators of  $\mu_x$  and  $\mu_y$  based on MRSS with concomitant variable  $X$  can be shown to exist and are unique, say  $\hat{\mu}_{x,MRSS}$  and  $\hat{\mu}_{y,MRSS}$ , and they are given by the solutions of the following two equations:

(a) If  $m$  is odd:

$$\mu_x - \bar{x}_{MRSS} + \left(\frac{m-1}{2}\right) \sum_{j=1}^r \sum_{i=1}^m \left\{ \frac{\varphi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)}{\Phi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)} - \frac{\varphi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)}{[1 - \Phi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)]} \right\} = 0$$

(4.5)

$$\mu_y = \bar{y}_{MRSS} - \rho (\bar{x}_{MRSS} - \mu_x) \quad (4.6)$$

(b) If  $m$  is even:

$$\begin{aligned} \mu_x - \bar{x}_{MRSS} + \left(\frac{1}{n}\right) \sum_{j=1}^r \sum_{i=1}^{\left(\frac{m}{2}\right)} \left(\frac{m}{2} - 1\right) \left\{ \frac{\varphi(x_{((\frac{m}{2})i:m)j} - \mu_x)}{\Phi(x_{((\frac{m}{2})i:m)j} - \mu_x)} \right\} \\ + \left(\frac{1}{n}\right) \sum_{j=1}^r \sum_{i=((\frac{m}{2}+1))}^m \left(\frac{m}{2}\right) \left\{ \frac{\varphi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)}{\Phi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)} \right\} \\ - \left(\frac{1}{n}\right) \sum_{j=1}^r \sum_{i=1}^{\left(\frac{m}{2}\right)} \left(\frac{m}{2}\right) \left\{ \frac{\varphi(x_{((\frac{m}{2})i:m)j} - \mu_x)}{1 - \Phi(x_{((\frac{m}{2})i:m)j} - \mu_x)} \right\} \\ - \left(\frac{1}{n}\right) \sum_{j=1}^r \sum_{i=((\frac{m}{2}+1))}^m \left(\frac{m}{2} - 1\right) \left\{ \frac{\varphi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)}{1 - \Phi(x_{((\frac{m+1}{2})i:m)j} - \mu_x)} \right\} = 0 \end{aligned}$$

(4.7)

$$\mu_y = \bar{y}_{MRSS} - \rho (\bar{x}_{MRSS} - \mu_x). \quad (4.8)$$

These imply that the estimator of  $\theta$  based on MRSS with concomitant variable is given by

$$\hat{\theta}_{MRSS} = \Phi\left[\frac{\hat{\mu}_{x,MRSS} - \hat{\mu}_{y,MRSS}}{\sqrt{2(1-\rho)}}\right] \quad (4.9)$$

The MLEs under RSS and MRSS with concomitant variable can't be obtained in closed form. In order to get a closed form of approximate MLEs of  $\mu_x$  and  $\mu_y$ , we replace the last terms in the left hand sides of

equations (4.2), (4.5) and (4.7) by their expectations. This technique was used by Mehrotra and Nanda (1974) for censored data, Zheng and Al-Saleh (2002) for MLE using RSS, and Abu-Dayyeh and Al-Sawi (2007) using moving extreme ranked set sampling. But, it can be shown easily that the expectation of each of these terms is zero. Therefore, the MMLEs (modified MLEs) for  $\mu_x$  and  $\mu_y$  are respectively given by the means of the x's and y's under the sampling scheme under consideration. Hence, the MMLE of  $\theta$  is given as follows:

(a) Under RSS with concomitant variable it is given by:

$$\hat{\theta}_{Mod,RSS} = \Phi\left[\frac{\bar{x}_{RSS} - \bar{y}_{RSS}}{\sqrt{2(1-\rho)}}\right] \quad (4.10)$$

(b) Under MRSS with concomitant variable it is given by:

$$\hat{\theta}_{Mod,MRSS} = \Phi\left[\frac{\bar{x}_{MRSS} - \bar{y}_{MRSS}}{\sqrt{2(1-\rho)}}\right] \quad (4.11)$$

### 5. Simulation

We compared the estimators  $\hat{\theta}_{SRS}$ ,  $\hat{\theta}_{RSS}$ ,  $\hat{\theta}_{MRSS}$ ,  $\hat{\theta}_{Mod,RSS}$  and  $\hat{\theta}_{Mod,MRSS}$  by using their biases and MSEs. The biases and MSEs depend on the number of cycles ( $r$ ), the set size ( $m$ ),  $\mu_x$ ,  $\mu_y$  (only through  $\mu_x - \mu_y$ ) and  $\rho$ . An extensive simulation was conducted using a program written using FORTRAN and routines from NAG libraries. Several combinations of the four parameters  $r$ ,  $m$ ,  $\rho$ ,  $\mu_x - \mu_y$  were considered. The parameter values considered were  $m=1, 2, 3, 4, 5$  and  $6$ ,  $r=10, 15$  and  $20$ ,  $\rho$  from  $-1.0$  to  $1.0$  and  $\mu_x$  and  $\mu_y$  ranging from  $-4.0$  to  $4.0$ . The biases, estimates and efficiencies of the estimators  $\hat{\theta}_{RSS}$ ,  $\hat{\theta}_{MRSS}$ ,  $\hat{\theta}_{Mod,RSS}$  and  $\hat{\theta}_{Mod,MRSS}$  with respect to  $\hat{\theta}_{SRS}$  are reported in Tables 2, 3, 4 for when  $r=20$  and  $m=2, 3, 4$  and  $\rho = -.8, -.5, -.3, .3, .5, .8$  and  $\mu_x - \mu_y = -1.00, -0.75, -0.62, -0.3, 0.3, 0.47, 0.85, 1.57$ . The efficiency of the estimator  $\hat{\theta}$  w.r.t the estimator  $\hat{\theta}_{SRS}$  is defined by:

$$e(\hat{\theta}, \hat{\theta}_{SRS}) = \frac{MSE(\hat{\theta}_{SRS})}{var(\hat{\theta})}$$

The following can be deduced from Table 1 :

- (a) The biases of  $\hat{\theta}_{MRSS}$  and  $\hat{\theta}_{Mod,MRSS}$  are equal and the biases of  $\hat{\theta}_{RSS}$  and  $\hat{\theta}_{Mod,RSS}$  are equal.
- (b) The bias of  $\hat{\theta}_{MRSS}$  is smaller than that of  $\hat{\theta}_{RSS}$  which is in turn smaller than that of  $\hat{\theta}_{SRS}$ .
- (c) The biases of all estimators are very small. So, we may consider all of them as unbiased estimators of  $\theta$ .
- (d) The efficiencies of all the estimators are greater than one.
- (e) The efficiencies of all estimators increase in  $m$  for fixed  $\rho$ ,  $r$  and  $\mu_x - \mu_y$ .
- (f) The efficiencies of all estimators is in case  $\rho$  is negative are better than when  $\rho$  is positive.
- (g) Based on Tables 2-7, we may conclude that  $\hat{\theta}_{RSS}$ ,  $\hat{\theta}_{MRSS}$ ,  $\hat{\theta}_{Mod,RSS}$  and  $\hat{\theta}_{Mod,MRSS}$  are real competitors of  $\hat{\theta}_{SRS}$ .

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**Tables**

Table 1: Efficiency of  $\hat{\theta}_{RSS}$  w.r.t.  $\hat{\theta}_{SRS}$

$\mu_x - \mu_y$	m=2	m=3	m=4	m=5	m=2	m=3	m=4	m=5
	$\rho = -0.8$				$\rho = 0.8$			
-1.00	1.1047	1.1931	1.2477	1.2956	1.0154	1.0022	1.0141	1.0152
-0.75	1.1097	1.1962	1.2598	1.3154	1.0055	1.0044	1.0054	1.0094
-0.62	1.1262	1.2087	1.2812	1.3190	1.0132	1.0169	1.0039	1.0076
-0.30	1.1317	1.2198	1.2791	1.3412	1.0122	1.0154	1.0097	1.0177
0.30	1.1304	1.2187	1.2771	1.3281	1.0124	1.0182	1.0154	1.0227
0.47	1.1294	1.2090	1.2756	1.3251	1.0064	1.0137	1.0124	1.0173
0.85	1.1206	1.2005	1.2595	1.3010	1.0023	1.0018	1.0009	1.0087
1.57	1.0836	1.1474	1.2030	1.2344	1.0037	1.0371	1.0011	1.0174
	$\rho = -0.5$				$\rho = 0.5$			
-1.00	1.0841	1.1459	1.1782	1.2093	1.0204	1.0325	1.0263	1.0391
-0.75	1.0826	1.1470	1.1919	1.2188	1.0119	1.0351	1.0409	1.0415
-0.62	1.0953	1.1533	1.1984	1.2318	1.0213	1.0419	1.0470	1.0475
-0.30	1.1022	1.1645	1.2068	1.2418	1.0242	1.0372	1.0558	1.0518
0.30	1.1016	1.1632	1.2132	1.2305	1.0268	1.0420	1.0524	1.0623
0.47	1.0887	1.1642	1.1931	1.2394	1.0291	1.0311	1.0488	1.0606
0.85	1.0876	1.1428	1.1840	1.2341	1.0207	1.0309	1.0486	1.0488
1.57	1.0678	1.1068	1.1442	1.1734	1.0130	1.0266	1.0177	1.0243

	$\rho = -0.3$				$\rho = 0.3$			
-1.00	1.0623	1.1122	1.1390	1.1687	1.0350	1.0467	1.0658	1.0677
-0.75	1.0777	1.1187	1.1533	1.1798	1.0313	1.0515	1.0710	1.0737
-0.62	1.0721	1.1234	1.1563	1.1831	1.0418	1.0582	1.0691	1.0875
-0.30	1.0817	1.1339	1.1575	1.1901	1.0397	1.0631	1.0764	1.0844
0.30	1.0844	1.1309	1.1704	1.1866	1.0274	1.0589	1.0789	1.0727
0.47	1.0763	1.1290	1.1643	1.1844	1.0388	1.0519	1.0753	1.0832
0.85	1.0794	1.1072	1.1499	1.1735	1.0316	1.0513	1.0666	1.0639
1.57	1.0450	1.0796	1.1137	1.1205	1.0121	1.0266	1.0451	1.0227

Table 2: Biases and Efficiencies of the Estimators, m=2, r=20

$\rho$	$\mu_x - \mu_y$	B-SRS	B-RSS	B-RSSM	B-MRSS	B-MRSSM	SRS /RSS	SRS /RSSM	SRS /MRSS	SRS/ MRSSM
-0.8	-1.00	0.0021	0.0017	0.0017	0.0017	0.0017	1.4088	1.3996	1.4088	1.3996
	-0.75	0.0021	0.0013	0.0013	0.0013	0.0013	1.4107	1.4006	1.4107	1.4006
	-0.62	0.0014	0.0012	0.0012	0.0012	0.0012	1.4098	1.3990	1.4098	1.3990
	-0.30	0.0007	0.0003	0.0003	0.0003	0.0003	1.4067	1.3958	1.4067	1.3958
	0.30	-0.0009	-0.0003	-0.0003	-0.0033	-0.0003	1.4149	1.4033	1.4149	1.4033
	0.47	-0.0017	-0.0009	-0.0009	-0.0009	-0.0009	1.4050	1.3928	1.4050	1.3928
	0.85	-0.0020	-0.0015	-0.0015	-0.0015	-0.0015	1.4057	1.3963	1.4057	1.3963
	1.51	-0.0030	-0.0021	-0.0021	-0.0021	-0.0021	1.4347	1.4266	1.4347	1.4266
-0.3	-1.00	0.0023	0.0019	0.0019	0.0019	0.0019	1.2693	1.2645	1.2693	1.2645
	-0.75	0.0018	0.0017	0.0017	0.0017	0.0017	1.2653	1.2592	1.2653	1.2592
	-0.62	0.0015	0.0013	0.0013	0.0013	0.0013	1.2700	1.2653	1.2700	1.2653
	-0.30	0.0013	0.0008	0.0008	0.0008	0.0008	1.2555	1.2482	1.2555	1.2482
	0.30	-0.0012	-0.0011	-0.0011	-0.0042	-0.0011	1.2524	1.2465	1.2524	1.2465
	0.47	-0.0008	-0.0011	-0.0011	-0.0011	-0.0011	1.2578	1.2519	1.2578	1.2519
	0.85	-0.0023	-0.0015	-0.0015	-0.0015	-0.0015	1.2666	1.2606	1.2666	1.2606
	1.51	-0.0031	-0.0024	-0.0024	-0.0024	-0.0024	1.2854	1.2798	1.2854	1.2798
0.3	-1.00	0.0028	0.0026	0.0025	0.0026	0.0025	1.1064	1.1041	1.1064	1.1041
	-0.75	0.0026	0.0020	0.0020	0.0020	0.0020	1.1320	1.1290	1.1320	1.1290
	-0.62	0.0024	0.0023	0.0023	0.0023	0.0023	1.1104	1.1073	1.1104	1.1073
	-0.30	0.0008	0.0014	0.0014	0.0014	0.0014	1.1179	1.1156	1.1179	1.1156
	0.30	-0.0015	-0.0013	-0.0013	-0.0048	-0.0013	1.1292	1.1258	1.1292	1.1258
	0.47	-0.0016	-0.0020	-0.0020	-0.0020	-0.0020	1.1076	1.1051	1.1076	1.1051
	0.85	-0.0030	-0.0027	-0.0026	-0.0027	-0.0026	1.1296	1.1274	1.1296	1.1274
	1.51	-0.0026	-0.0025	-0.0025	-0.0025	-0.0025	1.1238	1.1201	1.1238	1.1201
0.8	-1.00	0.0023	0.0020	0.0020	0.0020	0.0020	1.0440	1.0435	1.0440	1.0435
	-0.75	0.0033	0.0026	0.0026	0.0026	0.0026	1.0522	1.0515	1.0522	1.0515
	-0.62	0.0029	0.0030	0.0030	0.0030	0.0030	1.0265	1.0258	1.0265	1.0258
	-0.30	0.0024	0.0024	0.0024	0.0024	0.0024	1.0301	1.0291	1.0301	1.0291
	0.30	-0.0024	-0.0017	-0.0018	-0.0051	-0.0018	1.0303	1.0292	1.0303	1.0292
	0.47	-0.0028	-0.0026	-0.0026	-0.0026	-0.0026	1.0291	1.0287	1.0291	1.0287
	0.85	-0.0029	-0.0025	-0.0025	-0.0025	-0.0025	1.0562	1.0557	1.0562	1.0557
	1.51	-0.0006	-0.0006	-0.0006	-0.0006	-0.0006	1.0251	1.0237	1.0251	1.0237

Table 3: Biases and Efficiencies of the Estimators, m=3, r=20

$\rho$	$\mu_x - \mu_y$	B-SRS	B-RSS	B-RSSM	B-MRSS	B-MRSSM	SRS /RSS	SRS /RSSM	SRS /MRSS	SRS/ MRSSM
-0.8	-1.00	0.0014	0.0010	0.0010	0.0009	0.0009	1.7723	1.7365	1.9824	1.9817
	-0.75	0.0015	0.0007	0.0007	0.0006	0.0006	1.7556	1.7249	1.9742	1.9737
	-0.62	0.0009	0.0005	0.0006	0.0005	0.0005	1.7848	1.7503	1.9750	1.9744
	-0.30	0.0007	0.0003	0.0002	0.0001	0.0001	1.7865	1.7523	1.9749	1.9745
	0.30	-0.0007	-0.0001	-0.0002	0.0000	0.0000	1.7704	1.7368	1.9667	1.9663
	0.47	-0.0005	-0.0002	-0.0002	-0.0003	-0.0003	1.8001	1.7646	1.9809	1.9803
	0.85	-0.0010	-0.0009	-0.0009	-0.0007	-0.0007	1.7489	1.7127	1.9595	1.9585
	1.51	-0.0020	-0.0011	-0.0011	-0.0010	-0.0010	1.7490	1.7159	1.9573	1.9567
-0.3	-1.00	0.0017	0.0011	0.0011	0.0009	0.0009	1.4700	1.4535	1.5554	1.5552
	-0.75	0.0014	0.0011	0.0011	0.0012	0.0012	1.4853	1.4682	1.5647	1.5644
	-0.62	0.0012	0.0007	0.0006	0.0008	0.0008	1.4652	1.4486	1.5543	1.5543



	-0.30	0.0010	0.0004	0.0005	0.0008	0.0008	1.4624	1.4432	1.5692	1.5691
	0.30	-0.0004	-0.0001	-0.0002	-0.0001	-0.0001	1.4459	1.4278	1.5423	1.5423
	0.47	-0.0004	-0.0006	-0.0006	-0.0005	-0.0005	1.4480	1.4303	1.5510	1.5506
	0.85	-0.0018	-0.0010	-0.0010	-0.0010	-0.0010	1.4447	1.4272	1.5662	1.5660
	1.51	-0.0022	-0.0017	-0.0017	-0.0015	-0.0015	1.4731	1.4569	1.5742	1.5739
0.3	-1.00	0.0022	0.0015	0.0015	0.0018	0.0018	1.2162	1.2084	1.2387	1.2385
	-0.75	0.0016	0.0013	0.0013	0.0016	0.0016	1.1941	1.1888	1.2189	1.2188
	-0.62	0.0015	0.0014	0.0014	0.0010	0.0010	1.2210	1.2134	1.2544	1.2544
	-0.30	0.0009	0.0009	0.0009	0.0006	0.0006	1.2006	1.1942	1.2378	1.2378
	0.30	-0.0010	-0.0009	-0.0009	-0.0005	-0.0005	1.2138	1.2050	1.2532	1.2532
	0.47	-0.0010	-0.0008	-0.0008	-0.0009	-0.0009	1.1995	1.1925	1.2412	1.2410
	0.85	-0.0020	-0.0020	-0.0020	-0.0017	-0.0017	1.2258	1.2201	1.2629	1.2629
	1.51	-0.0018	-0.0015	-0.0015	-0.0015	-0.0015	1.2043	1.1977	1.2629	1.2629
0.8	-1.00	0.0015	0.0014	0.0014	0.0014	0.0014	1.0398	1.0384	1.0574	1.0574
	-0.75	0.0019	0.0019	0.0018	0.0018	0.0018	1.0479	1.0463	1.0624	1.0624
	-0.62	0.0021	0.0016	0.0016	0.0017	0.0017	1.0611	1.0593	1.0675	1.0676
	-0.30	0.0014	0.0013	0.0014	0.0012	0.0012	1.0573	1.0552	1.0761	1.0761
	0.30	-0.0012	-0.0015	-0.0015	-0.0012	-0.0012	1.0503	1.0494	1.0560	1.0560
	0.47	-0.0019	-0.0014	-0.0014	-0.0016	-0.0016	1.0593	1.0582	1.0633	1.0634
	0.85	-0.0019	-0.0018	-0.0018	-0.0017	-0.0017	1.0550	1.0538	1.0651	1.0651
	1.51	-0.0004	-0.0003	-0.0003	-0.0004	-0.0004	1.0627	1.0611	1.0725	1.0725

Table 4: Biases and Efficiencies of the Estimators, m=4, r=20

$\rho$	$\mu_x - \mu_y$	B-SRS	B-RSS	B-RSSM	B-MRSS	B-MRSSM	SRS /RSS	SRS /RSSM	SRS /MRSS	SRS/ MRSSM
-0.8	-1.00	0.0015	0.0007	0.0007	0.0007	0.0007	2.1386	2.0828	2.3585	2.3549
	-0.75	0.0007	0.0004	0.0004	0.0004	0.0004	2.0863	2.0256	2.3433	2.3396
	-0.62	0.0008	0.0003	0.0004	0.0002	0.0002	2.1159	2.0545	2.3585	2.3542
	-0.30	0.0004	0.0001	0.0001	0.0002	0.0002	2.1361	2.0742	2.3430	2.3375
	0.30	-0.0007	-0.0002	-0.0002	-0.0003	-0.0003	2.1612	2.1033	2.3923	2.3892
	0.47	-0.0007	-0.0001	-0.0001	0.0000	0.0000	2.0920	2.0297	2.3146	2.3101
	0.85	-0.0010	-0.0006	-0.0006	-0.0005	-0.0005	2.1078	2.0460	2.3434	2.3398
	1.51	-0.0014	-0.0007	-0.0007	-0.0006	-0.0006	2.1081	2.0454	2.3581	2.3531
-0.3	-1.00	0.0012	0.0008	0.0008	0.0006	0.0007	1.6347	1.6110	1.7317	1.7293
	-0.75	0.0007	0.0007	0.0007	0.0006	0.0006	1.6210	1.5940	1.7099	1.7078
	-0.62	0.0008	0.0006	0.0006	0.0005	0.0005	1.6124	1.5867	1.7027	1.7007
	-0.30	0.0005	0.0005	0.0005	0.0002	0.0002	1.6107	1.5840	1.7151	1.7132
	0.30	-0.0005	-0.0002	-0.0002	-0.0002	-0.0002	1.6050	1.5783	1.7205	1.7181
	0.47	-0.0012	0.0000	0.0000	-0.0001	-0.0001	1.6338	1.6061	1.7250	1.7234
	0.85	-0.0014	-0.0007	-0.0006	-0.0008	-0.0008	1.5995	1.5724	1.7041	1.7024
	1.51	-0.0014	-0.0010	-0.0010	-0.0010	-0.0010	1.6051	1.5785	1.7218	1.7209
0.3	-1.00	0.0011	0.0012	0.0012	0.0010	0.0010	1.2455	1.2382	1.2864	1.2864
	-0.75	0.0015	0.0008	0.0008	0.0009	0.0008	1.2571	1.2478	1.2950	1.2946
	-0.62	0.0008	0.0009	0.0009	0.0012	0.0012	1.2514	1.2428	1.2894	1.2887
	-0.30	0.0005	0.0006	0.0006	0.0005	0.0005	1.2377	1.2301	1.2757	1.2751
	0.30	-0.0007	-0.0005	-0.0005	-0.0004	-0.0004	1.2654	1.2555	1.2852	1.2848
	0.47	-0.0008	-0.0009	-0.0009	-0.0007	-0.0007	1.2559	1.2446	1.2995	1.2990
	0.85	-0.0015	-0.0012	-0.0012	-0.0010	-0.0010	1.2562	1.2462	1.3076	1.3070
	1.51	-0.0014	-0.0011	-0.0011	-0.0010	-0.0010	1.2615	1.2544	1.2962	1.2961
0.8	-1.00	0.0012	0.0011	0.0011	0.0010	0.0010	1.0552	1.0530	1.0890	1.0888
	-0.75	0.0014	0.0013	0.0013	0.0014	0.0014	1.0662	1.0643	1.0633	1.0632
	-0.62	0.0015	0.0014	0.0014	0.0013	0.0013	1.0463	1.0442	1.0618	1.0616
	-0.30	0.0010	0.0011	0.0011	0.0011	0.0011	1.0608	1.0595	1.0818	1.0817
	0.30	-0.0010	-0.0011	-0.0011	-0.0013	-0.0013	1.0565	1.0544	1.0686	1.0686
	0.47	-0.0017	-0.0015	-0.0015	-0.0014	-0.0014	1.0560	1.0534	1.0704	1.0703
	0.85	-0.0014	-0.0011	-0.0011	-0.0012	-0.0012	1.0716	1.0698	1.0780	1.0779
	1.51	-0.0003	-0.0003	-0.0003	-0.0003	-0.0003	1.0494	1.0475	1.0745	1.0744

# FAIR TRADE SUPPORTING GROUP: WHAT THEY KNOW, FEEL AND PREFER

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## Abstract

*Against free trade, another type of trade, namely Fair Trade, offers to small producers in the underdeveloped countries of the Third World a guaranteed minimum price for each product. Fair Trade increased rapidly during the last decade in Europe and North America, while in Greece it has been recently introduced by the Altromercato shops in Athens and Thessaloniki. The Fair Trade Hellas also developed a group of supporters.*

*This paper presents the results of a preliminary on-line research study that examined supporters' intentional purchasing behaviour towards all available fair trade products; also their preferences about a new fair trade marmalade. The investigation included a set of variables that may influence future behaviour, such as consumers' level of awareness, their prior buying experiences, their attitudes towards fair principles and objectives, as well as selected demographic and psychographic characteristics of the sample.*

*It was found that supporters would like to buy mostly fair snacks, coffee, pasta, rice, sugar and souvenirs. With regard to a new fair marmalade, supporters prefer this to be offered at a reasonable price and to be organic by all means. Also, it might be produced in two types, one that might contain nuts and another that might contain honey. It was also found that these consumers hold very strong positive attitudes towards principles, objectives and effectiveness of the fair trade movement. They are very scrupulous people, who share strong universalistic and collectivistic values, while low levels of power and individualism.*

*Though limited due to the small response rate, the results of this study open significant paths for future research in order to understand better the insights of the ethical consumption that concerns the fair trade products in Greece.*

*Key Words: Fair Trade, Supporters' Group, Consumer Behaviour*

## 1. Introduction

The capitalistic free trade regime keeps in poverty the majority of humanity, especially populations in Africa and Latin America. The aggressive liberalization of international trade has given tremendous power to the big monopolistic business. The relevant evolution has been aided by international institutions, such as the World Bank and the International Monetary Fund as well as the World Trade Organization. Multinational organizations push prices under cost and make it impossible for small producers to compete on the market place.

For example, with reference to coffee, there are five big business (Philip Morris, Nestle, Sare Lee, Procter and Gamble and Tchibo), which control around the 70% of the global market (Schmelzer, 2006). In the meanwhile, the level of capital concentration constantly increases (Gibbon, 2005). In the coffee trade, exporters received US\$ 10-12 per year during the eighties, while only half of it, US\$ 5.5, in 2003 (Osorio, 2004). On the other hand, retail sales in developed countries increased from US\$30 billion in the 1990 to around US\$80 billion in 2003 (Osorio, 2004).

Against free trade, another type of trade, namely Fair Trade, offers to small producers in the underdeveloped countries a guaranteed minimum price, usually above the current world price for each product. According to the **International Federation for Alternative Trade (IFAT)** Fair Trade aims to offer fairer trade relations, protection of human and working rights and support to economic development to the less developed countries (IFAT, 2007).

Fair Trade increased rapidly during the last decade in Europe and North America, while in Greece it has been recently introduced by the Altromercato shops in Athens and Thessaloniki. These shops deliver a plethora of fair products and they are expanding their product line frequently. The steering group (that established Fair Trade in Greece) also developed a group of supporters, who are usually the first to buy the fair products, join the Fair Trade events and happenings etc. The management of Altromercato shops holds a number of ideas concerning new product development, among which there might be a traditional marmalade being produced by isolated small producers.

This paper aims to present the results of a research study that examined supporters' intentional purchasing behaviour towards all available Fair Trade products, as well as their preferences about a new fair marmalade. The investigation included a set of variables that may influence future behaviour, such as consumers' level of awareness, their prior buying experiences, their attitudes towards fair principles and objectives as well as selected demographic and psychographic characteristics of the sample.

## 2. Review of the literature

From a marketing point of view, the Fair Trade is considered to be included in the so-called ethical consumption, i.e. the consumption that takes into account the societal norms or, in other words, '*what is good for the society*' (Smith, 1990). Rather recently, in a number of field research papers qualitative or a combination of qualitative and quantitative methodology has been used to investigate consumers' fair behaviour in relevance to other ethical issues, such as slavery (McDonagh, 2002), environmental protection (Lureiro and Lotade, 2005; De Ferran and Grunert, 2007), labour standards and discrimination (Rode *et al.*, 2008).

Most of the studies conclude that there are beliefs and values, which might influence purchasing choices for the Fair Trade products, such as environmental concern, respect for human rights (De Ferran and Grunert, 2007), concern for working conditions (Strong, 1996), idealism (De Pelsmacker *et al.*, 2003), ethical obligation and self-identity (Shaw *et al.*, 1999, 2000, 2003). There are also product attributes such as brand, flavour and label, which were found able to influence the consumers' purchasing behaviour (De Pelsmacker *et al.*, 2003). Implications have been made that the specialized stores should emphasize social responsibility and social-oriented values in their communication, whereas the super markets should offer quality products and constant availability of the Fair Trade products (De Ferran and Grunert, 2007).

Mintel research (2004) suggested that in 2003 only the 28.3% of consumers actually bought Fair Trade products and the majority of these were one-off purchases (Nicholls and Lee, 2006). Cowe and Williams (2000) argued that although most surveys reveal that around 30% of the population is particularly motivated to buy ethical products, these products make up only fewer than 3% of their individual markets. This phenomenon has been named the "30:3 syndrome". Nicholls and Lee (2006), who investigated children, argued that there is an urgent need to develop meaningful Fair Trade brands that combine strong brand knowledge and positive brand images to bridge the gap between ethical attitudes and ethical purchase behaviour. Lastly, there is a recent exploratory consumers' survey of ours (Delistavrou and Tilikidou, 2009), implemented in Thessaloniki, Greece focusing on consumers' intentional purchasing behaviour.

## 3. Theory and Method

It was assumed that what supporters' knew and feel about Fair Trade, as well as their prior experience in fair buying might influence their future purchasing behaviour. Also, that demographic and psychographic characteristics might add to what we know about fair trade supporters. Specifically, with regard to the new marmalade, it was assumed that conjoint measurement might help in determining the mostly desired new product attributes. Five attributes were selected to be investigated: price (€2.30, €2.70, €3.00 per 380gr), organic or not, calories (regular or light, 25% less sugar) or not, sweetener (honey or sugar) and with nuts or not. The orthogonal design provided ten combinations.

## 4. Questionnaire Content

An **Awareness of Fair Trade** four items Guttman's scale: 1 = I have seen Fair Trade products, 2 = I have seen a Fair Trade shop, 3 = I have visited the Fair Trade shop and 4 = I have bought a/some Fair Trade product/s.

A **Past Purchasing Behaviour** scale including 15 items (one for each Fair Trade product category) being measured on a five-point satisfaction scale from 0 = Not at all satisfied to 4 = Absolutely satisfied.

A **Place of Purchase** five items scale: 1= From abroad, 2 = From an S/M, 3 = From the Altromercato in Athens, 4 = From the Altromercato in Thessaloniki.

An **Intentional Purchasing Behaviour** scale, including the same items with those of the **Past Behaviour** scale, served as the main dependent variable of the investigation. It was measured on a five-point possibility scale from 0 = Totally Unlikely to 4 = Very Likely.

A **Fair Trade Attitudes** scale, which was purposively developed for the requirements of this research during a long, antecedent procedure. Details that concern the measure development procedure have been described elsewhere (see Tilikidou and Delistavrou, ---). The final scale that was used in this survey included 24 items, measured on a five-point Likert scale. The Fair Trade Attitudes scale had been tested in an exploratory consumers' survey (Delistavrou and Tilikidou, ---) and provided a Cronbach's alpha value of 0.8792. As it indicated an accepted level of reliability according to Robinson *et al.* (1991), it was judged suitable to be used in the supporters' group as well. In this study the scale provided a 0.7780 Cronbach's alpha.

Five demographic characteristics (gender, age, education, income and occupation) were added in the investigation, being measured on the N.S.S.G. scales. The following four psychographic scales were also employed: **Universalism** (six items) and **Power** (three items) - adopted from the Schwartz's (1992) *List of Values* - as well as **Collectivism** (four items) and **Individualism** (three items) - adopted from Shrum and McCarty (2001). They provided the following Cronbach's values: Universalism ( $\alpha=0.7206$ ), Power ( $\alpha=0.7942$ ), Collectivism ( $\alpha=0.8582$ ) and Individualism ( $\alpha=0.6533$ ). With the exception of the Individualism scale, all other reliability coefficients fell well within the acceptable limits according to Robinson *et al.* (1991).

The ten combinations of the marmalade attributes were presented to the respondents by the ten following cards:

Marmalade 1: Organic, With Honey, No Squarely, €2.30/380gr

Marmalade 2: No Squarely, €2.70/380gr

Marmalade 3: With Honey, Light (25% less sugar), No Squarely, €3.00/380 gr

Marmalade 4: Organic, Light (25% less sugar), No Squarely, €2.70/380gr

Marmalade 5: With Honey, With Nuts, No Squarely, €2.70/380gr

Marmalade 6: Organic, With Nuts, No Squarely, €3.00/380gr

Marmalade 7: Light (25% less sugar), With Nuts, No Squarely €2.30/380gr

Marmalade 8: Organic, Light (25% less sugar), With Honey, With Nuts €2.70/380gr

Marmalade 9: Organic, Light (25% less sugar), With Honey, No Squarely €3.00/380gr

Marmalade 10: Organic, With Honey, With Nuts, No squarely, €2.30/380gr

The respondents were asked to rate each one of the marmalade combinations on a rating scale from 0 to 10 and then tick whether they were going to buy (or not) each marmalade. The questionnaires were delivered through internet to the Fair Trade Hellas supporters' data base but the response rate (20%) was not very satisfactory.

## 5. Results

The **Awareness** scale indicated that 93.9% of the supporters have previously bought a fair product. The **Place of Purchase** indicated that most of the supporters (83.6%) had made their prior purchases from the Altromercato in Thessaloniki. The **Past Purchasing Behaviour** takes theoretical values from 0 to 60 and provided a Mean of 29.4286, which indicates an average overall satisfaction of their prior experiences. The higher satisfaction Means (above 3 in a 0 to 4 scale) were found with reference to sugar, snacks, souvenirs and coffee. The lower Means were found with reference to cosmetics and clothes.

The **Intentional Purchasing Behaviour** scale takes theoretical values from 0 to 60 and provided a Mean of 43.6047, which indicates that supporters are rather likely to make a future purchase of fair products. With reference to product categories, the higher Means were obtained by snacks, coffee, pasta, rice, sugar and souvenirs.

With regard to the personality variables it is observed that the **Universalism** scale takes theoretical values from 0 to 24 and provided a Mean of 21.9394, which is a very high level of universalistic values; on the opposite, the **Power** scale takes theoretical values from 0 to 12 and provided a Mean of 2.7273, which indicates an overall absolute disagreement to the power values. The **Collectivism** scale takes theoretical values from 0 to 16 and provided a Mean of 11.7846, which indicates a general agreement to the collectivistic values, while on the opposite the **Individualism** scale takes theoretical values from 2 to 12 and provided a rather low Mean of 4.7077.

The **Fair Trade Attitudes** scale takes theoretical values from 0 to 96 and provided a Mean of 77.7500, which indicates a generally rather high level of positive attitudes towards fair trade principles.

According to the item means (Table 1) supporters mostly believe in the ability of Fair Trade to assist the Third World producers to earn a fair income, decent living standards, human and working rights; this is because Fair Trade can secure a minimum price for each product. They also believe that buying fair products simultaneously informs and educates consumers in a socially responsible behaviour. On the other hand, supporters strongly disagree that Fair Trade claims are nothing more than advertising tricks, that it is not their own responsibility to help the less developed countries, that it is aimless to buy fair products since not many other people do so or that they harm the Greek products by preferring the Fair Trade products. Also, they do not think that they should be exclusively interested in the financial problems of their own country.

**Table 1 Fair Trade Attitudes**

		<b>Mean</b>	<b>Std. Dev.</b>
D01	I stand for a Fair Trade network, which can ensure a fair price for each product of the less developed countries	3.3692	0.8762
D02	Fair Trade may contribute to the balancing of inequality, which rules the free world trade	3.2687	0.8087
D03	Fair Trade is able to assist the Third World producers to sell their production and earn a fair income	4.0597	4.9875
D04	Fair Trade may contribute to the abolition of poverty in the economically weak countries	3.2090	0.8264
D05	The problem of the economically weak countries can not be faced by such movements as Fair Trade	1.5224	0.9105
D06	Every man is entitled to decent standards of living as well as health care, education, security and democracy	3.9403	0.2955
D07	Human and working rights of people in the Third World should be protected	3.9254	0.3169
D08	Fair Trade is able to contribute to the protection of the human and working rights of people in the Third World	3.1940	0.7228
D09	Eventually Fair Trade is going to assist to the development of infrastructure for security, education, health care and social welfare in the economically weak countries	3.0448	0.7474
D10	Fair Trade may contribute to the abolition of child labour	2.9701	0.8343
D11	Fair Trade may contribute to the parity of women in their work. family and local society	3.0448	0.7674
D12	It seems fair to me to pay a premium for a fair product in order to contribute to the welfare of people in the Third World	3.1791	0.8151
D13	Buying fair products simultaneously informs and educates consumers in a socially responsible behaviour	3.3433	0.8081
D14	The Fair Trade products are not as good as the regular products in terms of quality	0.9848	1.0596
D15	Fair Trade claims are nothing more than advertising tricks	0.6866	0.7428
D16	I believe that the Fair Trade advertisements would be distinguished by honesty	2.7692	0.8798
D17	I would like to have the chance to find the Fair Trade products in many other places than the specialized stores	3.1515	0.8813
D18	The Fair Trade shall acquire better prospect if the fair products enter the big S/Ms	2.4697	1.2676
D19	The Fair Trade contributes to the protection of the environment and to the sustainable development as well	3.1231	0.7808
D20	It is not my own responsibility to help the less developed countries	0.5303	0.8453
D21	It seems aimless for me to buy fair products since not many other people do so	0.4394	0.8063
D22	I don't think that poverty in the Third World might be challenged if I bought fair products	1.0758	1.0423
D23	I harm the Greek products by preferring the Fair Trade products	0.7879	0.7129
D24	I am exclusively interested in the financial problems of my own country and not in the problems of the less developed countries	0.4848	0.6138

With regard to the attributes of the new marmalade conjoint analysis was conducted through SPSS. Pearson's  $r$  and Kendall's tau were found significant ( $p < 0.001$ ). The part – worth scores (utilities) indicate the influence of each factor level on respondents' preference for a particular combination. It is observed (Table 2) that price was the most important factor (31.37% average importance) followed by organic (27.48%) and sweetener (20.03%). The rating (from 1 to 10) also indicated that the higher Mean (7.3220) was obtained by Marmalade 10 (see Table 3), which means that this combination is considered to be the better of all. On the other hand, more consumers declared their intention to buy Marmalade 1 (86.2%), while Marmalade 10 and Marmalade 6 captured the second place (70.8%) in the consumers' intentions to buy them.

**Table 2 Conjoint analysis results**

Averaged Importance	Utility	Factor
+-----+		<b>ORGANIC</b>
I27.48 I	-0.3882	--I no
+-----+	0.3882	I--- yes
+-----+		<b>SUGAR</b>
I20.03I	-0.2829	--I honey
+-----+	0.2829	I-- sugar
+-----+		<b>CALORIES</b>
I18.48I	-0.2610	--I regular
+-----+	0.2610	I-- light
++		<b>NUTS</b>
2.64 II	0.0373	I no
++	-0.0373	I yes
+-----+		<b>PRICE</b>
I31.37 I	-0.2076	--I 2.70
+-----+	-0.3392	--I 3.00
I	0.5468	I---- 2.30
6.1813	CONSTANT	
Pearson's R = 0.996	Significance = 0.0000	
Kendall's tau = 1.000	Significance = 0.0003	
Kendall's tau = -1.00 for 2 holdouts	Significance = 0.0000	

**Table 3 Rating and purchasing intentions**

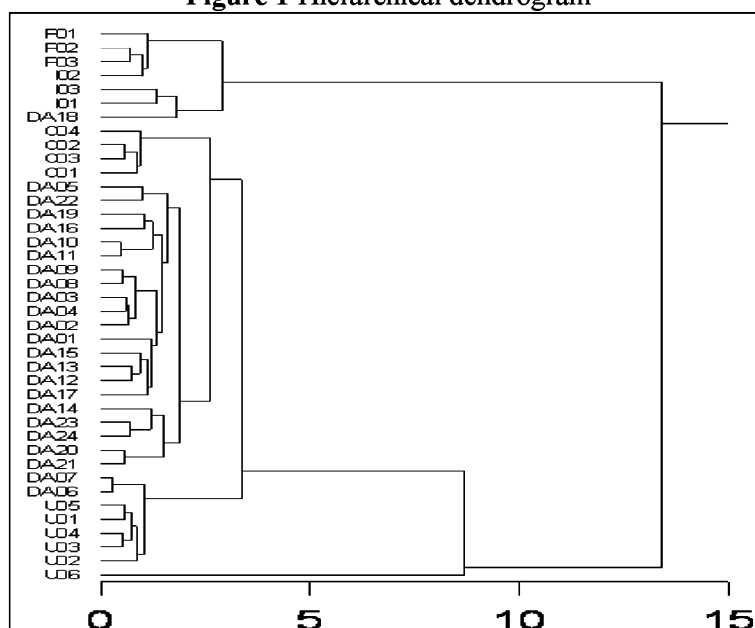
	Rating Mean	Purchase (% YES)		Rating Mean	Purchase (% YES)
<i>Marmalade 1</i>	7.1846	86.2%	<i>Marmalade 6</i>	6.9153	70.8%
<i>Marmalade 2</i>	5.6230	52.3%	<i>Marmalade 7</i>	5.4912	32.3%
<i>Marmalade 3</i>	5.0484	27.7%	<i>Marmalade 8</i>	6.1186	52.3%
<i>Marmalade 4</i>	6.2581	55.4%	<i>Marmalade 9</i>	5.6102	36.9%
<i>Marmalade 5</i>	6.3051	58.5%	<i>Marmalade 10</i>	7.3220	70.8%

The One-Way ANOVA was employed to examine the mean differences in **Intentional Purchasing Behaviour** across each one of the demographic characteristic, but no statistically significant results were found.

As the other parametrical statistical techniques failed to provide statistically significant relationships, we employed the non-parametric technique of Hierarchical Analysis (Figure 1) to explore the associations among the items of the attitudes and psychographics. The most interpretable solution resulted in two clusters. In cluster A, Universalism items appear at the bottom of the almost whole set of the attitudinal items, while

the Collectivism items appear at the top of it. In cluster B there is only one item (DA18) of the attitudinal items, which is joined together with the Individualism and Power items.

**Figure 1** Hierarchical dendrogram



It seems that the attitudes towards Fair Trade principles and objectives are encompassed by the universalistic values from one side and by the collectivistic values from the other side. This means that people's values about equality, democracy, care to the nature, protection of the weak, harmony and peace, from one hand, and also values about team goals, from the other hand, are closely associated to principles about decent standards of living, human and working rights for people in the Third World and beliefs about the ability of Fair Trade to help the Third World producers to sell their production and earn a fair income. It is to be noted that the power and individualistic values are associated with just one attitude, which concerns the entry of the fair products into the S/Ms. Most probably this finding needs further discussion.

## 6. Discussion

It is to be firstly noted that the limited sample size minimized the statistical data analysis and thus this discussion should be taken as a preliminary step to understand more deeply supporters' feelings and intentions.

According to our results the "30:3" syndrome - which is the rule in consumers' surveys - is not at all apparent among the supporters' group. Almost all of them have actually bought fair products, while they declared their intentions to keep doing so. However, future research might very well include further details in supporters' buying behaviour, such as frequency of purchase, money spent, on-line shopping etc, beyond their preferences towards product categories.

Very strong beliefs (as expected) were stated with regard to the necessary aid for people in the less developed countries to gain a minimum price for their products, as well as towards the necessary protection of their human and working rights. It is to be noted though, that supporters also believe that Fair Trade movement is very well able to achieve these goals. Consumers too (see Delistavrou and Tilikidou, - - -) were found to believe in fair principles but they are not so sure that Fair Trade may indeed offer a significant contribution to the situation in the Third World. Further, supporters strongly disagree that they would harm Greek products and producers if they bought fair products, while consumers seem rather sceptic about that. On the other hand, even committed supporters keep some reservations with regard to the honesty of advertisements (see DA16 in Table 1), maybe because they would not like to misdoubt that fair claims are nothing more than advertisement tricks (DA15).

It has to be discussed too that supporters, although they would naturally like to find the fair products more easily (DA17), they do not tend to agree that the fair products should be delivered by the S/M chains (DA18). It is to be noted that the only attitudinal item, which was found closely to power and individualism in hierarchical clustering, is the one that concerns the financial prospects of fair products if entered in the S/Ms. In contrast, the majority of consumers were found to believe very strongly that the fair products shall acquire better prospect if they are entered in the big S/Ms (see Delistavrou and Tilikidou, - - -).

It is an issue of further discussion to discover what lies behind these opinions of supporters. Is it that they are scrupulous consumers, who do not mind the inconvenience to visit a specialized store in the centre of the city in order to buy just a packet of coffee and do their duty to the poor? Or is it that they believe that the fair products do not belong to the S/Ms due to principle reasons. As a matter of fact, the S/Ms are most probably the most profit-oriented part of the retail sector. On the other hand, the fair trade network by principle develops non-governmental, non-profit organizations. This point of view might be connected to a theoretical debate that has already started inside the academic community. The subject of this debate concerns the content and scope of Fair Trade itself. It is questioned whether Fair Trade is in or against the market (Schmelzer, 2006). Further, whether Fair Trade is just another neoliberal solution aiming to profit out of market opportunity, or it is a movement which challenges the free market function and aims to social changes. It is a duty of future research to clarify as much as possible the relevant Fair Trade supporters' beliefs.

## 7. Conclusions

Those supporters, which joined the investigation, were found to hold very strong beliefs towards principles, objectives and effectiveness of the fair trade movement. They are very scrupulous people, who hold strong universalistic and collectivistic values, while low levels of power and individualism. They declared their intentions to buy mostly fair snacks, coffee, pasta, rice, sugar and souvenirs.

With regard to the new fair trade marmalade supporters seem rather happy to welcome it. According to their statements, price is the most important factor. Marmalade 10 is considered to be the better of all; marmalade 1 is their first purchasing choice, while marmalade 10 and marmalade 6 are their second purchasing choice. If these results taken together, they lead to the conclusion that this new marmalade should be offered at a reasonable price and be organic by all means. Also, it might be produced in two types, one that might contain nuts and another that might contain honey.

The low response rate indicated that the Altromercato shops should communicate more often with their supporting group and make better use of their data base. Fair Trade Hellas to take serious consideration of their true feelings. Though limited due to the small response rate, the results of this study open significant paths for future research to follow in order to understand better fair purchasing behaviour and add to the demographical and psychographical profiles of supporters and consumers too. Future research might need to plow to qualitative methods - such as discussion groups - to reveal much more about future fair consumer behaviour.

It is well understood that it is little what we have come to reveal with regard to ethical consumers' actual feelings and preferences. Furthermore, it is also well understood that ethical consumption is not in the mainstream of the marketing academic community and thus it is always neglected by the academic research. It is also acknowledged that, no matter how scrupulous consumers are, the economic crisis in evolution and the constant decrement in the incomes of the working classes restrain their best of intentions. However, as Hopkins (1991) wrote "*while too many people live in total poverty or in regions where consumers' choice is a luxury, there are still several billion who can make a difference through their purchases*".

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# MULTI-CRITERIA ANALYSIS IN STUDENT'S SATISFACTION MEASUREMENT IN HIGHER EDUCATION: THE CASE OF HEALTH CARE MANAGEMENT DEPARTMENT IN THE TECHNOLOGICAL EDUCATIONAL INSTITUTE OF ATHENS

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## **Abstract**

*The measurement of the student's satisfaction from the offered educational task and services in Higher Education, becomes in the current period a necessary tool for the assessment course that all Technological Institutes and Universities should undertake. The measurement and analysis of the student's satisfaction constitutes a significant factor for the improvement of the educational task and the corresponding processes and services given that it provides the departments with remarkable information and results that support their middle term planning and programming for better quality of the educational services.*

*The measurement of the student's satisfaction is obtained with the application of Multi-criteria Satisfaction Analysis. Significant results of the applied methodology are the determination of strong and weak points of the educational services that formulate notable proposals for the improvement of the satisfaction level and the quality of the offered services.*

*Key words: Multicriteria Analysis, Satisfaction Measurement, Quality of Education Services*

## **1. Introduction**

The concept of quality in higher education has received a significant importance recently. Changes brought about by the transition to a knowledge economy have created a demand for higher skills levels in most professions. Consequently countries wishing to move towards the knowledge economy should undertake reforms to raise the quality of their education through changes in content and skills. Education authorities are thus increasingly applying quality assurance and quality control techniques in the management of Universities and academic programs. The need for such an assessment has been also raised by the increasing demand for higher education and the large number of similar academic departments worldwide.

Quality and customer satisfaction are strongly interrelated concepts ( Heskett et al 1994, Roth and Jackson 1995, Oliver and DeSarbo 1989 ) indicating so the great impact that customer satisfaction implies in the quality of the offered services.

In higher education, student's satisfaction plays a positive effect on student's motivation, student's retention and recruiting efforts (Elliot and Shin, 2002).

Patterson et al (1997), Babin and Griffin (1998) have also shown the positive impact of student's satisfaction in minimizing the student's turnover ratio and on the social acknowledgement of the establishment. On the other hand Politis and Siskos (2004), Bouris and Dimas (2009) highlight the effects from the student satisfaction to the department's approach to quality management.

Therefore every educational establishment must adopt an evaluation system for its offered services, so that it can be regularly informed for the degree of its student's satisfaction (Elliot and Shin, 2002).

The aim of this paper is to present a research study on the measurement of student's satisfaction that attend the Health Care Management Department of the Technological Educational Institute of Athens and to show the implications that arise for the improvement of the offered services.

The rest of the paper is organized as follows: section 2 presents the research methodology which comprises the planning of the research and methodological issues, in section 3 the presentation of the results is provided while section 4 summarizes the conclusions and the derived suggestions.

## 2. Research Methodology

### 2.1. Research Planning

The research was conducted in the Technological Educational Institute of Athens for the Health Care Management Department and reflects the satisfaction degree of its students for the spring semester 2008. More specifically the planning of the research was based on the following steps: preliminary analysis, questionnaire development, research conduction, analysis and results.

Preliminary analysis comprises the identification and the settlement of the problem, where the targets of the satisfaction project are clearly determined. The second step comprises the design and the development of the questionnaire as well as the accomplishment of the research. Significant component in this step is the determination of the satisfaction criteria and the measurement scale, that constitute the structure of the questionnaire.

Several criteria have been determined that formed the dimensions of the student's global satisfaction, where each criterion was then analyzed in a number of sub-criteria that captured better the student's satisfaction (table 1). Based on the above dimensions

a simple questionnaire with 31 questions was designed for which a 5-point Likert scale was used (ranged from 'totally agree' to 'totally disagree').

The completion of the questionnaires was obtained by the students during their registration period in all the semesters of the program-study, where the completion time varied from 15 to 20 minutes. 203 questionnaires were completed that correspond to 22% of the active student population of the department.

The internal reliability of the questionnaires was measured with Cronbach's alpha coefficient. The coefficient was estimated to 83% indicating satisfactory levels of internal reliability.

**Table 1: Criteria for Student's Global Satisfaction**

1. PROGRAMME STUDY	2. ACADEMIC STAFF	3. TANGIBLES (EQUIPMENT)	4. ADMINISTRATIVE SERVICES	5. IMAGE – FAME
1.1 Adequacy 1.2 Organization 1.3 Workload 1.4 Profession 1.5 Contiguity 1.6 Course update 1.7 Module variety	2.1 Friendly behavior 2.2 Preparation adequacy 2.3 Communication 2.4 Education methodology 2.5 Objectivity 2.6 Informing 2.7 Availability	3.1 Building adequacy 3.2 Other facilities 3.3 Education material 3.4 Labs adequacy 3.5 Labs timing 3.6 Library Timing 3.7 Library's Reading room 3.8 Lending Procedures 3.9 Library's Electr system	4.1 Correspondence 4.2 Friendly behavior 4.3 Clear informing 4.4 Service speed	5.1 Expectations 5.2 Recognition 5.3 Representation-Promotion 5.4 Interdisciplinary

### 2.2. Methodological Framework

The analysis of the student's satisfaction was obtained with the MUSA method (Multi-criteria Satisfaction Analysis) which constitutes a multi-criteria approach for the measurement of customer satisfaction (Grigoroudis and Siskos, 2002). The method is used for the assessment of global and partial satisfaction functions and  $Y^*$  and  $X_i^*$  respectively, given customers' ordinal judgments  $Y$  and  $X_i$  (for the  $i$ -th criterion). The assumption of an additive utility model is the main principal of the method, and it is represented by the following ordinal regression analysis equation:

$$Y^* = \sum_{i=1}^n b_i X_i^* - \sigma^+ + \sigma^-$$

where  $Y^*$  is the estimation of the global value function,  $n$  is the number of criteria,  $b_i$  is a positive weight of the  $i$ -th criterion,  $\sigma^+$  and  $\sigma^-$  are the overestimation and the underestimation errors, respectively, and the value functions  $Y^*$  and  $X_i^*$  are normalized in the interval  $[0,100]$ .

In this context, the customer satisfaction measurement problem may be formulated as an optimization problem using goal programming techniques.

### 3. Results

The analysis indicates that the Health Care Management Department enjoys a high global satisfaction 83,5% (mean value) while the rest 16,5% of the students claim to be unsatisfied from the quality of services provided by the Department.

In particular the students appear to be fully satisfied with the Image-Fame of the Department and quite satisfied with the Program Study, Academic Staff and Administrative Services (figure 1), with the exception of Tangibles (Equipment) which amounts to 63,3%.

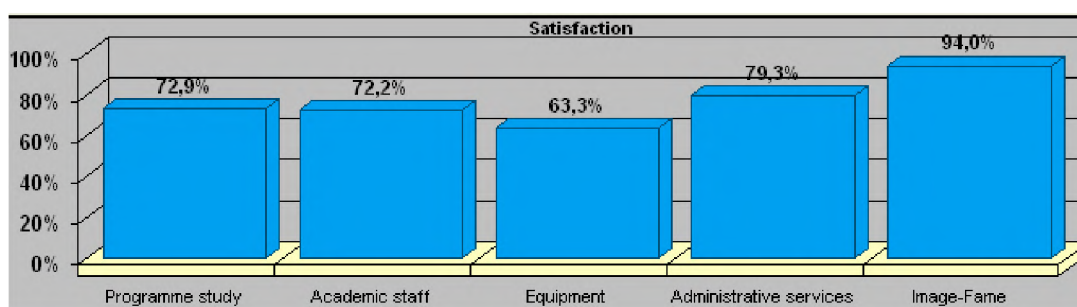


Figure 1: Student's satisfaction in different criteria

The high level of satisfaction for the criterion Image of the Department can be rather attributed to the recognition the Department receives and the competition among similar Departments of other Universities and Technological Institutes.

On the other hand the most significant criterion for the students seems to be the Image-Fame of the Department with a weight factor of 51,1% (figure 2) whereas the rest of the criteria carry much smaller weights, indicating thus the improvement that should be obtained in the performance of those criteria.

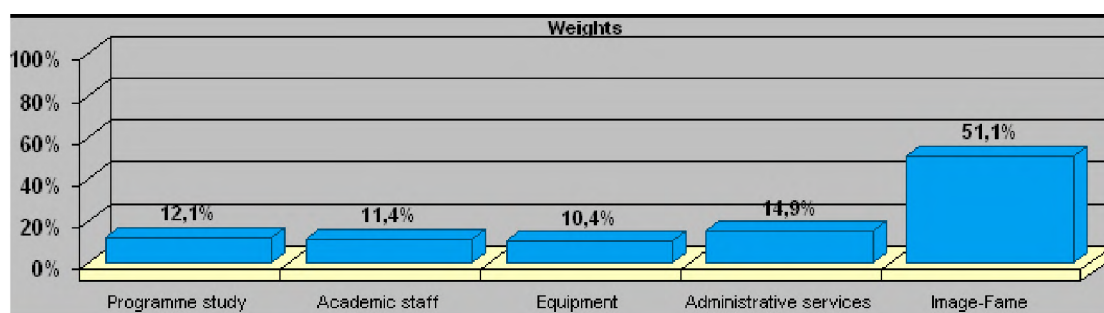


Figure 2: Weight factors for the satisfaction criteria

All five criteria show negative demanding levels (figure 3) implying that students appear to be neutral or non demanding so that the total demanding index is measured to  $-0,60\%$ .

Demanding indexes ( $D$ ) express the average deviation between satisfaction functions and linear value functions with the following interpretation:

Non demanding students ( $D = -1$ ) are those that declare satisfied although their expectations are fulfilled in a low level.

Neutral students ( $D = 0$ ) are the students whose satisfaction increases proportionally to their fulfilled levels of expectations.

Demanding students ( $D = 1$ ) are those students that declare satisfied when they get only the highest level of services.

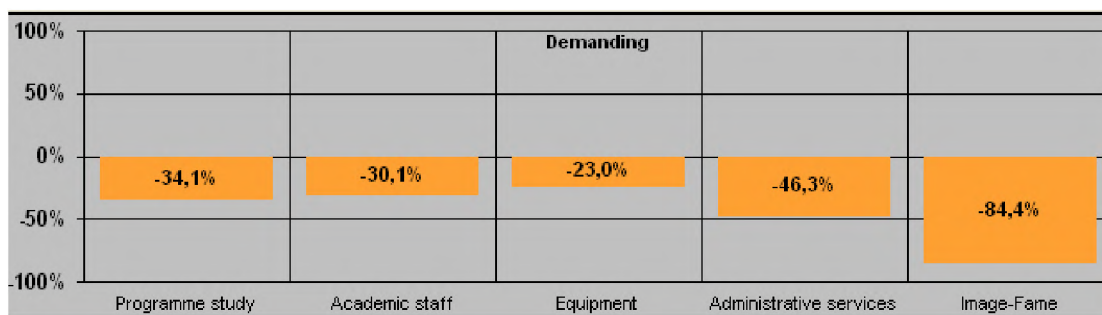


Figure 3: Demanding levels for the satisfaction criteria

Regarding the sub-criteria of each criterion tables 2 and 3 summarizes all the results as far as satisfaction indices, weights and demanding levels are concerned.

Table 2: Sub-criteria indexes

CRITERIA	SATISFAC	WEIGHT	DEMAND
1.PROGRAM STUDY			
1.1. Adequacy	74,9%	0,172	-0,514
1.2. Organization	75,3%	0,167	-0,520
1.3. Workload	75,2%	0,167	-0,512
1.4. Profession contiguity	70,9%	0,167	-0,420
1.5. Course update	75,7%	0,167	-0,520
1.6. Variety of modules	73%	0,161	-0,505
2.ACADEMIC STAFF			
2.1. Friendly behavior	71,7%	0,143	-0,440
2.2. Preparation adequacy	72,3%	0,143	-0,435
2.3. Communicability	75,9%	0,158	-0,497
2.4. Education methodology	68,2%	0,127	-0,369
2.5. Objectivity	71,7%	0,143	-0,440
2.6. Informing	72%	0,143	-0,440
2.7. Availability	73,2%	0,143	-0,435

With respect to the quality of education perceived by the students, it should be noticed that there is room for improvement in all the sub-criteria of the Program Study and Academic Staff particularly for the sub-criteria 1.4. and 2.4. On the other hand all the sub-criteria for the above two dimensions are equally balanced in importance whereas the students seem to appear neutral and non demanding.

A similar picture arises for the sub-criteria in the other dimensions (table 3) where room for improvement exist for all the sub-criteria. However attention should be given in those of the criterion 'Tangibles' and particularly to 3.3 and 3.9 which they possess the lowest levels of satisfaction. All sub-criteria are equally weighted in their dimensions with exception the 'Recognition' sub-criterion in the Image dimension which seems to be the most important in that dimension. Again the students appear to be neutral in the 'Tangibles' sub-criteria and non demanding in the 'Administrative Services' and 'Image' ones.

Table 3: Sub-criteria indexes (continuation)

CRITERIA	SATISFAC	WEIGHT	DEMAND
3.TANGIBLES			
3.1. Building adequacy	64,8%	0,111	-0,208
3.2. Other facilities	65,8%	0,111	-0,226
3.3. Education material	58,4%	0,111	-0,084
3.4. Labs adequacy	65,6%	0,111	-0,240
3.5. Labs timing	66,8%	0,111	-0,280
3.6. Library timing	67%	0,111	-0,280
3.7. Library reading rooms	65,9%	0,111	-0,254
3.8. Lending procedures	66,5%	0,111	-0,280
3.9. Library's electronic system	57,2%	0,111	-0,080
4.ADMINISTRATIVE SERVICES			
4.1. Correspondence	80,2%	0,25	-0,680
4.2. Friendly behavior	80%	0,25	-0,680

CRITERIA	SATISFAC	WEIGHT	DEMAND
4.3. Clear informing	80,1%	0,25	-0,680
4.4. Service speed	79,7%	0,25	-0,680
5.IMAGE-FAME			
5.1. Expectations	92%	0,187	-0,573
5.2. Recognition	96,8%	0,226	-0,645
5.3. Representation-Promotion	94,2%	0,200	-0,600
5.4. Quality	93,4%	0,187	-0,573
5.5. Interdisciplinary	92,4%	0,200	-0,600

It should be mentioned though that student’s expectations from the department were met to a high level obtaining a satisfaction degree of 92% and also the recognition, quality and promotion amounts for high satisfaction degrees as well. The above results may be combined to an action diagram (figure 4) representing the weak and strong points of the student’s satisfaction and indicating the improvements that should be made.

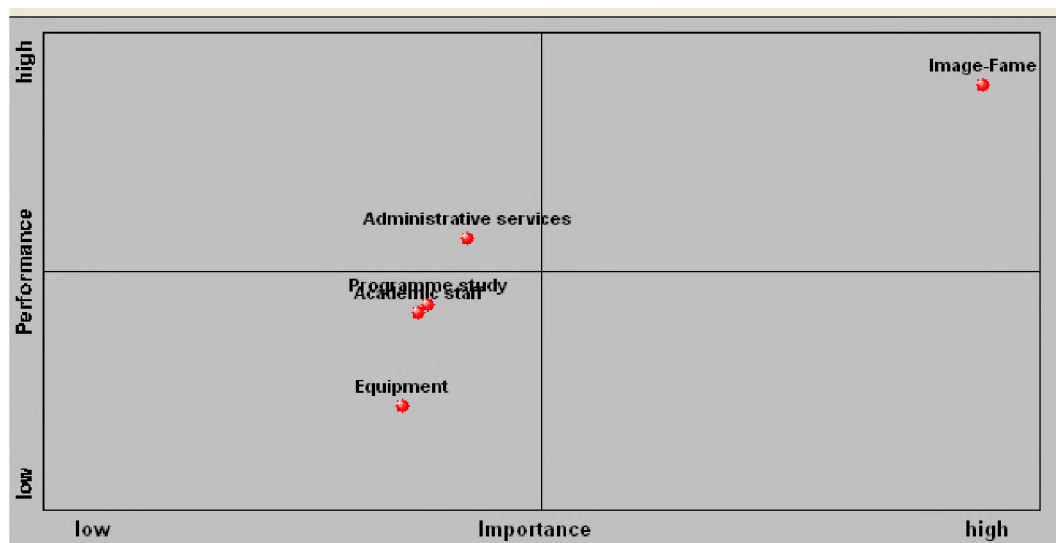


Figure 4: Action diagram for the satisfaction criteria

Action diagrams are designed using the values of the weights and of the satisfaction indices. From figure 4 we observe that the criterion ‘Image’ with high satisfaction level and weight factor lies in the power area (3<sup>rd</sup> quadrant) and constitutes the comparative advantage of the department since it contributes significantly in the formation of the global student satisfaction. On the other hand three criteria (Program Study, Academic Staff, Equipment –Tangibles) are located in the first quadrant (status quo area) which they present low importance and their satisfaction levels are considered low compared with the mean satisfaction level (83,5). Attention should be given initially in the improvement of the satisfaction performance of those criteria and then in their importance, since the student’s behavior changes and therefore the importance of the criteria could be also changed.

#### 4. Conclusions

The increasing competition among universities internationally, due to the spread of technology and the agreements and assessment of the universities, has lead to a furious competition for the students and the academic staff. Satisfaction projects has proven to smoothen the competitive procedure, since they provide the establishments with valuable information regarding the improvement of their educational services.

The current research implies that the quality of education offered at the Health Care Management Department lies at high level. Particularly the basic conclusions are summarized as follows:

- The mean global satisfaction is quite high (83,5%) suggesting though marginal improvements.
- The most important satisfaction dimension and with very high satisfaction degree (94%) is the “Image-Fame” of the department.

The improvement efforts and the suggestions that arise are based on the logic of preserving the satisfaction levels of the strong points while increasing the satisfaction levels of the weak points.

In this respect improvement actions should initiate for the dimension “Tangibles” and all its characteristics since students display the lowest level of satisfaction in that criterion. The policy therefore of the department should be conducted towards that direction in order to improve the quality of its offered services.

However a point that needs investigation is the demanding level of the students that appear to be neutral and non demanding in all the criteria although literature review suggests that students participate actively in the formation and the improvement of the services (Helms and Key, 1994).

A repeated cycle of research is thus recommended to examine those issues and to include other possible factors which affect the satisfaction level of the students.

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# IDEAL HUMAN RESOURCE MANAGEMENT PROFILE VERSUS EXISTING HUMAN RESOURCE MANAGEMENT PROFILE IN GREEK MANUFACTURING INDUSTRY

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## Abstract

*The term of Human Resource Management (HRM), which has prevailed the last years, was used in order to attribute the particular approach of management of labour relations, while it was also often used as a reaction to the term of personnel management. The HRM approaches workforce as the most important capital, which is capable of giving the enterprise a dynamic and viable competitive advantage. In the passage of years the researchers have proposed a lot of HRM practises which have the force to improve and to support the performance of the enterprise.*

*The aim of this study is the determination of the misfit between the "ideal" and the existing HRM model in the Greek industrial sector. Moreover, an attempt is made in order to explore the impact of misfit in the operational performance of the enterprise. For the achievement of the objectives a research, in 208 medium and large size Greek industrial enterprises, was conducted showing a negative impact of misfit in the operational performance of the industry.*

## Introduction

According to Armstrong (2000), the main objective of HRM is to guarantee the capability of the enterprise to acquire success through people. Sisson (1995) thinks that the starting point, for the enterprise, should be the recognition that the person is not simply a factor of production along with the capital and the instruments, but the biggest resource in order for the enterprise to acquire comparative advantages. The effective exploitation of human potential is believed to create competitive advantage for the enterprise (Pfeffer, 1994), while the methods of management of the human resources constitute a precious creative source of competitive advantage (Amit and Belcourt, 1999). The way that enterprises recruit, educate, reward, motivate and discipline their employees are of central importance for the success of the enterprise. Taking for granted that the human workforce is regarded as the most important component for the success of the enterprise, a lot of enterprises have realised that the people are the ones that can give them comparative advantages (Mathis and Jackson, 2000). The successful management of the human resources constitutes the basic element of the total strategy of growth and success of many enterprises (Mulvie and McDougall, 1990).

## Human Resource Management Practices

The human workforce is a type of resource on which the enterprises do not have a complete control. Nevertheless, there are certain tools which allow them to practise their influence in the quality and the attribution of the human workforce on which they rely on. The HRM practices which they adopt will have great influence in the performance that is achieved by the enterprise (Moriones and Cerio, 2000). The choices of enterprises for special practices and the degree that these practices are completed in a policy connected with the strategy of the enterprise are very important for the competitiveness (Sisson, 1995). Traditionally the HRM practices drew more attention from service companies than industrial companies. Nevertheless the increase of the operational performance through the right management is equally important for both types of enterprises. We could say that the high technology and the innovative industrial practices alone can bring a small increase in the performance if the essential practices of HRM are not in the position to create a constant social - technical framework. For this reason the industrial enterprises should evaluate carefully the existing practices of human capital and to modify them, if it is essential, so the workers can contribute satisfactorily in the improvement of the operational performance of the enterprise (Ahmad and Schroeder, 2002). Through the passage of years researchers have proposed a lot of practices for human resources who



have the power to improve and to support the performance of the enterprise. These practices emphasise on the choice of workers based on the culture of the enterprise, the behavior, the attitude and the essential technical abilities which are required for the work, the probable compensation for the performance and the intensification of the workers for the fast incorporation to team work (Ahmad and Schroeder, 2002; Moriones and Cerio, 2000). From the literature review we can conclude that the behavior of workers inside the enterprise has an important impact in the performance of the enterprise and that the HRM practices can influence the individual performance not only through the effect in the skills of workers and the motivation, but also through the structure of the enterprise which allows the workers to improve their work (Huselid, 1995). Various other studies look for the impact of HRM practices in the performance of the enterprise (Kathuria and Partovi, 1999; Kinnie and Staughton, 1991) in the industrial relations and in the industrial and enterprising psychology (Jones and Wright, 1992; Kleiner, 1990). The bibliography moreover widely reports that the HRM practises can help in the creation of a source in a viable competitive advantage, specifically wherever they are aligned with the competitive strategy of the enterprise (Jackson and Schuler, 1995; Porter, 1985).

Delaney *et al.* (1989), in a research, which they carried out in 1986, used ten practices that refer to the fields of personnel selection, evaluation of personnel, high compensations, planning of work, complaining process, diffusion of information, evaluation of behavior and attendance of workers in the process of decision-making. Huselid (1995) in order to create a completed and modern list of high performance processes, in work added in these ten practices, three more which are widely acceptable in their affect in the performance of the enterprise: the intensive effort of recruitment, the average of annual hours of education for each worker and the criteria of promotions. Pfeffer (1994), proposed a list of 16 practises forming the opinion that one of the 16 best practices in the successful enterprises is the measurement of practices while he claimed that the seriously committed enterprises, in order to achieve the competitive advantage, through the people make the measuring of their efforts a critical component in the general process. In 1998 Pfeffer proposed seven HRM practises, decreasing the initial list by merging some of them. These practices which are expected to increase the performance of the enterprise are the following: (1) Employment security, (2) Selective hiring of new personnel, (3) Self –managed teams and decentralization of decision making as the basic principles of organizational designs, (4) High compensation, (5) Extensive training, (6) Reduced status distinctions and (7) Extensive sharing of financial and performance information throughout the organization. Each one of these practices is absolutely related to the others (Ahmad and Schroeder, 2002). The enterprises, depending on the strategy and the capabilities that they have, give different weight in every one of the HRM practises. Formally, when an enterprise puts the biggest possible effort for the growth, establishment and application of every one of these practices it achieves the ideal HRM system. This ideal type of system is expected to produce the higher performance in the enterprise. As closer to the ideal HRM system an enterprise is, so much better its performance will be. According to Ahmad and Schroeder (2002), if the co-operation between the practises is subsantiated, then an enterprise with an HRM system similar to the ideal type will interpret considerably the biggest part from the variation in the performance of the enterprise than whichever individual HRM practises or anyother combination of them.

## **Research Methodology**

### **Data Collection**

Field of the research constituted the sector of Greek industry. The Greek industry, as most sectors of the Greek economy, is characterized by the small size of the enterprises as only 2% of these industries have more than 500 employees (ICAP, 2002). The target population of the research constitute by 5.964 industries which are reported in the list of S.E.V (Hellenic Federation of Enterprices). An effort was made to cover most industrial sectors, according to the classification of NACE (National Classification of Economic Activity-rev.1), from all the regions of the country.

The collection of needed information was contacted by the use of questionnaire which was dispatched by post, fax or via e-mail in randomly selected industries. From 285 questionnaires that were sent in total, 212 returned completed. Response rate reaches 75% and is considered very satisfactory, particularly if it is compared with the average of 20% that Young (1996) reports for researches that are made in enterprises and are addressed to superior executives. In similar researches as those of Ahmad and Schroeder (2002) the response rate was 60%. In the final sample which is constituted by 208 industrial units, more than 100 are found in the list of the 500 biggest industries of our country, with an average of 270 permanent employees and average annual turnover of 82 million €.

## Measurement of Variables

Pfeffer's seven HRM practices were selected for the purpose of this research, while the questionnaire of Ahmad and Schroeder (2003), after some indispensable modifications, was the basic research instrument. In each question (statement), the personnel managers answered using the following five-point Likert scale: 1 = It never happens, 2 = It seldom happens, 3 = It happens some times, 4 = It often happens and 5 = It always happens. In this way was estimated the degree of application of HRM practices by the Greek manufacturing companies.

Moreover, in order to determine the Greek "ideal" HRM model, according to personnel managers, it was asked by them to declare their degree of importance of each statement using the following five-point Likert scale: (1) Unimportant, (2) Of little importance, (3) Moderately important, (4) Important and (5) Very important. In order to measure operational performance 3 variables were used from the work of Hill (1989) and 2 variables from the work of Vickery et al. (1997). In each of these variables the responsible were asked if the performance in their company is: (1) Very below average, (2) Below average, (3) On average, (4) Above average and (5) Very above average of the industry.

The content validity of the questionnaire was ensured through pre-test and structured interviews with the personnel managers and academic experts in the field. For the test of construct validity, was conducted: a) Exploratory Factor Analysis and b) Reliability Analysis with the use of S.P.S.S 17.0.

All items that did not contribute strongly to the corresponding factor (practice) or to the alpha value were removed. After the purification of the factors, was calculated the average score from all the items of the factor and the average score became the value representing the factor.

## Data Analysis- Results

Thirteen factors have been created from the seven practices and their mean scores are presented in the table below.

**Table 1: Means of Practices**

Practices	Factors	Original Mean	Greek Ideal Mean	Ideal Mean
<b>1. Employment insecurity</b>	1. Employment insecurity (2)*	4,05	4,17	5
<b>2. Selective hiring</b>	2.1 Manufacturing and human resources fit (5)*	3,73	4,14	5
	2.2 Behavior and attitude (7)*	3,70	4,11	5
<b>3. Use of teams and decentralization</b>	3.1 Team activities (6)*	3,63	4,06	5
	3.2 Interaction facilitation (3)*	3,57	4,18	5
<b>4. Compensation contingent on performance</b>	4.1 Contingent compensation (3)*	2,55	3,61	5
	4.2 Incentives to meet objectives (4)*	3,30	4,17	5
<b>5. Extensive training</b>	5.1 Training on job skills (5)*	3,64	4,19	5
	5.2 Training in multiple functions (4)*	3,64	4,08	5
<b>6. Status differences</b>	6. Status differences (4)*	2,65	3,00	5
<b>7. Sharing information</b>	7.1 Communication of strategy (4)*	3,86	4,25	5
	7.2 Feedback on performance (3)*	2,95	3,69	5
	7.3 Diagrams (4)*	2,47	3,27	5

\*number of items in each factor

The results of table 1, show that the enterprises, depending on the strategy and the capabilities that they have, give different weight in every one of the HRM practises. According to researchers, the extend of application of practices which are applied can differ between the sectors and/or the countries for various reasons, such as the culture and the temperament (Salk and Brannen, 2000), the governmental regulations and the policies (Morishima, 1995), the competitive priorities (Boxall and Steeneveld, 1999), and the application of different management practices (Snell and Dean, 1992). Hofstede (1980) also argued that the national culture affects in the attitude and in the behavior of the workers. In an enterprise which is activated in different countries the culture of workers is considerably different. Consequently the choice of the practises that every enterprise will choose constitutes an important factor in the determination of the degree at which the practices will contribute in the improvement of the performance (Bailey, 1993; Guest, 1997; Huselid, 1995).

From table 1 arises also that the model that the Greek personnel managers believes as “ideal” for the Greek industrial units is fairly different from the one proposed by theory and other foreign managers. The Greek “ideal” model, in the contex of this study, is the model that arised from the declarations of Greek personnel managers.

Table 2 shows a positive and in some cases strong correlations, among the different HRM practices confirming the opinion of Ahmand and Schroeder (2003) who argue that when a company increases its effort in one of the HRM practices, increases the effort in the other practices also.

**Table 2: Correlation Coefficients among factors**

	1.	2.1	2.2	3.1	3.2	4.1	4.2	5.1	5.2	6.	7.1	7.2	7.3
1.	1												
2.1	,240**	1											
2.2	,293**	,610**	1										
3.1	,295**	,494**	,591**	1									
3.2	,250**	,502**	,621**	,735**	1								
4.1	,179*	,365**	,416**	,469**	,490**	1							
4.2	,172*	,388**	,560**	,486**	,581**	,637**	1						
5.1	,365**	,465**	,608**	,507**	,621**	,466**	,605**	1					
5.2	,121	,301**	,452**	,463**	,418**	,322**	,437**	,475**	1				
6.	,015	,038	,077	,040	,032	,074	,140*	,084	,047	1			
7.1	,229**	,444**	,562**	,539**	,563**	,445**	,617**	,619**	,382**	,012	1		
7.2	,142*	,435**	,535**	,491**	,572**	,516**	,563**	,626**	,407**	,068	,665**	1	
7.3	,087	,337**	,378**	,338**	,398**	,453**	,412**	,421**	,283**	,046	,448**	,753**	1

\*p<0.05, \*\*p< 0.01.

In order to determine the misfit and its impact on operational performance of companies, in this study defined as misfit the dissimilarity between the “ideal” and the existing HRM model and the following formula is used to calculate it.

$$MISFIT_i = \frac{\sum_{k=1}^n (x_k - x_{ik})^2}{k}$$

where  $x_{ik}$  is the score of  $k$ th factor of the existing HRM model of a particular unit  $i$ ,  $x_k$  is the score of the  $k$ th factor of the “ideal” HRM model and  $k$  the factors representing the HRM model. In this study  $i$  varies from 1 to 208 and  $k$  varies from 1 to 13. The MISFIT, in each company, can be ranged from 0 to 16.

**Table 3: Paired Samples t- test**

Factors	t- value	Sig. (2 tailed)
1. Employment insecurity	-2,644	0,009
2.1 Manufacturing and human resources fit	-8,802	0,000
2.2 Behavior and attitude	-9,751	0,000
3.1 Team activities	-10,326	0,000
3.2 Interaction facilitation	-11,097	0,000
4.1 Contingent compensation	-13,335	0,000
4.2 Incentives to meet objectives	-12,331	0,000
5.1 Training on job skills	-10,714	0,000
5.2 Training in multiple functions	-8,390	0,000
6. Status differences	-18,346	0,000
7.1 Communication of strategy	-8,422	0,000
7.2 Feedback on performance	-12,609	0,000
7.3 Diagrams	-9,948	0,000

It is obvious from the table 3 that there are statistically significant differences between the existing and the “ideal” HRM model, in all the factors and consequently in all the practices ( $p < 0,01$ ). That means that the Greek industrial units do not apply the practices according to the manager’s desires and instructions but according to the owner’s and the economical and organizational capabilities that they have.

The relationship between the operational performance and the partial MISFIT of each factor that constitutes the HRM practices is negative as all the correlation coefficients are negative. The same is happening between the operational performance and the MISFIT of the sum of factors that constitutes the HRM model. In particular, the correlation coefficient is  $-0,288$  and is significant at  $0,001$  level. Formally, when an enterprise puts the biggest possible effort for the growth, establishment and application of every one of these practices it achieves the ideal HRM system. This ideal type of system is expected to produce the higher performance in the enterprise. As closer to the ideal HRM system an enterprise is, so much better its performance will be.

## Conclusions

The Greek Industrial sector doesn't use the HRM practices in such an extensive way. Gives priority to the employment security and to the communication of strategy while considers as less important the contingent compensation and the status difference. However, there is a strong and positive relationship among the practices. There is also, a significant difference between the HRM model that is applied and the “ideal”, according to Greek personnel managers. Moreover, the MISFIT of each practice is negatively related to the operational performance and the same happen more intensely between the total MISFIT and operational performance.

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# A MULTIVARIATE LOGISTIC MODEL FOR COMPETING TECHNOLOGICAL PRODUCTS IN A MARKET

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## Abstract

*We propose a multivariate extension of discrete logistic model to represent the whole competition of  $m$  technological products, coming from a technology, in a specific market. The relation to Lotka-Volterra model is examined and used for an improvement of the model. We apply the proposed model to the data set of the Greek mobile phones market data, consisting of 3 competitors, to evaluate model performance in fitting and forecasting. In both markets the model fitting and forecasting performance is acceptable and encouraging. Finally some remarks, conclusions and future tasks are discussed both methodological and practical about multivariate logistic model.*

## 1. Introduction

The progress of technology results to the design and introduction of new technological products that finally appear to every day life of citizens in society. In the case of technological products introduced to the market for the customer, usually more than one companies or organizations produces and supply the product. For the whole market of the technology an innovation diffusion process is expected until the product or technology adopted by all potential customers. A competition for maximum market share and profit between those competing products and companies take place. Improvements of the products lead to substitution of earlier products by superior products. An example is the analysis of computers market evolution during last decades [1, 2].

To study the adoption process of the technological products one can use the known technological forecasting models such Logistic, Bass, Fisher-Pry, etc. Lately are presented and are available even stochastic versions of those models [3]. A problem arise when the products of technology sold by more than one company, then the competing products on the same market can studied by summing up all the products data or product per product individually. It is also known from literature specific models of technological substitution and multiple generation products [2, 4], but this is not the main case studied here.

It is useful from many points of views to study the whole competition of the competing technological products and companies. From the companies point of view it is important to take into account the competition and competitors, from the technology point of view it is important to examine if the competition change the adoption process and how this done. Finally from the customer point of view it is generally accepted that competition is offering better products, prices or both. For example, in the report of OECD [5] about mobile telecommunications worldwide, it is pointed out that the penetration rate of mobile phones is higher in countries with more competitors in the market.

In this paper we use the discrete form of logistic model to represent mathematically the whole competition of  $m$  technological products of a technology in a particular market. Some basic considerations are the potential of the market, the potential adopters of technology (buyers of the products), known as saturation point in technological forecasting. The products are buoyed by imitation of non-customers to customers (adopters). A customer buys the product that seem to him more attractive or suitable to particular personal needs.

Because of multiple products or companies who offer the product, the whole market data is a multivariate time series. To study the whole competition at once, a multivariate model is needed to represent the evolution of all products in the market. Each product (or company) represented by a variable of the multivariate model. The common point of these products is that shares the same market and serves a particular need of the customers. Modis [6, 7] proposed the use of two variables Lotka-Volterra model to study such data.

In section 2 starting from the logistic model in discrete form we introduce a multivariate formulation of the model for  $m$  competing products in the same market by some suggestions, transformations and algebraic calculations. A fitting method is proposed to simplify model application to real data sets, using spreadsheet functions and tools. At section 3 the model applied to the data set of Greek mobile phones market subscribers (cumulative quarterly data), which consist of three competitors. As well it is examined the performance of the proposed model in fitting and forecasting. Finally in the last section we summarize the conclusions for

the proposed model. Also discussed theoretical and practical remarks concerning the application of the model to real data. Future tasks and objectives close this work.

## 2. The Discrete Multivariate Logistic Model

A classic formulation of normalized univariate (single variable) discrete logistic model [9, 10, 11] is:

$$x_{n+1} = x_n b(1 - x_n) \quad (1)$$

where  $x$  variable take values in the interval  $(0,1)$ . For the case of a technological product, the variable  $x_n$  measures for example the buyers of the product (as market share percentage),  $b$  is the control parameter of growth (imitation coefficient) and the term  $(1-x_n)$  measures the remaining potential customers (buyers) on the market. The evolution of the product in the market depends on all previous terms and parameters. For logistic equation (1) it is known that the model values  $x_n$  converges to the value  $(1-1/b)$  as  $n$  goes to infinity (if  $1 < b < 3$ ), independent from the starting value  $x_0$  [10,11]. Because sometimes is difficult to transform meaningful the available data to vary between 0 and 1, a different formulation of logistic model is useful. An appropriate transformation of the model is the following such that  $x_n$  can get values between 0 and  $K$  (positive value):

$$x_{n+1} = x_n b \left( \frac{K - x_n}{K} \right) \quad (2)$$

after some calculation yields:

$$x_{n+1} = bx_n - \frac{b}{K} x_n^2 \quad (3)$$

In this form the parameter  $K$  represent the carrying capacity (saturation level) of the market, all the potential consumers of the product. The term  $\frac{K - x_n}{K}$  of eq. (2) is the substitution of the term  $(1-x_n)$  in equation (1) and represents the remaining potential of the market. The values of  $x$  now converge to the value  $K(1-1/b)$  as  $n$  grows.

This formulation of the model remains problematic because the model cannot take all the values in the whole interval  $(0, K)$  but only in the interval  $(0, K \frac{b-1}{b})$ . It is preferable to have the model written in a form such that  $x$  can take values in the whole interval  $(0, K)$ , and saturates to market size  $K$ .

Observing that the limit value of  $x$  in eq. 2 is  $K \frac{b-1}{b}$ , we introduce a new transformation of logistic model.

By using a new parameter  $M$  such that  $M = K \frac{b-1}{b}$  in equation (2), replacing the  $K$  parameter  $K = \frac{Mb}{b-1}$  yields the logistic model of the form:

$$x_{n+1} = x_n \frac{(b-1)}{M} \left[ \frac{Mb}{(b-1)} - x_n \right] \quad (4)$$

after some simplifications:

$$x_{n+1} = bx_n - \frac{(b-1)}{M} x_n^2 \quad (5)$$

Now the limit value of  $x$  variable after the required iterations is  $M$ , the real saturation limit (market size) of the product diffusion to the market.

### 2.1 Building the Multivariate Logistic Model

In equation (4) of the logistic model the term  $\left[ \frac{Mb}{(b-1)} - x_n \right]$  represents the remaining potential of the market. If there is another competing product  $y$  in the same market, then in the previous term of equation (4)

is needed to introduce the second competitor (e.g. the y competitor value in the market). A simple way to do that is to use the term  $\left[ \frac{Mb}{(b-1)} - x_n - y_n \right]$ , inserting the  $y_n$  value of product y. By this term we take in consideration the true remaining potential of the market for product x and y both. The evolution in the market of the y product can be handled by a similar equation of (4) and (5). The system of differences equations for the two competing products x, y in the market yields:

$$\begin{aligned} x_{n+1} &= x_n \frac{(b_x - 1)}{M} \left[ \frac{Mb_x}{(b_x - 1)} - x_n - y_n \right] \\ y_{n+1} &= y_n \frac{(b_y - 1)}{M} \left[ \frac{Mb_y}{(b_y - 1)} - x_n - y_n \right] \end{aligned} \quad (6)$$

after some calculations resulting the system of differences equations below:

$$\begin{aligned} x_{n+1} &= b_x x_n - \frac{(b_x - 1)}{M} (x_n^2 + y_n x_n) \\ y_{n+1} &= b_y y_n - \frac{(b_y - 1)}{M} (x_n y_n + y_n^2) \end{aligned} \quad (7)$$

is reasonable to suggest that the values of parameter b for each product x,y generally are different,  $b_x$ ,  $b_y$  respectively. By this system of differences equations we can represent and examine the competition of two products in the same market. The common parameter in the system of equations (7) is the parameter M, the size of the market, because competitors compete each other for this. We call eq. 7 the Multivariate Logistic (ML) model with 2 products (variables).

## 2.2 Generalization to Three and More Competitors in the Market

Using the same approach that above to pass from univariate logistic model to competition of 2 products in a market (from eq. 4 to eq. 6), it is easy to arrive at 3 products x, y, z Multivariate Logistic model. Simply incorporate the third product z value  $z_n$  in equation (6).

The system of difference equations for the case of three products, competing in a market, in discrete form is:

$$\begin{aligned} x_{n+1} &= x_n \frac{(b_x - 1)}{M} \left[ \frac{Mb_x}{(b_x - 1)} - x_n - y_n - z_n \right] \\ y_{n+1} &= y_n \frac{(b_y - 1)}{M} \left[ \frac{Mb_y}{(b_y - 1)} - x_n - y_n - z_n \right] \\ z_{n+1} &= z_n \frac{(b_z - 1)}{M} \left[ \frac{Mb_z}{(b_z - 1)} - x_n - y_n - z_n \right] \end{aligned} \quad (8)$$

the Multivariate Logistic model with 3 products in simpler form becomes:

$$\begin{aligned} x_{n+1} &= b_x x_n - \frac{(b_x - 1)}{M} (x_n^2 + y_n x_n + z_n x_n) \\ y_{n+1} &= b_y y_n - \frac{(b_y - 1)}{M} (x_n y_n + y_n^2 + z_n y_n) \\ z_{n+1} &= b_z z_n - \frac{(b_z - 1)}{M} (x_n z_n + y_n z_n + z_n^2) \end{aligned} \quad (9)$$

The associated Extended Multivariate Logistic model derived simply introducing 3 more parameters  $a_x$ ,  $a_y$ ,  $a_z$  in system of equation (9):



$$\begin{aligned}
 x_{n+1} &= a_x x_n - \frac{(b_x - 1)}{M} (x_n^2 + y_n x_n + z_n x_n) \\
 y_{n+1} &= a_y y_n - \frac{(b_y - 1)}{M} (x_n y_n + y_n^2 + z_n y_n) \\
 z_{n+1} &= a_z z_n - \frac{(b_z - 1)}{M} (x_n z_n + y_n z_n + z_n^2)
 \end{aligned} \tag{10}$$

This approach can be extended to m different products  $x_1, x_2, x_3, \dots, x_m$  of a particular technology in a market using the equation:

$$x_{i,n+1} = x_{i,n} \frac{(b_x - 1)}{M} \left[ \frac{M b_x}{(b_x - 1)} - \sum_{j=1}^m x_{j,n} \right] \quad i,j=1,2,..m \text{ products} \tag{11}$$

in simplified form the system becomes:

$$x_{i,n+1} = b_i x_{i,n} - \frac{(b_i - 1)}{M} \sum_{j=1}^m x_{i,n} x_{j,n} \quad i,j=1,2,..m \text{ products} \tag{12}$$

By this simplified approach of the Multivariate Logistic model, the growth of a product  $x_i$  depends on current product position  $x_{i,n}$  in the market, the parameter of product growth rate  $b_i$  (imitation coefficient or competitiveness coefficient) and the remaining market potential (the total market size  $M$  minus the sum of market positions of all competing products).

The control parameter  $b_i$  is the important parameter for the evolution of each product to the market. In cases of m products competition it is reasonable to suppose that the final market position of each product  $x_i$  expected to be analogous of the value of  $b_i$  (and secondly to starting value  $x_{i,0}$ ). Because at every time period each product  $x_i$  gains from the remaining potential of the market a fraction analogous to  $b_i$ , the parameter  $b$  also measures the competitiveness of each product.

The Extended Multivariate Logistic (EML) model for m competitors in a market has an analogous equation of (12):

$$x_{i,n+1} = a_i x_{i,n} - \frac{(b_i - 1)}{M} \sum_{j=1}^m x_{i,n} x_{j,n} \quad i,j=1,2,..m \text{ products} \tag{13}$$

This version of the multivariate logistic model has totally  $2m+1$  parameters (and m "hidden" parameters for the starting values). Parameters  $a_i$  holds the growth of each product and parameters  $b_i$  the market limits and competition.

### 2.3 Fitting the Multivariate Logistic Model to Data Sets

A model is useful if it is easy to apply to real data sets. Here we present a simple method to apply the proposed ML and EML model to a market data set. To fit a model to real data the simplest tool is to use the available software utilities and methods. Data today usually exist in spreadsheet worksheets (or easily transferred to), an easy way to fit the proposed model is to use the solver tool of a spreadsheet. The solver tool or command can find the appropriate values of parameters even in nonlinear relations (model).

To use the solver tool of a spreadsheet needed to write the formula for the model estimations next to real data values column of each product (competitor), with absolute reference to spreadsheet cells containing the values of the model parameters. Then the Squared Errors of model estimations calculated and the Sum of the Squared Errors (SSE) of each product curve. Using the solver tool we ask to minimize the total SSE (sum of all products curves errors), by changing the values of model parameters  $a_i, b_i, M$  and initial values  $x_0$  (actually the values in associated spreadsheet cells).

Because of nonlinearity of the ML and EML model it is necessary to have good starting values of the parameters. In the spreadsheet worksheet it is easy to find good starting values by experimentation, because entering starting values to parameters cells the statistics of fit calculated immediately. In practice required to tested different starting values of parameters, to ensure that solver algorithm converges to best set of parameter values (solution) for the data and not to a local minimum [15].

A disadvantage and theoretical problem of the proposed fitting method is the absence of model parameters and fitting statistics (like Standard Error). But user can estimate the error of fitting and related statistics such

that SSE, Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE) and Mean Absolute Deviation (MAD). From a practical point of view MAPE and MAD is easier to understand by practitioners and decision-makers and will be used to next section.

### 3. Application of the Model to Greek Mobile Phones Markets

Mobile telecommunications is a new technology and hold much attention from scientists of many fields. The diffusion of mobile phones has already studied extensively [13, 5]. In the case of data used here the product actually defined as the subscription of the customer to a mobile phones telecommunications company. Because this technology needs a network to operate, the governments worldwide apply licenses to a limited number of companies that offer mobile telecommunications to customers. Usually market starts to operate with two competitors and new entrances performed later by auctions of the new license. In most European countries today operates 3, 4, or 5 competitors in their markets [5].

#### 3.1 Application to Greek Market Data Set of Mobile Phones Subscribers

The Greek market of mobile phones starts to operate in July 1993 with two competitors, Panafon and Telestet, both with the GSM 900 MHZ system of cellular telephony. The market data where collected from press releases and financial statements of the companies, that exist on their Internet sites. All the data used in this study are available from the author upon request. The data are quarterly cumulative subscribers (in thousands) for the time period Dec 1995- Dec 2000 of each company at the end of each quarter. Data before Dec 1997 are available on yearly basis only. Third competitor Cosmote, a subsidiary of public Greek Telecommunications Organization (OTE), starts to operate later in May 1998.

To apply the Multivariate Logistic model we use the equation (9) for three competing products (companies). The data for each firm start at different time period, for ours formulation of the ML model this is not a problem, in figure 3 is presented the fitting of the model to all available data of Greek mobile phones market. The fit to the Panafon and Telestet data starts at Dec 1995, to Cosmote data at June 1998. As metioned above Cosmote start operate at May 1998, at June reported only about 74 thousands of subscribers. The company already had pre-subscriptions of about 200 thousands of persons, but in June 1998 probably for practical reasons the company did not succed to fill all those pre-orders. The vertical dashed line in figure 3 separate the fitting and forecasting period of the model curves and data. The fit is good and the model predict that in next year Cosmote overpass Panafon subscribers and becomes market leader.

The predicted final market size is  $M=7508.2$  thousands of subscribers and will be reached after about two years (the total population of Greece is about 10500 thousands). The detailed data for parameters values of the ML model fit to Dec 1995-Dec 2000 data, presented in the third column of table 1 under the label ML model. More precicelly in table 1 presented the total fit statistics, the predicted total market size  $M$  (third line) and the total SSE (forth line) of all competitors data fit. To next lines of the table presented the parameters values of model and fitting statistics for each competitor data.

An interesting point is in the values of control parameter  $b$ , Cosmote has the bigger value  $b=1.517$  and that's why predicted to dominate the market next year (finally predicted to reach 3042.3 thousands of subscribers). Follows Telestet with  $b=1.217$ , but his position predicted as third (1931.1 thousands of subscribers).

To next forth column of table 1 are presented the results of EML model fitting to data. The fitting performance is better than ML model (in terms of SSE, MAD and MAPE), but mainly produced by the significantly better fitting to Telestet data, as can be shown in table 1. For eample the  $SSE=4251$  of EML model to Telestet data is about half of  $SSE=8524$  of ML model to same data. In fifth column of table 1 we present the results of applications of univariate logistic model to each competitor data separetely.

From univariate logistic model application market leader predicted Panafon with value of  $M=2630$  slighly bigger than 2546 of Cosmote. But from the multivariate model the final state predicted totally different, final market size  $M=3042$  for Cosmote and 2535 for Panafon.

But certainly this is against the origin of competition, competitors is natural to react to this situation. In fact in Greek mobile phones market at Jun 2000 when Cosmote pass Telestet subscribers (see figure 1), Telestet reduce prices by 20%, Panafon follows to lower prices and Cosmote react setting there prices equal to competitors.

The last entrant in Greek market, Cosmote, lunch the market in May 1998. To examine the full competition period in last three columns of table 1 presented the results of applications of the 3 models (ML, EML, univariate) to this part of data (Jun 1998-Dec 2000). The fit and statistics of ML model is very similar to that of ML for all the data in third column of table 1. The values of  $b$  and  $M$  parameters remain about the same,

statistics of fit also (except the SSE value, but now there are fewer data). Most significant improvement observed to Telestet data where MAD fall to 11.24% from 19.82 and MAPE to 1.09% from 5.25%.

In EML model (seventh column of table 1) observed significant differences from that of all data EML. First is that predict final Telestet dominance after a long period of Panafon dominance. The fit and predictions (projections) presented in figure 2, where forecasting period is extended to shown this complicated situation. A natural question concerns the comparison with the results obtained by application of the univariate logistic model to the total market data (sum of all competitors' subscribers). Applying the proposed univariate logistic model (eq. 3) to the sum of market data we obtain  $M=8724$ ,  $b=1.244$ ,  $SSE=56503$ ,  $MAD=50.55$ ,  $MAPE=5.45\%$ .

It is interesting to examine the forecasting ability and performance of the proposed model. A part of our available data are used to evaluate the succes of predictions by the models, to the rest unused part of data in fitting. In Table 2 presented the predictions and their statistics of the models (ML, EML, univariate) to all except the last four data values (year 2000 data). For each competitor the four first lines present the predicted values by the models, the next two lines  $MAPE_{1,2}$  statistic for the first 2 predictions (Mar 2000 and Jun 2000) and  $MAPE_{1,4}$  for the whole 4 predictions of year 2000. Also presented the  $MAD_{1,2}$  for the first 2 predictions and  $MAD_{1,4}$  for the all year 2000 quarterly predictions. Those price changes expected to affect the market and model forecasting performance. For the whole market, all models had similar predictions and statistics, but for the whole year the better was ML model applied to all data Dec 1995-Dec1999 followed by ML model applied on data of Jun 1998-Dec 1999.

#### 4. Conclusions and future tasks

We have presented a multivariate adaptive logistic model capable to cope with the competition of technological products in a market during introduction. The proposed model can apply to any number of competitors in a market. The total number of model parameters for EML model is  $2m+1$ , where  $m$  is the number of competing products. We also propose a method to fit the model using a solver tool available to anyone with access to a computer and a spreadsheet application.

The ML and EML models are applied successfully to Greek mobile phones market cumulative subscribers. The evaluation of models forecasting ability performed for those data is encouraging and illustrates the characteristics and advantages of the proposed model. A certain advantage of multivariate logistic model is the ability to set the market size parameter  $M$  easier than univariate logistic model, in the presence of competition. The main remaining problem is changes in the competition status (for example price changes) of the market. Those changes cannot affect immediately the model parameters values and can lead to problematic predictions.

A theoretical improvement of the EML model is to investigate and use the relation with the Bass model in discrete form [11]. It looks interesting to build and test a multivariate Bass model.

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### Appendix

**Table 1:** Model parameters and fitting statistics values of Multivariate Logistic (ML), Extended ML and univariate Logistic fit, to Greek mobile phones market cumulative subscribers by company

	Parameters and Statistics	Dec 1995-Dec 2000 DATA			Jun 1998-Dec 2000 DATA		
		ML model	EML model	Univariate Logistic	ML model	EML model	Univariate Logistic
All Market	M	7508.2	7743.7	7503.5	7487.7	8410	7732.0
	SSE	39609	38219	38623	27767	25457	27220
PANAFON	M	2534.8	2493.3 (→0)	2630.4	2505.4	3609.8 (→0)	2920.0
	b	1.189	1.202	1.238	1.184	1.178	1.205
	a	-	1.192	-	-	1.172	-
	x <sub>0</sub>	157.7	155.3	111.1	807.3	819.3	812.3
	SSE	16027	16230	18514	9897	8831	7371
	MAD	27.52	27.50	28.67	29.45	23.60	22.25
	MAPE	3.10	3.00	4.88	1.81	1.75	1.64
TELESTET	M	1931.1	+∞	2327.5	1954.3	8410	2266.5
	b	1.217	1.169	1.221	1.226	1.202	1.228
	a	-	1.194	-	-	1.202	-
	x <sub>0</sub>	82.1	98.2	81.1	493.0	504.7	499.8
	SSE	8524	4251	2650	2925	2458	2294
	MAD	19.82	14.23	17.17	11.24	11.45	11.30
	MAPE	5.25	1.61	5.01	1.09	1.00	0.99
COSMOTE	M	3042.3	2040.3 (→0)	2545.5	3028.0	2570.2 (→0)	2545.5
	b	1.517	1.637	1.430	1.518	1.655	1.430
	a	-	1.573	-	-	1.553	-
	x <sub>0</sub>	159.5	143.4	158.4	159.1	150.3	158.4
	SSE	15060	17738	17556	14945	14168	17556
	MAD	23.35	28.56	29.44	23.44	26.19	29.44
	MAPE	2.86	2.74	2.97	2.85	2.61	2.97

**Table 2:** The forecasting evaluation of the model variations to Greek mobile market Data set. Results presented by competitor and for four time periods into the future (Mar 2000 to Dec 2000).

		Real	Univariate model		ML model		EML model	
			Dec 95- Dec 99	Jun 98- Dec 99	Dec 95- Dec 99	Jun 98- Dec 99	Dec 95- Dec 99	Jun 98- Dec 99
All Market	Mar 00	4271.2	4293.5	4318.9	4447.6	4335.2	4335.2	4318.1
	Jun 00	4831.9	4644.6	4683.7	4989.1	4739.2	4691.0	4679.0
	Sep 00	5399.0	4926.2	4974.7	5485.2	5061.2	4956.1	4948.8
	Dec 00	5932.0	5160.1	5211.4	5908.7	5297.0	5158.3	5142.0
	MAPE <sub>1-2</sub>		2.20%	2.09%	3.69%	1.71%	2.21%	2.13%
	MAPE <sub>1-4</sub>		6.54%	6.05%	2.34%	5.09%	6.42%	6.48%
	MAD <sub>1-2</sub>		104.80	97.94	166.78	78.36	102.46	99.91
	MAD <sub>1-4</sub>		363.57	335.20	110.77	282.38	355.38	360.00
Panafon	Mar 00	1773.0	1745.4	1783.2	1822.9	1768.6	1790.3	1773.3
	Jun 00	1901.9	1831.1	1898.4	1956.5	1862.2	1903.1	1873.2
	Sep 00	2056.9	1898.8	1998.2	2069.5	1932.1	1999.7	1954.0
	Dec 00	2226.0	1950.8	2082.5	2159.6	1980.7	2083.1	2018.8
	MAPE <sub>1-2</sub>		2.64%	0.38%	2.84%	1.17%	0.52%	0.76%
	MAPE <sub>1-4</sub>		6.33%	2.52%	2.32%	4.86%	2.56%	3.96%
	MAD <sub>1-2</sub>		49.20	6.89	52.21	22.07	9.19	14.49
	MAD <sub>1-4</sub>		132.95	54.00	45.84	103.58	54.62	84.79
Telestet	Mar 00	1278.0	1329.0	1316.7	1264.1	1262.7	1350.6	1310.9
	Jun 00	1414.8	1481.8	1453.6	1362.3	1343.1	1531.6	1441.4
	Sep 00	1580.0	1637.9	1587.0	1445.6	1403.6	1730.3	1571.4
	Dec 00	1645.0	1794.3	1713.8	1512.3	1446.1	1948.0	1704.8
	MAPE <sub>1-2</sub>		4.35%	2.87%	2.41%	3.15%	6.95%	2.21%
	MAPE <sub>1-4</sub>		5.35%	2.59%	5.36%	7.39%	10.45%	2.15%
	MAD <sub>1-2</sub>		58.88	38.57	33.38	43.68	94.52	29.55
	MAD <sub>1-4</sub>		81.12	38.13	83.57	115.79	160.48	31.80
Cosmote	Mar 00	1220.2	1219.1	1219.0	1360.6	1303.9	1194.3	1233.9
	Jun 00	1515.2	1331.7	1331.7	1670.3	1533.9	1256.3	1364.4
	Sep 00	1762.1	1389.5	1389.5	1970.1	1725.5	1226.1	1423.4
	Dec 00	2061.0	1415.0	1415.0	2236.7	1870.2	1127.2	1418.4
	MAPE <sub>1-2</sub>		6.11%	6.11%	10.87%	4.05%	9.60%	5.54%
	MAPE <sub>1-4</sub>		16.18%	16.18%	10.52%	4.86%	23.73%	15.37%
	MAD <sub>1-2</sub>		92.44	92.44	147.77	51.24	142.41	82.28
	MAD <sub>1-4</sub>		300.96	300.96	169.82	82.48	438.65	286.47

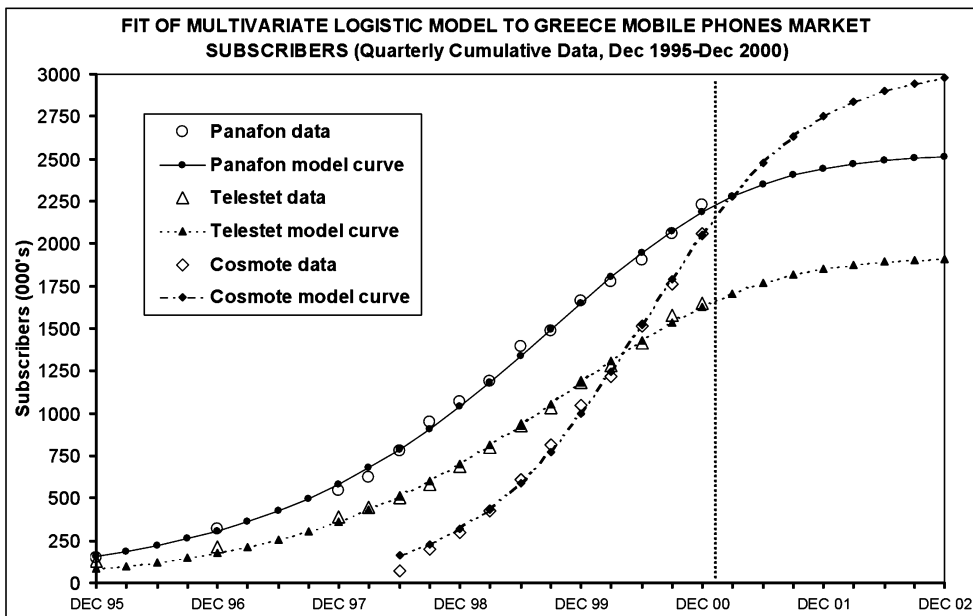


Figure 1: Application of the proposed Multivariate Logistic (ML) model to all data of Greek Mobile Phones Market.

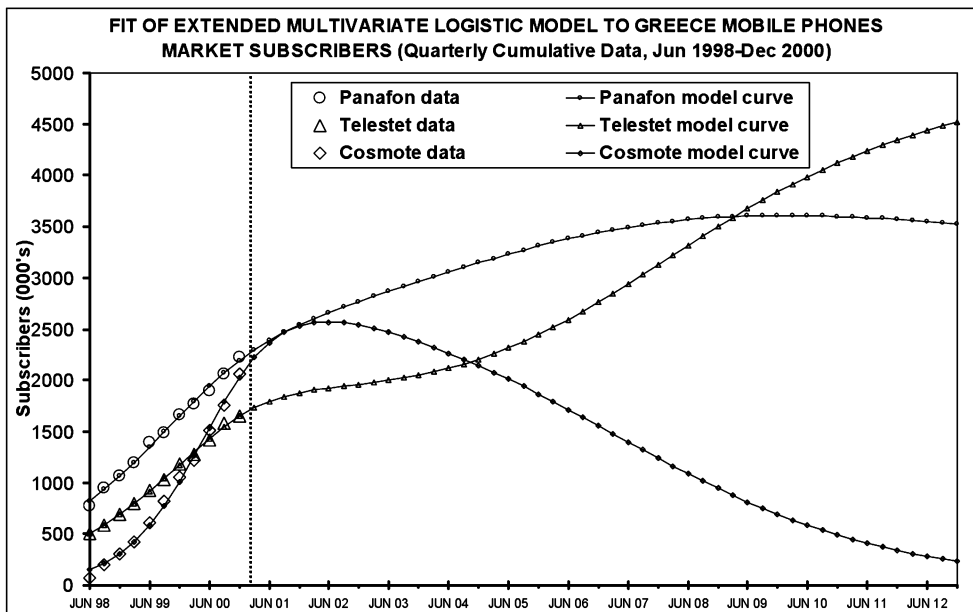


Figure 2: Application of the proposed Extended Multivariate Logistic (EML) model to last part of available data of Greek Mobile Phones Market Subscribers.

# CONSIDERATION REGARDING THE EFFECT OF INTEGRATED USE OF TECHNOLOGIES AND TECHNIQUES FOR SMALL AND MEDIUM ROMANIAN ENTERPRISES BASED ON KNOWLEDGE

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## Abstract

*The last two decades have witnessed a significant increase in discussions about the different dimensions of knowledge and knowledge management (KM). Many factors have contributed to this growing interest including globalization, increased competition, diffusion of new ICTs (information and communication technologies) and new procurement routes, among others. There are a range of techniques and technologies that can be used for KM in construction of Small and Medium Enterprises based on knowledge. The use of techniques for KM is not new, but many technologies for KM are fairly new and still evolving. Knowledge-based economy indicate that most of Small and Medium Enterprises based on knowledge do not adopt a structured approach for selecting KM technologies and techniques. The use of KM techniques is more evident compared to KM technologies. There is also reluctance among Small and Medium Enterprises based on knowledge to invest in highly specialised KM technologies. The high costs of specialist KM technologies are viewed as the barrier to their adoption. In conclusion, the paper advocates integrated use of KM techniques and technologies in Small and Medium Enterprises based on knowledge.*

**Key words:** *Small and Medium Enterprises based on knowledge, KM techniques, KM technologies, performance, competence*

## 1. Introduction

The whole relationship that a company develops during its existence to realize its activity represents the economical, social, competition and political medium for all organizations, especially for small and medium Romanian enterprises based on knowledge. Stakeholders for small and medium Romanian enterprises based on knowledge keep in touch and relate to the suppliers, buyers, local and general public administration, state organizations, consumer associations, syndicates, employers, etc.

Small and Medium Enterprises based on knowledge interact and there is a consent regarding the existence of a strong and direct proportional relationship between the size of the company and its amplitude and competence (structure) of the medium.

The object of the Small and Medium Enterprises based on knowledge's activity is of economic nature and, in order to develop it, the enterprise contacts many other economic enterprises, initiating buy-sell relations, information-documentation relations, project relations, etc. The involvement of the labor force into the activity of the Small and Medium Enterprises based on knowledge is economical through their appointment contracts, but it brings the social aspect into the field of its medium, that means viewing the existence the employees as human beings. The social aspects becomes amplified through the consequences induced by the way the Small and Medium Enterprises based on knowledge contribute or not to meeting some of the needs of the population through the object of their production, etc.

The general trend is to develop the relationship inside the business medium and increase it to new partners and then passing to new, superior levels until the global level is reached. For various reasons, some of them being earning performance reasons, some small and medium enterprises based on knowledge could

have a business contraction based on their own recession, the country's recession or the recession of the countries in which it operates.

In the Romanian economy, as well as the world economy, there is a general trend of blockage and economical crisis and the financial help for the Small and Medium Enterprises, especially the Small and Medium Enterprises based on knowledge, becomes very important and immediate.

## 2. Romanian Small and Medium Enterprises based on knowledge

Romanian Small and Medium Enterprises based on knowledge are those enterprises that carry out services in different domains but they have as common denominator the intellectual capital, intangible capital and they revolutionise the knowledge through their number, their impact and the economical, scientific, educational, ecological and cultural performance.

We consider that Romanian Small and Medium Enterprises based on knowledge are the following:

- commercial societies producers of computers and computer components
- commercial societies producers of computers software
- solicitor firms
- law firms
- officer of the court profession
- mediation firms
- audit firms
- accountancy firms
- surveying firms
- liquidation firms
- optical laboratories
- fine mechanics laboratories
- research and projects institutes
- companies specialising in data storage, sites' administrators, bloggs, consulting in information technology and the instruments offered by IT&C.
- companies specializing in consulting and management
- advertising companies
- companies specializing in training

The specialists' opinions regarding the definition of the Small and Medium Enterprises based on knowledge have different characteristics.

Our opinion is that the Small and Medium Enterprises based on knowledge transform knowledge in products and services, in intellectual and competent capital as raw material, capitalizing the services as efficiently as possible through processes of buying and selling, storing, sharing, developing, protecting the knowledge whilst conditioning the obtaining of profit and the sustainability of the company.

The Small and Medium Enterprises based on knowledge need the most advanced information and communication technologies for the development and assurance of their activities, regarding them as essential tools for their sustainability.

Figure 1 presents the interaction of technologies within Small and Medium Enterprises.

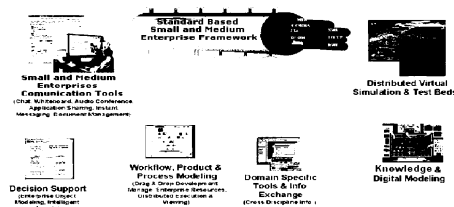


Figure nr. 1 The interaction of technologies within the Small and Medium Enterprises

The Small and Medium Enterprises based on knowledge suffer a lack of transparency, where there are few comparable elements, and the emotional and human factors have a large impact on a transaction (buying-selling products, services). On many occasions the evaluation of the performance of the Small and Medium Enterprises based on knowledge is linked more with the value of its assets rather than the company's potential, the difference between the two being the intellectual capital.



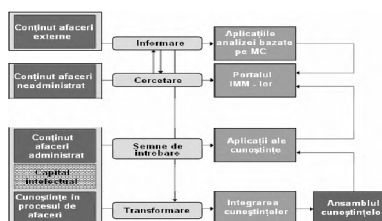


Figure nr.2 The management of knowledge in a Small and Medium Enterprises based on knowledge

### 3. Information and communication technologies in the Small and Medium Enterprises based on knowledge

Information and communication technologies inside the knowledge management (KM) in Small and Medium Enterprises based on knowledge consist of a combination between hardware and software technologies. Hardware technologies and their components are important for the knowledge management system in the Small and Medium Enterprises based on knowledge because they have the role of platform for the software and for the storage and transfer of knowledge. Some of the hardware requirements of a Knowledge Management system (KM) include personal computers or work stations to facilitate the access to knowledge, servers for high traffic for the organization to be in the network, open architecture for interoperability in distributed media, mass-media rich in applications that need the integrated digital network of services (ISDN) and high speed optic fiber to offer access to the public network (Internet) and private network (Intranet and Extranet) and facilitate the access to and exchange of knowledge (Lucca et al., 2000). In the next figure, we present an open architecture:

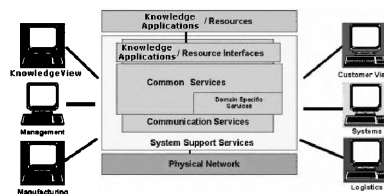


Figure nr.3 Interoperability inside the Small and Medium Enterprises based on knowledge

Software technologies have an important role in facilitating the application of Knowledge Management (KM). The number of software applications has increased considerably in recent years, the suppliers of software offering different solutions for different tasks. The large number of suppliers that offer solutions to Knowledge Management (KM) makes the identification of the best solutions difficult. This led to the adoption of different models in organizations for establishing the Knowledge Management (Tsui, 2002b).

**Socializing**, as a process, occurs through team work of compatible individuals, with similar cultural profiles. The first software socializing instruments could be considerate distance collaborating software. This class of instruments sustains not only socializing, but also the other processes of knowledge conversion. In socializing, the accent is on sharing the knowledge and building the trust inside the team. Virtual media of communication opened to the public are: discussion groups, forums, intra-net, blogs, chat and wiki pages.

- Discussion groups and forums facilitate the conversation of persons having common interests.
- The level of the professionalism varies and the orientation is practical in general.
- The Intra-net communication software are generally reserved to companies, due to high prices
- Blogs are a new communicating system that promises to become a new method of marketing and public opinion survey
- Chat maintains an active informal network inside and outside a company
- The editing system of Wiki pages is an efficient alternative to an asynchronous communication in text format between the members of the same team or outside of it.

The Internet technologies are supplemented by the software dedicated to the virtual collaboration inside an organization (groupware), with the help of which, members of a team can share experiences, such as conferences, presentations, discussions, or could even work together using visual instruments or modeling in real time. The classic example of this type of software is Lotus Notes application, which facilities simultaneous work on documents but offering only the possibility of asynchronous discussions. A superior form is the videoconference, a solution for the real time communication. (Lotus Sametime and Microsoft

NetMeeting). The present form of this software for cooperating at a distance combines the videoconference with simultaneous work on applications and documents (IBM –Boeing Team Space project). Although the main activity is that of combining explicit knowledge, the participation to these kinds of activities is a form of tacit learning. The major deficiency is establishing a reduced degree of trust compared to meetings face-to-face.

Due to the complexity and speed at which the knowledge market is changing, there are also necessary methods of search and retrieval of expertise; these are search engines of persons by their capacities (by type and value of the tacit/implicit knowledge). Such products are Lotus Discovery Server, which determines the profile of the persons from the online application form and from the documents whose authors these individuals are and Tacit Knowledge Systems Knowledge Mail, which use text mining on emails written by employers in order to determine their expertise.

*Externalization* is a difficult process, which has to be practiced and methodized. Detailed interviewing of the experts or requesting the description of certain process could lead to the exploitation. Externalization supposes the creation of a mental model shared by the dialog members followed by the articulation of the new knowledge. These methods lead the positive results when the answers have to be expressed into a predefined ontology of the domain, increasing the clarity and concision of the obtained knowledge. This is the design approach of the expert systems that requires procedural knowledge from key members of the organization.

The knowledge management takes the majority of the discoveries of the expert systems and continues with a deepening of the research in the methodology and the creation of instruments of ontology.

The theoretical results of this research will be approached in the section dedicated to the methodology of knowledge management, which has as nucleus the activities regarding the life cycle of ontologies.

Alongside the software dedicated to the work with the ontology, the externalization instruments include the software dedicated to brainstorming and those of search and organization of the archives of discussion groups.

*Internalization.* The new acquired knowledge has to be understood thoroughly (through their function) and connected to the already existent knowledge system, in order to be used efficiently.

The problem of knowledge abundance makes necessary the existence of a standardization of quality and filtration of knowledge, in order to guide the study to the most relevant knowledge. The filtration could be seen as a phase of document classification from the point of view of their utilities. Alongside filtration, the assistance systems of internalization could offer metadata, the context within the taxonomy specified in the language of the domain ontology, the definitions of the terms, visualizations (e.g. Thesaurus). Furthermore, they could consist of instruments of exploitation of knowledge and the relationship between different pieces of knowledge, such as the project Lexical Navigation. To all these instruments dedicated to the internalization of the knowledge, the “classical” instruments can be added.

#### **4. The financing of the medium of the Small and Medium Enterprises based on knowledge**

The productive logics of the Small and Medium Enterprises based on knowledge subordinates to financial logics, but the movement of capital is no longer inspired by the solid bases of the real economy. Until now the objectives of the real economy had priority and the financial-monetary domain had to adapt to them: the level of the price was derived from the ratio of demand and supply of the goods and services, and the interest rate represented the ratio between available economies and the need for investments. The situation has changed; direct foreign investments are the oxygen of the real economy, the monetary stability is a priority and, because of this, there are some restrictions on the real economy. The rate of interest derives from the anticipation of the monetary market and from the imperatives of stability of the central banks.

If until now the strategies were concentrated to finance the developing firms, attracting of strategic investors was the policy of the Small and Medium Enterprises based on knowledge. From 2009 these would concentrate on “buy-side” because a part of the clients of the firm have turned from direct investors, into investors involved in transactions with distressed assets.

The restructuring of the activity has been imminent because the economic crisis involves a financial blockage of all participants to the real economy. There are running projects for which the financing is essential, and economic entities being in financial blockage search financing from the capital market, because banks have stopped credits or give them very rarely to Small and Medium Enterprises.

For 2009 we can expect to an increase of these types of projects without funds and crash of the Small and Medium Enterprises without financial sustaining. The volume of the investors has increased as soon as

the expectancies about evaluation of the Small and Medium Enterprises have become more realistic and more transparent.

The majority of the investors are strategic but we prefer the associations between strategic investors and investment funds. This formula assures the growth and development of all organizations, especially the Small and Medium Enterprises based on knowledge, through reducing the inefficiency and know-how transfer (acquisition of new communication and information technology). The performance of the Small and Medium Enterprises based on knowledge are increasing.

## **5. Techniques in Knowledge Management in the Small and Medium Enterprises based on knowledge**

Statistical methods of analyses of quality necessary for the services of the Small and Medium Enterprises based on knowledge are seldom used by some firms. The necessary attributes of quality gives the clients satisfaction in proportion to the performance of the products/service and, implicitly, to the performance of the enterprise. The increase of the level of satisfaction is obtained by developing those attributes. Because the clients freely express their wishes above these attributes, the necessary quality is often called "the client's voice".

To obtain some tactic and strategic solutions, to build competitive advantages on long or short term, Small and Medium Enterprises based on knowledge have to determine their clients and other persons they address, the zone/aria they come from, their social status, the price they are prepared to pay. Therefore they have to accomplish a segmentation of the market. For a particular solution of segmentation of the market to be efficient and lead to profit entrepreneurial strategies, there are 6 criteria that have to be performed:

- **Identificability:** the segments have to be well separated and to have clear differences between them
- **Consistency:** the identified segments have to contain enough units in order to assure marketing strategies specified for each segment.
- **Accessibility:** the units of the segments have to be accessible through publicity or direct sales.
- **Stability:** there must be no major changes between the units of the identified segments.
- **Sensibility:** the units of the identified segments have to respond uniquely to the marketing efforts specified for each segment.
- **Actionability:** the identified segments have to foresee the directions of the marketing efforts.

The obtained solutions regarding the segmentation of the market depend on the variable used and on the methods and procedures used for obtaining the classification.

The nature and quality of the segment depend on the variables used. Four classes of segmenting variables can be used:

- General observable variables: demographic variables, social-economic variables etc.
- Observable variables specific to the product: the frequency of utilization, the consumers' loyalty.
- Unobservable general variables: variables referring to the life style etc.
- Unobservable general variables specific to the product: benefits, utilities, preferences, intentions, etc.

After the identification of the amount of potential variables for segmentation, a method of stratification is used in order to identify the segments. M. Wedel and W. A Kamakura classify these methods in four categories:

- A priori descriptive methods: frequency tables
- A priori predictive methods: discriminant analysis
- Post hoc descriptive methods: classification methods, mixed methods
- Post hoc predictive methods: logistic regression methods, CRAID, CART, mixed regression methods, or with latent classes.

The descriptive methods are methods that analyze a set of variables, without any separation between dependent and independent variables. They are used to determine some market segments with properties defined by the segmentation variables.

The predictive methods are methods that analyze a set of variables with the purpose of explaining a dependent variable using a set of independent variables.

## **6. Conclusions and recommendations**

The constitution of the Small and Medium Enterprises based on knowledge and the actions of other Romanian economic actors follow complex aims and effects, but it is very clear that in the Romanian,

European, or international economic medium, all of them very volatile due to globalization, the stability or certainty in movement becomes fundamental, because the turbulence seems to have emerged everywhere. Of course, in the case of the Small and Medium Enterprises based on knowledge, the firms have learnt long time ago, and are still learning, how to work towards success, but the present economic media that overlap more and more, this reaction is no longer sufficient because the competition become global and the means of its development have become complicated.

In the EU the national character of economy is blotting out more and more and the European economy combines more and more in its home as well as on other meridians with the economies from other countries or integrationist regional groups in various degrees. The Small and Medium Enterprises based on knowledge are the engine of this economy and are the most developed link, but in a such context, Romanian enterprises confront with 3 important problems: the information, the influence and the financing that they have to manage as well as they could. These problems are not new, but now they have become explosive.

The performance of the Small and Medium Enterprises based on knowledge have to be optimal and, implicitly, the competence of their employees, through the acquisition the new information and communication technology (TIC), which are strictly necessary for developing their activity and assuring their sustainability.

The access to financing, as an essential ingredient of accelerating the innovative process inside the Small and Medium Enterprises based on knowledge, has to be sustained constantly for a sustainable development of these firms.

One of the important points of "Cartel of Bologna" refers to the access to financing as an essential ingredient of accelerating the innovative process inside the Small and Medium Enterprises based on knowledge. The uncertainty and the asymmetry of information that feature in the Small and Medium Enterprises based on knowledge are amplified in the case of the innovative Small and Medium Enterprises, which makes their access to a financing more difficult. Firstly, the economic effects resulting from innovative activities have a higher degree of uncertainty. Secondly, the enterprises/contractors have more information about the nature and the characteristic of the products and the technological processes than the potential investors. Thirdly, the innovative activities are usually intangible, so their evaluation *ex ante* is difficult, using monetary terms, before they have commercial success. Therefore, financing the innovative Small and Medium Enterprises is very risky and has a high degree of uncertainty, creating reserve from investors and enforcing the government's involving through specific programs, for supplying the private sources to financing the innovative Small and Medium Enterprises based on knowledge.

The economic structure of the Small and Medium Enterprises differs from the economic structure of a great company that operates on a market. Any company combines the own financial resources with the attracted ones. Lack of real guaranties from the Small and Medium Enterprises makes the access to the resources to be different. The financial structure for the innovative and Small and Medium Enterprises based on knowledge and the modality they finance their development depend on:

- institutional efficiency of the capital market
- regulation of the domain regarding the supervision of the involved institutions in financing businesses with high risk.

## 7. An example. Example of market segmentation-descriptive approach

At the launch of a new software product on the market, the producer firm carried out a test of the buyers of own products. The survey was carried out in Bucharest, having chosen 10 shops that sell the products of the firm. From these shops, 180 clients consumers were randomly selected. They were asked to complete a questionnaire with 17 questions.

The survey was carried out in order to find out the segmentation of the market depending on how the ratio price-quality was considered, how the advertisement and the package influence the buying decision and what the consumers appreciate most in the products of the firm: newness, originality, the ratio price-quality, the quality, or the fact that the product is an advanced and rapid software.

The variables used for segmentation are:

- What do you appreciate best in our firm's products?
  - newness
  - originality
  - the ratio price-quality
  - quality
  - it is an advanced, rapid software

- How does the ratio price-quality seem to you at the level of these products?
  - satisfying
  - unsatisfying
- Do you think that presentation of these products influenced your choice?
  - ↓yes
  - ↓a little
  - ↓no
- Did it happen that, after you saw an advertisement for the products of the firm, you went and bought at least one of them?
  - yes
  - no

Following the application of an analysis of multiple correspondences, 8 new cardinal independent variables were obtained, referred from here onwards with  $d_i$ .

The new variables are linear combinations of the firsts.

The modalities of the questions are correlated with the new variables, as follows:

1. *What do you appreciate best in our firm's products?*

- newness: positively strongly correlates with  $d_1$  and negatively strongly correlates with  $d_8$
- originality: positively strongly correlates with  $d_7$  and negatively strongly correlates with  $d_2$ ;
- the ratio price-quality: positively correlates with  $d_2, d_6$  and negatively strongly correlates with  $d_4$ ;
- quality: positively strongly correlates with  $d_3$ ;
- it is a soft rapidly advanced: positively strongly correlates with  $d_5$ ;

2. *How does the ratio price-quality seem to you at the level of these products?*

- satisfying: positively strongly correlates with  $d_6$  negatively correlates with  $d_1$  and  $d_8$ ;
- unsatisfying: negatively strongly correlates with  $d_6$ , positively correlates with  $d_1$  and  $d_8$

3. *Do you think that presentation mode of these products influenced your choice?*

- ↓ yes: positively strongly correlates with  $d_4$  and negatively strongly correlates with  $d_3$ ;
- ↓ a little: positively strongly correlates with  $d_3$  and negatively correlates with  $d_1, d_2, d_4, d_6$  and  $d_7$ ;
- ↓ no: positively correlates with  $d_1, d_3$  and  $d_7$  and negatively strongly correlates with  $d_4$ ;

4. *Did it happen that, after you saw an advertisement with the products of the firm, you went and bought at least one of them?*

- yes: positively correlates with  $d_2, d_7$  and negatively correlates with  $d_6, d_1, d_8$ ;
- no: positively correlates with  $d_6, d_1$  and  $d_3$  and negatively correlates with  $d_2, d_7$ ;

For choosing the number of layers, there is a possibility to arrange a hierarchical classification and identification at the level at what the graphs should be cut to obtain a better aggregation.

After application of the Ward algorithm, the hierarchical classification in figure nr.4 was obtained. Variations initial had a few answers, we made a stratification into 3 groups using mobile centers

Tree Diagram for 90 Cases

Ward's method

Euclidean distances

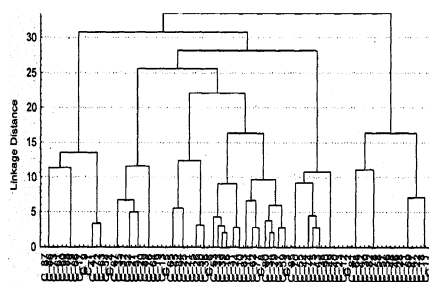


Figure nr.4 Classification tree obtained through Ward method

Source: Cristina Boboc, *Multidimensional Statistics Analyze, Application inside the study” Products and Services*

Therefore, a stratification into 3 groups will be used, with an iterative unhierarchical method of partition-the method of mobile centers.

Centers from three groups of variables and the variations between the centers of the 3 segments are:

Cluster	1	2	3
Dimension 1 ( $d_1$ )	0,12	0,10	-0,18
Dimension 2 ( $d_2$ )	-0,71	-0,13	0,35
Dimension 3 ( $d_3$ )	0,44	-0,27	0,28
Dimension 4 ( $d_4$ )	0,29	0,41	0,64
Dimension 5 ( $d_5$ )	-0,21	0,26	-0,31
Dimension 6 ( $d_6$ )	-1,21	-0,13	0,48
Dimension 7 ( $d_7$ )	-0,65	-0,08	0,27
Dimension 8 ( $d_8$ )	1,29	-0,55	0,47

Taking into account the existing correlations between the initial variables and the centers of the three groups, the three segments of the market can be characterized as follows:

**Segment 1**, that represents 9% of the market, consists of the persons that appreciate mostly the quality of the products of the firm, but they consider the ratio price-quality not satisfactory, and they are not influenced by the presentation mode and the advertisement in their buying decision.

**Segment 2**, that represents 53% of the market, consists of the persons that appreciate mostly the newness and the product is a new rapid software. They also consider the ratio price-quality being satisfactory and they are also influenced by the product presentation and advertisement in their buying decision.

**Segment 3** that represents 38% of the market, consists of the persons that appreciate mostly the ratio price-quality and they are also influenced by the advertisement but not the presentation in their buying decision.

Starting from these three segments, the persons’ characteristics in each of the three categories have to be studied and the degree to which they are devoted clients-consumers of the products.

The study can be continued to determine the characteristics of people who are part of the 3 categories and to the extent to which they are loyal customers of company products.

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# DIFFERENCES IN MANAGEMENT ACCOUNTING BETWEEN FAMILY ENTERPRISES AND NON-FAMILY ENTERPRISES A STATISTICAL APPROACH

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## Abstract

*Management accounting deals with the subject family enterprises rather little in spite of its high economical relevance. Based on the hypothesis that family enterprises aim at humane objectives to a greater extent and use controlling-instruments to a lesser extent than non-family enterprises the results of an empirical study for the region Upper-Austria are presented. The conclusion is that apart from the extent of the return on equity the objectives of the family enterprises do not differ much from those of the non-family enterprises. Contrariwise a high level of professionalization of employing controlling-instruments can be identified for family enterprises. The second point of interest is the search for differences between medium and large sized enterprises.*

*Moreover this paper demonstrates an application of (multiple) correspondence analysis in business research. Correspondence analysis is an explanatory data analytic technique and is used to identify systematic relations between categorical variables. It is related to the principal component analysis and the results provide information on the structure of categorical variables similar to the results given by a principal component analysis in case of continuous variables. Classical correspondence analysis is designed two-dimensional, whereas the multiple type of it is an extension to more than two variables.*

*After an introductory overview of the idea an example in this recent business research project is presented.*

*Keywords: Business administration, empirical research, correspondence analysis*

## Main Text

In spite of the high economical relevance management accounting deals with the subject family enterprises in empirical research rather little. Based on the hypothesis that family enterprises aim at humane objectives to a greater extent and use instruments of management accounting to a lesser extent than nonfamily enterprises, results of an empirical study for the region Upper Austria are presented. The conclusion is that apart from the extent of the return on equity the objectives of responding family enterprises do not differ much from those of non-family enterprises. Contrariwise a high level of professionalization of applied instruments of management accounting can be identified for family enterprises.

The research method is based on a standardized questionnaire, which was available via internet. All enterprises in Upper Austria with 50 or more employees (1180 enterprises) were invited to take part in the survey. The usable return was 236 enterprises or 20%, 189 of them declared themselves as family enterprises (80,1%) and 47 as non family enterprises (19,9%). Due to the fact that the proportion of family enterprises in Austria is about 70-80%, the sample can be treated as representative.

For verifying several hypotheses concerning management accounting classical statistical tests were used: Chi-squared-Test, Fisher Exact Test, Kolmogorov-Smirnov-Test, T-Test and Mann Whitney Test.

The main point for further discussions is how a family enterprise is defined. There are many different approaches to define it.

Some of the popular criterions are as following:

- Level of equity held by a single family
- Degree of implication of the family in the management structure
- More than 50% of ownership is held by a family
- A family group controls the business

In this survey the enterprises had to decide by themselves weather they are a family enterprise or not according to (at least one of the) following criteria:

- Arbitrary legal structure



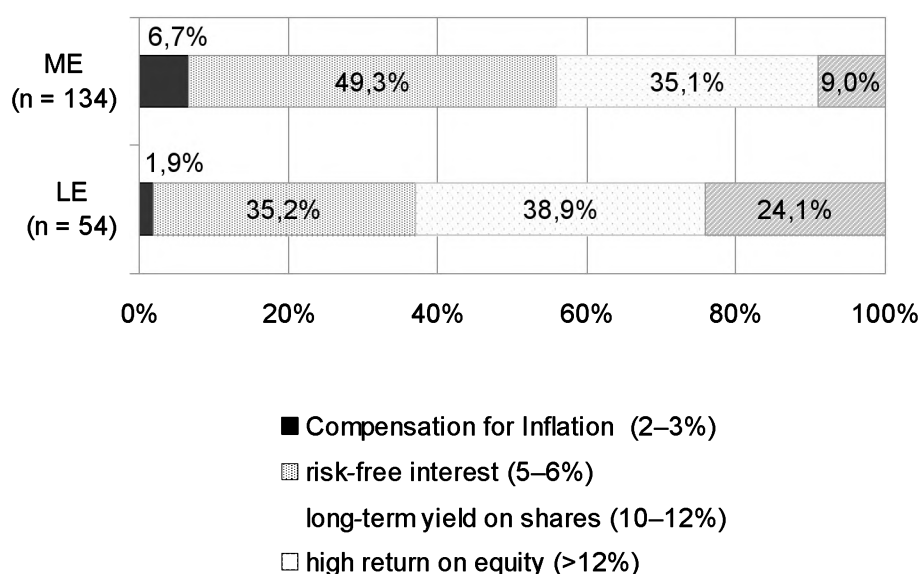
- More than 50% ownership is held by family members or family close foundations
- Family members are part of management
- Syndications of families or branches of families

It is generally accepted that family enterprises aim to achieve a combination of financial and nonfinancial goals. This research will check the following hypothesis:

- Family enterprises aim at humane objectives to a greater extent than nonfamily enterprises.
- Family enterprises aim at financial objectives to a lesser extent than nonfamily enterprises.
- Family enterprises demand a lesser return of equity than nonfamily enterprises.
- Family enterprises use instruments of management accounting to a lesser extent than nonfamily enterprises (strategic and operative).

Family enterprises are more often than not small enterprises, too. Therefore each of the above hypotheses was tested with respect to structure and size.

One of the results of the can be seen in the following figure:



	ME (50 - 249 employee)	LE (≥ 250 employee)
ROE ≤ 12%	91,0 %	75,9 %
ROE > 12%	9,0 %	24,1 %

n = 188

significant, p = 0,007

So there is a significant difference in the aspired return of equity (ROE) between medium-sized (ME) and large enterprises (LE) (and also between family and non family enterprises).

From this result the question arose, weather the structure (family or non family enterprises) or the size or any other criterion is the reason for the different aspired returns of equity. Are there some common factors, which can be extracted for explaining the different aspired returns?

For extracting common explanatory factors a final correspondence analysis was calculated, which is a principal component analysis for categorical data.

The starting point of a principal component analysis is the correlation matrix. The purpose is to create a model for data with fewer factors. The mathematical background for extracting factors is an eigenvalue

decomposition. For the complete solution the number of factors is equal to the number of variables, the optimal number of factors is decided with the scree test or the Kaiser criterion.

The starting point of a correspondence analysis is the matrix of standardized residuals. The purpose is the same as for the principal component analysis. The mathematical background for extracting factors is the singular value decomposition. For the complete solution the number of factors is again equal to the number of variables, the optimal number of factors is decided similar to the scree test or the Kaiser-criterion.

With the notation

- P Correspondence matrix (relative frequencies  $p_{ij}$ )  
 r Mass of rows (marginal frequencies  $c_i$ )  
 c Mass of columns (marginal frequencies  $r_j$ )  
 A Matrix of standardized residuals  

$$a_{ij} = (p_{ij} - r_i c_j) / \sqrt{r_i c_j}$$

$$A = U \Gamma V^T$$
 Singular value decomposition  
 U left singular vectors (columns), orthonormal  
 singular values (descending), diagonal matrix  
 V right singular vectors (columns), orthonormal

the singular Value Decomposition gives

$$A^T A = V \Gamma \underbrace{U^T U}_I \Gamma V^T = V \Gamma^2 V^T \text{ and } A A^T = U \Gamma^2 U^T$$

and therefore we get the right singular vectors as eigenvectors of  $A^T A$ , the left singular vectors as eigenvectors of  $A A^T$  and the squared singular values, which are the eigenvalues of  $A^T A$  and  $A A^T$ . The squared singular values are also called principal inertias, and the proportion of the inertias to the total inertias gives the explained variance.

Similar to the principal component analysis the calculation gives the factors and the loadings for each variable on each factor. The result can be viewed in a plot, if two factors are extracted.

The input variables for the correspondence analysis were owner (family enterprise FU or non family enterprise NFU), branches of trade, number of employees, turnover, structure (shared or not shared) and aspired equity yield rate. Due to the fact that the sample size was rather slow, and the information about the branches was rather poor, the variable branches had to be cancelled.

The correspondence analysis extracted two factors, the first factor was mainly determined by size (number of employee), the second factor was less important and was mainly determined by size (turnover of enterprise). The structure (family business or non family business enterprise) was nearly completely determined by the first factor. So the most important variable for prediction of the aspired equity rate is the size of an enterprise expressed by the number of employee.

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# INTERNET ADDICTION: SOME DISTURBING RESULTS FROM A SAMPLE SURVEY AMONG UNIVERSITY STUDENTS FROM GREECE

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## Abstract

*The aim of this paper is to estimate the prevalence of Internet addiction among Greek University students. Results of a sample survey among 1875 Greek University students, ages 18-27, are presented. The questionnaire consisted of Young's Diagnostic Test for Internet Addiction (YDTIA),<sup>1-4</sup> as well as an inventory that included demographic factors and questions about the relations of students with parents, teachers and friends, their academic performance and their psychological characteristics. The consistency of YDTIA was tested with Cronbach's alpha (0.71) with standardized items alpha (0.73). Results show that a) the prevalence rate is 13.12% b) Men are more addicted to the use of the Internet than women c) Academic performance, social relations and psychological characteristics of the students are impaired by the addiction to the use of the Internet d) The applications of the Internet which are most frequently used are: Chat, Sex Pages, Games, and e-mail e) Students studying more "applied" subjects, like Computer Science present a higher percentage of Internet addiction than students studying more "theoretical" subjects like Law or Business Administration.*

## 1. Introduction

The Internet is a widely recognized channel for information exchange, academic research, entertainment, communication and sales of products.<sup>5-8</sup> Although everybody is praising the positive aspects of the Internet, there is a growing academic research about the negative sides of its excessive use.<sup>9-13</sup>

Byun et al.<sup>5</sup> estimate that 9 million Americans could be labeled as pathological Internet users<sup>14-17</sup> with unpleasant consequences in their social life, their job security and their psychological condition.

The disturbing phenomenon of Internet addiction has been recorded through academic research in USA,<sup>18-19</sup> South Africa,<sup>20-21</sup> South Korea,<sup>22-24</sup> Taiwan,<sup>11, 25-27</sup> Norway,<sup>28</sup> England,<sup>29-33</sup> Italy,<sup>34</sup> Greece,<sup>12, 13, 35-37</sup> Switzerland,<sup>5</sup> China,<sup>5</sup> and Cyprus.<sup>38</sup>

In Greece, Internet addiction is treated as a disorder in the Public Hospital for Children, P. & A. Kyriakou in Athens<sup>37</sup> and in the Center for Therapy of Dependent Persons (KETHEA, Pleusis) in Athens.

So far, no data are available about the extent of Internet addiction among Greek University students, because the previous studies<sup>36, 37</sup> in Greece have focused in finding the percentage of Internet addicted among students in high School of ages 12 to 18.

The aim of the present paper is to assess the prevalence of Internet addiction among Greek University students, ages 18 to 27, to examine possible gender and type of study differences and to find possible determinants of Internet addiction. For the purposes of our study, we have selected by randomized stratified selection a sample of 1875 students, ages 18 to 27 from the five Schools (SDO, STEF, SEYP, STETROD, SGTKS) of the Technological Educational Institute (TEI) of Athens (TEIA), the Technological Educational Institute (TEI) of Piraeus, Dept. of Accounting (TEIPIR), and from three Universities in Athens [Economic University, Dept. of Business Admin., 1st and 2nd semester, (ECONUN); School of Law (LAWUN) of the National University in Athens, 1st and 2nd semester; and the Agricultural University, 1st and 2nd semester (AGRICUN)]. The desirable accuracy of the sample or the maximum sampling error E, derived from the formula  $n = (z_{\alpha/2})^2 / 4E^2$ , using Tabachnick and Fidell<sup>39</sup> was  $E = 0.02$ , where  $n = 1875$ ,  $z_{\alpha/2} = 1.96$  is the 97.5 quantile of the Normal Distribution, and  $\alpha = 0.05$ .

Young’s Diagnostic Test for Internet Addiction (YDTIA) has been translated into Greek and back into English by two independent translators, following the usual procedure Young’s Questionnaire was applied because many other researchers have applied it in different cultures.<sup>28</sup> Furthermore, an evaluation of the sensitivity, specificity and diagnostic accuracy of the eight criteria of YDTIA was made.

## 2. Methods

The sample consisted of 1875 students (mean age 19.52±2.38) who were studying in 36 classes among 9 University and TEI Departments in Athens, Greece. We obtained the sample by the method of randomized stratified selection in every Department. A questionnaire – consisting of sociodemographic items and the eight items of YDTIA – was administered to each participant.

The sociodemographic questionnaire recorded information about gender, age, individual habits, Internet applications which are most frequently used, relations with parents, teachers, friends, psychological characteristics of the respondents, and academic performance of the respondents.

According to Beard<sup>9</sup> “an individual is addicted to the medium called Internet when the individual’s psychological state, which includes both mental and emotional states, as well as his scholastic, occupational and social interactions, is impaired by the overuse of the medium. Broadly speaking, “addiction is a compulsive uncontrollable dependence on a substance, habit or practice to such a degree that cessation causes severe emotional, mental or physiological reactions.”<sup>40</sup>

The YDTIA consists of eight yes or no questions about the use of Internet. Respondents who answered yes to five or more of the eight criteria were classified as Internet dependents (YID) and the rest were classified as Internet non-dependent (YIND) according to Young. In this paper, we establish a new category of Internet Users, the ones who answered 3 to 4 criteria of the YDTIA. This category was named “At-Risk Internet users” (ATRIU). The category of users who answered yes in 3 to 8 criteria was classified as “Problematic Internet Users” (YPIU).

## 3. Results

### Characteristics of YDTIA

We carried out a Principal Component Analysis of the eight items of YDTIA. The first component had an eigenvalue of 2.71 while all remaining three components had values below 1.0. Thus the first component was selected which was explaining 33.83% of the total variance.

The eight items of YDTIA gave correlations of 0.71 to 0.70 and Spearman’s correlations calculated between the eight items were statistically significant at the 0.001 level of significance (p<0,001).

The consistency of YDTIA was tested with Cronbach’s alpha (0.71) and Cronbach’s alpha based on standardized items (0.73); also the Spearman-Brown Coefficient was (0.72). Thus, the YDTIA has a good reliability, consistency, and unidimensionality. In all calculations of this paper, we used the Statistical Package for Social Science (SPSS), Version 16.0.<sup>39</sup>

**Table 1. Sociodemographic and Academic Characteristics of the sample of University students who answered the Questionnaire.**

	Positive Diagnostic Criteria (yes) in YDTIA				Total N
	0 Positive criteria N (%)	1-2 Positive criteria N (%)	At risk Internet users	Dependent Users	
			3-4 Positive criteria N (%)	5-8 Positive criteria N (%)	
<i>Section 1</i>					
<i>Gender differences</i>					
Total sample	411 (22.0%)	774 (41.5%)	438 (23.5%)	244 (13.1%)	1867
Male	164 (8.8%)	333 (17.8%)	223 (11.9%)	157 (8.4%)	877 (47%)
Female	247 (13.2%)	441 (23.6%)	215 (11.5%)	87 (4.7%)	990 (53%)

	Positive Diagnostic Criteria (yes) in YDTIA				Total N
	0 Positive criteria N (%)	1-2 Positive criteria N (%)	At risk Internet users	Dependent Users	
			3-4 Positive criteria N (%)	5-8 Positive criteria N (%)	
<b>Section 2</b>					
<i>Location of computer differences</i>		$\chi^2=37.34, df=15, p<0.001$			
Total Sample	399 (21.7%)	765 (41.6%)	435 (23.7%)	238 (13.0%)	1837
Home	311 (16.9%)	651 (35.4%)	374 (20.4%)	187 (10.2%)	1523 (83%)
School	23 (1.3%)	35 (1.9%)	20 (1.1%)	11 (0.6%)	89 (5%)
Internet Café	26 (1.4%)	40 (2.2%)	23 (1.3%)	20 (1.1%)	109 (5.9%)
Friend's house elsewhere	30 (1.6%) 9 (0.5%)	23 (1.3%) 16 (0.9%)	10 (0.5%) 8 (0.4%)	7 (0.4%) 13 (0.7%)	70 (3.8%) 46 (2.5%)
<b>Section 3</b>					
<i>Academic Performance differences</i>		$\chi^2=31.45, df=9, p<0.0001$ AVEMARK = Average Mark in last Semester			
Total Sample	327 (21.1%)	634 (40.9%)	380 (24.5%)	208 (13.4%)	1549
AVEMARK<5	16 (1.0%)	26 (1.7%)	28 (1.8%)	23 (1.5%)	93 (6%)
5≤AVEMARK<6,5	116 (7.5%)	234 (15.1%)	137 (8.8%)	87 (5.6%)	574 (37.1%)
6,5≤AVEMARK<8	159 (10.3%)	325 (21.0%)	178 (11.5%)	71 (4.6%)	733 (47.3%)
8≤AVEMARK<10	36 (2.3%)	49 (3.2%)	37 (2.4%)	27 (1.7%)	149 (9.6%)
<b>Section 4</b>					
<i>Family Condition differences</i>		$\chi^2=31.2, df=12, p<0.001$			
Total Sample	410 (22%)	774 (41.5%)	436 (23.4%)	243 (13%)	1863
Married	15 (0.8%)	25 (1.3%)	16 (0.9%)	8 (0.4%)	64 (3.4%)
Single	380 (20.4%)	732 (39.3%)	408 (22%)	213 (11.4%)	1733 (93%)
divorced	15 (0.8%)	17 (0.9%)	12 (0.6%)	22 (1.2%)	66 (3.5%)

### Sociodemographic and academic characteristics of the study participants

From Table 1 we conclude the following regarding gender, family condition, academic performance and location of computer of the study participants:

#### Gender

There is a statistically significant difference in gender for the dependent Internet users (5 to 8 positive criteria in YDTIA). Males were dependent (8.4% of the total sample) at a higher percentage than females (4.7% of the total sample). In the total sample, the dependent users were (13.1%) whereas the users at risk (3-4 positive criteria) were (23.5%). In the total sample, (88%) of the students were problematic Internet users (1 to 8 positive criteria).

#### Family Condition

The striking social result is that number of divorced students (66 students or 3.5% in the total sample) is almost the same as the number of married students (64 students or 3.4% in the total sample). Therefore, out of the 130 students who have been married in the past, more than 50% have been divorced. This shows that the social foundations of marriage are in form of crisis in Greece.

The total percentage of divorced students who are dependent (1.2%) and, therefore, seek through the Internet social relationship, is higher than the percentage of divorced students who are normal Internet users (0 positive criteria of YDTIA).

## Academic performance

The percentage of dependent users who failed in the last semester (1.5%) is significantly higher than the percentage of normal Internet users who failed in the last semester (1.0%).

The percentage of dependent users who have achieved marks in the scale “very good” or “excellent” (6.5 to 10) is 6.3% and it is significantly lower than the corresponding percentage of the normal Internet users (12.6%).

The percentage of dependent users who failed in the last semester with mark less than 5 in the last semester (1.5%) is significantly higher than the corresponding percentage of normal users who have marks below 5 in the last semester (1.0%). Research by others reveals similar results in other countries.<sup>33, 41-43</sup>

## Location of users Computer

The majority of users (83%) use the Internet from home. The second biggest percentage of users (5.9%) uses the Internet from Internet Cafes.

## Internet Addiction According to YDTIA

The frequency of Internet addicted was 13.12% and the frequency of at-risk internet users was 23.4%. The frequency of Problematic Internet Users (who present 3 to 8 criteria of YDTIA) was 36.5%.

We designated very frequent (VFIU) and frequent (FIU) Internet users, the ones who used the Internet for more than 28 hours per week and for 8 to 27 hours per week respectively. Table 2 shows the following:

a) The percentage of VFIU was 24.8% b) The percentage of FIU was 10.4%. The total percentage of problematic Internet users, calculated for the frequent users (8 hours to 27 hours per week), was 24.4%+10.4%=34.8%. This result is close to Siomos<sup>36</sup> findings.

**Table 2. Percentages of users classified according to positive YDTIA criteria among categories of gender and time of use of Internet per week.**

		YDTIA				Total
		0 Criteria N (%)	1-2 Criteria N (%)	3-4 Criteria N (%)	5-8 Criteria N (%)	
<i>Non frequent Internet users (0-7 h per week)</i>						
<i>Non frequent Internet users (0-7 h per week)</i>	Male	73 (10.4%)	99 (14.1%)	49 (7.0%)	39 (5.5%)	260(37.0%)
	Female	152 (21.6%)	196 (27.9%)	73 (10.4%)	22 (3.1%)	443(63.0%)
	total	225 (32.0%)	295 (42.0%)	122 (17.4%)	61 (8.7%)	703(100.0%)
<i>Frequent Internet users (8-27 h per week)</i>						
<i>Frequent Internet users (8-27 h per week)</i>	Male	61 (8.8%)	155 (22.4%)	76 (11.0%)	43 (6.2%)	335(48.0%)
	Female	66 (9.5%)	171 (25.0%)	91 (13.2%)	29 (4.2%)	357(52.0%)
	total	127 (18.4%)	326 (47.0%)	167 (24.1%)	72 (10.4%)	692(100.0%)
<i>Very frequent Internet users (more than 27 h per week)</i>						
<i>Very frequent Internet users (more than 27 h per week)</i>	Male	26 (5.9%)	75 (16.9%)	95 (21.4%)	74 (16.7%)	270(61,0%)
	Female	18 (4.1%)	69 (15.6%)	50 (11.3%)	36 (8.1%)	173(39,0%)
	total	44 (9.9%)	144 (32.5%)	145 (32.7%)	110 (24.8%)	443(100,0%)

## Specificity, Sensitivity and Diagnostic Accuracy of the YDTIA for the Study Participants

We consider the eight Diagnostic Criteria of YDTIA. The *sensitivity* of a Diagnostic Criterion “A” refers to the probability of a positive answer in A by participants who are addicted according to YDTIA. It measures how well A detects the addiction.

The *specificity* of a Diagnostic Criterion “A” refers to the probability of a negative answer in A by participants who are not addicted according to YDTIA. It measures how well the Diagnostic Criterion A excludes the addiction. *Diagnostic accuracy* refers to the overall probability of the detection or exclusion of the addiction due to the answer to Diagnostic Criterion A of the test.<sup>44, 45</sup> The *positive diagnostic accuracy* of Diagnostic criterion A refers to the percentage of participants who answered positively A and they are addicted within all the participants who answered positively in Criterion A. Finally, the *negative Diagnostic Accuracy* refers to the percentage of participants who answered negatively in A and they are not addicted within all the participants who answered negatively in criterion A. From Table 3 we find that the 4<sup>th</sup> Diagnostic Criterion of Young “Do you feel restless, moody, depressed or irritable when attempting to cut down or stop Internet use?”, has the highest Diagnostic Accuracy (88.4%).

**Table 3. Specificity, Sensitivity and Diagnostic Accuracy of YDTIA for the Study Participants**

	Answers of addictive users		Answers of non addictive users		Sensitivity	Specificity	Diagnostic Accuracy	Positive Diagnostic Accuracy	Negative Diagnostic Accuracy
	YES	NO	YES	NO					
(1) Do you feel preoccupied with the Internet (i.e., think about previous online activity or anticipate next online session)?	201	34	478	1127	85,5%	70,4%	72,01%	29,6%	97,1%
(2) Do you feel the need to use the Internet with increasing amounts of time in order to achieve satisfaction?	196	44	290	1324	81,7%	82,0%	81,9%	40,3%	96,8%
(3) Have you repeatedly made unsuccessful efforts to control, cut back, or stop Internet use?	141	95	113	1497	59,7%	92,9%	88,1%	55,5%	94,0%
(4) Do you feel restless, moody, depressed, or irritable when attempting to cut down or top Internet use?	157	79	133	1472	66,5%	91,7%	88,4%	54,1%	94,9%
(5) Do you stay online longer than originally intended?	208	28	909	690	88,1%	43,2%	48,9%	18,6%	96,1%
(6) Have jeopardized or risked the loss of a significant relationship, job, educational, or career opportunity?	143	98	135	1472	59,3%	91,6%	87,4%	51,4%	93,8%
(7) Have you lied to family members, a therapist, or others to conceal the extent of your involvement with the Internet?	141	99	141	1465	58,8%	91,2%	87,0%	50,0%	93,7%
(8) Do you use the Internet as a way of escaping from problems or of relieving a distressed mood (e.g., feelings of helplessness, guilt, anxiety, depression)?	182	60	375	1227	75,2%	76,6%	76,4%	32,7%	76,6%

### Predicting factors of Internet Addiction

We performed stepwise multiple regression analyses with Internet addiction as the dependent variable. The results showed significant t-values for Internet Use Habits (hours of Internet use daily, Mean Academic Marks in last Semester’s exams, Enrollment in Unemployment Programs such as STAGE), Social conditions of participants (Marital status, Staying with parents), Location of computer (home, Internet Café), Internet Application with most frequent use (Chat, Sex pages, Games) and Demographics (Gender, Possession of Diploma for knowledge of the basics of computer, such as ECDL). The results are presented in Table 4.



**Table 4. Stepwise Regression Analyses with Internet Addiction, according to YDTIA, as the Dependent Variable.**

Variables	Step	R <sup>2</sup>	B	S.E.	Beta	t	p
<i>Habits of use</i>							
Hours of use of Internet daily	1	0,015	-0,025	0,003	-0,206	-7,77	0,000
Mean Academic mark in last semester	2	0,028	0,012	0,012	0,060	2,26	0,001
Enrollment in Unemployment Programs (Stage)	3	0,080	0,168	0,032	0,161	5,29	0,001
<i>Social Conditions</i>							
Marital Status	1	0,008	-0,113	0,030	-0,088	-3,76	0,000
Staying with parents	2	0,010	-0,027	0,014	-0,044	-1,88	0,000
Location of Computer	3	0,015	-0,017	0,008	-0,048	-2,05	0,000
<i>Internet Application</i>							
Sex	1	0,083	-0,043	0,007	-0,167	-6,076	0,000
Chat	2	0,124	-0,060	0,008	-0,192	-7,028	0,000
Games	3	0,135	-0,027	0,007	-0,114	-4,178	0,000
<i>Demographics</i>							
Gender	1	0,015	0,076	0,016	0,117	4,83	0,000
Possession of Diploma ECDL certifying knowledge of Computer	2	0,025	-0,033	0,012	-0,069	-2,83	0,000

#### 4. Discussion

##### Interpretation of results concerning Internet Addiction among Greek college students

Excessive use of the internet is related to the psychosocial health of the user, as Oczan and Buslu point out.<sup>46</sup> Often there is a psychopathology in the person that justifies his dependence from the Internet and this is shown by the coexistence of Internet dependence with other psychiatric disorders. Young and Rodgers<sup>48</sup> found a negative correlation between problematic use of the Internet and depression, while Kraut<sup>49, 50</sup> indicates a positive correlation between problematic use of the Internet and depression with loneliness and a negative correlation with perceived social support. Moraha-Martin and Schumacher<sup>51</sup> also describe a positive correlation between problematic use of the Internet and loneliness.

But the coexistence of psychiatric disorders is not adequate enough to lead to Internet dependence. The coexistence of psychiatric disorders, in combination with negative beliefs (maladaptive cognitions) of the individuals, are merged into a theory proposed by Davis,<sup>52</sup> to create Internet dependence. The theory argues that in order to become dependent on the internet there must first be a **distal contributory cause** (necessary). This is usually a pre-existing psychiatric disorder such as depression, another dependency, social phobia, etc. This reason alone may not lead to the development of Internet dependence. However, a **second necessary distal contributory cause** is the introduction of the Internet and the discovery of a special function of it by the person. A positive result from this operation will reinforce repeated use of this special function. Then, a **proximal sufficient cause** is the trigger that will ultimately create the symptoms of Internet dependence, as described by Young.<sup>2</sup> This cause is usually low self-esteem, a negative view of the world etc.

For this reason, during our systematic study of Internet dependence, we investigated the causes mentioned above. In this study we found that Internet dependent persons had began using the internet earlier than the non-dependent in most occasions.<sup>12, 13</sup> Also, we noticed that dependent users of the Internet were generally more disappointed with life and themselves than non-dependent Internet users. Overall, we identified that the second necessary cause is necessary and sufficient cause in the near .according to Davis.<sup>52</sup>

##### Interpretation of individual observations

*Why is there a gender difference among internet dependents?*

We found that Internet dependents are more likely to be males than females. One possible interpretation of this may lie in the process of socialization, which depends on gender. In some cultures, men are raised in

such a way as to know technology more than women. In Greece, a Mediterranean country, males are considered to be more superior from a social-status point of view. Thus, men probably deal more with technological fields – such as the Internet, as well as with other technical fields.<sup>38</sup>

#### *How is the existence of negative beliefs explained?*

The Internet dependent users feel abandoned by everyone, frustration and loneliness more than the non-dependent user; they lack social support. This shows the importance of social support in the development of Internet dependence. The fact that students are still in the period of puberty and have just left their homes for their studies, where they lived with their families, is considered to have contributed to this result. It seems likely that the use of the Internet becomes problematic at a period when the student is deficient of social support, both developmentally and from a learning point of view, and thus turns to the Internet for social support. This interpretation is supported by the fact that the percentage of Internet dependents is higher in the ages 18-20, which is the age during which enrollment in University occurs. In the age range 18-20, we observed more Internet dependents than non-dependents users.

#### *How can we explain the addictive behavior?*

Problematic Internet users experience negative feelings such as withdrawal from social life and feel unproductive because of their excessive use. At the same time though, they also experience positive emotions from this excessive use, such as more qualified, more social and more comfortable, and these positive feelings play a reinforcing role. This situation is indicative of the conflict described in many addictions. On the one hand, the person is harmed by the substance or behavior that he is addicted to, and he experiences the enhancing emotional changes that lead to the recurrence of the addictive behavior or the repeated use of the addictive substance.

### **Concluding Remarks**

Whereas Internet is a widely used medium for global communication, academic research, entertainment and commercial activities, many authors point out the dangers from an excessive use of Internet and other technological inventions such as the mobile phone, video games, playing television and gambling.<sup>10, 12, 30, 55</sup>

The central finding of our study is that the prevalence of Internet addiction among University students in Greece is 13.12%, in a sample of 1875 participants (8.4% among males, 4.7% among females).

Siomos<sup>36</sup> has estimated the prevalence of Internet addiction among Greek adolescents (12-18 years of age) and he has found 8.2% (6.2% for males and 2% among females). The results of our study are the first given, concerning Greek University students. Viewing Internet addiction as a matter of growing concern we defined the category of at-risk Internet Users as the ones fulfilling 3 to 4 criteria of YDTIA. The percentage of ATRIU is 23.5% (11.9% for males and 11.5% for females). We defined, also the problematic Internet Users as the ones who fulfill 3 to 8 criteria of YDTIA. The percentage of them is 36.5% (20.4% for males, 16.2% for females).

It is important to determine the factors which predict the new disturbing technological addiction of Internet excessive use. Those factors are home use, Internet Café use, Academic performance, Internet applications, such as Chat, Sex -pages and Games, and Demographics, such as Gender and Knowledge of basic Computer applications – as certified by the Diploma ECDL. A new result of this study is that the unemployment Status of a student and, therefore the greater lack of security regarding the future employment situation of him, as well as, the marital status of his are strong predictors of Internet Addiction. Also, the type of academic Department (Computer Science, School of Technological Applications) is a strong predictor of Internet Addiction.<sup>12, 13</sup>

Internet addiction is an emerging technological addiction<sup>29</sup> with far reaching consequences, because of the widespread use of this medium. Young<sup>4, 17, 48, 54</sup> has addressed the question of whether or not the Internet can be addictive, and the extent of problems associated with its misuse. The DSM-IV<sup>44</sup> criteria for pathological gambling were modified to develop an eight-item questionnaire, referred as YDTIA, since pathological gambling was viewed to be the closest in nature to pathological Internet use.

In our research we found that the percentage among Greek University Students at risk and problematic Internet users is quite high. This is a quite worrisome result. There is a need for further research in the casual mechanisms of this behavioral addiction. Also, there is a need for a campaign to inform Parents, Teachers and State Officials about the dangers of Internet which are gambling, trafficking of pornographic material, women and children for sexual abuse purposes,<sup>50, 55-57</sup> Cybersex and Cyberbullying.<sup>7</sup> Further research could

be carried out on other simultaneous addiction of Internet users such as alcoholism, smoking and taking drugs.

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# PSYCHOSOCIAL CHARACTERISTICS OF HEAVY AND NON HEAVY INTERNET USERS BASED ON A SAMPLE SURVEY AMONG UNIVERSITY STUDENTS, FROM GREECE

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## Abstract

*In recent years, a substantial amount of research has been devoted to the use and excessive use of the Internet (Young, 2004). In this paper, we present the results of a sample survey which was carried out among a random sample of 1876 Greek University students examining, for the first time, the consequences of heavy and non heavy Internet use. Multivariate Analysis of Variance (MANOVA), F- tests and t-tests were applied and the results showed that heavy Internet users compared to non heavy Internet users had more problematic interpersonal relations with parents, teachers, friends, were more depressed, lonely and with low self esteem, had a more disappointing academic performance and they were dependent on a greater percentage on alcoholism, smoking, drinking coffees and taking substances.*

## 1. INTRODUCTION

The majority of individuals uses the Internet without negative consequences and even benefit from it, because the Internet is a great source of information in the fields of Science, Commerce, Communication and Social activities. A great deal of research has been accumulated - and is still being carried out - on the potential negative impact from excessive use of Internet and related physical and psychological problems (Griffiths, 1999, 2000a,b; (Young, 1996a,b, 1997, 1998, 1999, 2004; Young and Rodgers, 1998; Greenfield, 2000).

The essence of the research on the negative impact of the use of the Internet is that users who spend a significant amount of time online often experience academic, social, and occupational difficulties as well as psychological impairments (Brenner, 1997; Nie and Erbring, 2000). The issue of the Internet use by College students has been discussed in a number of studies (Chen and Peng, 2007; Chou, 2001; Jones and Madden, 2002; Frangos and Frangos, 2009).

This is the first study which examines the consequences of excessive Internet use in a random sample of 1876 Greek University students. The respondents were students in the Schools of Administration and Economics, Technological Applications, Graphical Studies, Food Technology and Health and Sciences of the Technological Educational Institution of Athens, the School of Law in the National University of Athens, as well as in the Economic and Agricultural Universities of Athens.

Previous studies in Greece had the aim of determining the percentage of problematic Internet users among high school students (Siomos et al., 2008) and among adolescents (Tsitsika et al., 2009). The above authors found that percentages of 8.2% and of 10.0% for male users respectively, are excessive Internet users. Therefore, the problems of excessive Internet use among the Greek University students deserve careful attention.

On the basis of Young's findings (Young, 1998), the mean weekly on-line time for excessive users was 30 to 40 hours. Following Young's findings, for purposes of comparison in this paper, we give the following definition: A student with a total on-line weekly time greater or equal than 35 hours is defined as *heavy*

*internet user* (HIUS), while a student with total on-line weekly time less than 35 hours is defined as *non heavy internet user* (NHIUS).

In the present study, we examined the following: (a) We applied MANOVA (Seber, 1984), to determine if there are statistically significant differences in the social relationships and the psychological characteristics (depression, loneliness, low self esteem, lack of objectives in life) between heavy and non heavy Internet users, (b) We used (t) and (F) tests to determine the difference between men and women with respect to time spent weekly on the Internet and the difference in academic performance and Internet dependence between students at Technological Educational Institutions (TEI) and students at Universities. (c) We used an Exploratory Factor Analysis to identify the different factors which determine the dependency of a person on the Internet .

## 2. METHODS

This study was based on data from a survey of University students in certain Universities and Technological Educational Institutions (TEI) in Athens. The number of students who have answered the questionnaire of this study was (1876), and the respondents were selected randomly from the five schools of the Technological Educational Institution of Athens (TEI), namely the School of Administration and Economics (TEIA-SDO) the School of Technological Applications (TEIA-STEF), the School of Health and Social Services (TEIA-SEYP), the School of Graphical and Artistic Studies (TEIA-SGIKS) and the School of Food Technologies (TEIA-STETROD). Also, the questionnaire was answered by students at the Technological Educational Institute of Piraeus (TEIPIR), the Economics and Business University of Athens (EBUA), the School of Law at the National University of Athens (UNATLAW) and the Agricultural University of Athens (UNAGRIA).

The questionnaire included seven sections: demographics, academic performance, on-line experience, social relationships, Young's 8-item Diagnostic Test for Internet Addiction (YDTIA), self evaluation for psychological symptoms (SEPS) and other dependencies (excessive smoking, alcoholism, excessive drinking coffees and taking substances). The consistency of Young's Diagnostic Test for Internet Addiction (YDTIA) was tested with Cronbach's alpha (0.71) and Cronbach's alpha based on standardized items (0.73). Also, the Spearman-Brown Coefficient was (0.72) and Guttman Split-half coefficient was (0.72). The mean age of the respondents was 21 years with a standard deviation of 2.35 years. The male students were 878 and the female students were 998.

Non-response analysis did not find significant biases. Background characteristics of respondents and members of the whole population were almost identical, indicating that respondents were representative of the original population. To compare differences between these two groups we used MANOVA, t tests and F tests. Also, to compare differences among students at the different departments with respect to the characteristics of the mean weekly time spent on the internet applications (chat, sex pages, games and e-mail), we used MANOVA. The results are included in the following sections.

## 3. RESULTS

### 3.1 Demographics and on line experience

From the analysis of the questionnaires we found that (a) most of the respondents' Internet activities occurred at home (81.4%), at Internet Café (5.8%) at School (4.8%) and at a friend's house (3.7%). Participants' average total weekly time on the Internet was 19 hours with an average of 3.6 hours per week spent on chat rooms, 3 hours per week spent on games, 3.2 hours per week spent on sex-pages, 4 hours per week spent on searching for academic information and 4.5 hours per week spent on sending and reading incoming e-mail messages. These findings are in agreement with Chen and Peng's (2007) finding that University students use the Internet primarily for communicating. Some students have reported that they use MSN as a cheap Internet application for phoning to their friends.

Results also showed that, overall, men spent more time using the Internet than women ( $t=8.55$ ,  $p<0.0001$ ), and that men had been using the Internet for more years than women ( $t=7.69$ ,  $p<0.0001$ ). Men were using the Internet more time than women for chatting ( $t=2.99$ ,  $p<0,001$ ), searching sex pages ( $t=10.62$ ,  $p<0,001$ ), playing games ( $t=9.69$ ,  $p<0.001$ ) and reading announcements on blogs ( $t=4.54$ ,  $p<0.001$ ). Women were using the Internet more time than men for talking on e-radio.gr ( $t=-1.4$ ,  $p<0.01$ ) and searching for academic information ( $t=-1.72$ ,  $p<0.1$ ).

### 3.2 Comparison between University and Techn. Educ. Instit. students in certain aspects

The following Table 1 shows the differences between students at the Technological Educational Institutions of Athens and at Universities in Athens with respect to Internet addiction and its consequences.

**Table 1. Differences between students at the Technological Educational Institutions of Athens and at Universities in Athens with respect to Internet addiction and its consequences**

	Total Random Sample (1876)			Technological Educational Institutions of Athens			Universities in Athens		
	Male (%)	Female (%)	Total (%)	Male (%)	Female (%)	Total (%)	Male (%)	Female (%)	Total (%)
<b>YDTIA</b>									
0-2 Symptoms	26,6	36,6	63,2	26,0	39,3	65,3	23,3	39,2	62,5
3-4 Symptoms	25,6	21,9	23,6	10,2	12,2	22,4	12,9	10,3	23,3
5-8 Symptoms (Internet addiction)	18,0	8,9	13,2	7,5	4,9	12,4	9,9	4,3	14,2
Gender Difference	$\chi^2=24.2, df=2, p<0.0001$			$\chi^2=24.258, df=2, p<0.001$			$\chi^2=13.91, df=2, p<0.0001$		
<b>Psychological Attitudes</b>									
Loneliness	9,3	10,4	19,7	7,7	11,7	19,5	9,9	6,9	16,7
Job uncertainty	26,3	30,4	56,7	22,1	30,7	52,8	31,6	39,0	70,6
Low Self esteem	11,1	11,0	22,1	9,8	11,1	20,9	13,0	12,2	25,2
Feelings of being abandoned	6,0	5,7	11,7	6,0	6,0	12,0	4,3	4,3	8,6
Gender Difference	NS*			NS*			NS*		
<b>Overlapping Addictions</b>									
<i>Smoking (more than 7 cig/day)</i>	3,5	1,3	4,9	3,7	1,5	5,1	2,8	0,5	3,3
Gender difference	$\chi^2=32,28, df=5, p<0,0001$			$\chi^2=31,45, df=5, p<0,0001$			$\chi^2=12,66, df=5, p<0,0001$		
<i>Drugs (more than three times/week)</i>	2,7	0,8	3,5	2,9	0,7	3,6	1,7	0,9	2,8
Gender difference	$\chi^2=46,95, df=5, p<0,0001$			$\chi^2=51,13, df=5, p<0,0001$			NS*		
<i>Coffees (more than 7 coffees/day)</i>	1,6	0,5	2,1	1,9	0,5	2,5	0,9	0,4	1,3
Gender difference	$\chi^2=31,55, df=5, p<0,0001$			$\chi^2=32,85, df=5, p<0,0001$			NS*		
<i>Alcoholic drinks (more than 7 drinks/day)</i>	2,4	0,6	3,0	2,7	0,6	3,3	1,7	0,9	2,6
Gender difference	$\chi^2=77.66, df=5, p<0.0001$			$\chi^2=70,63, df=5, p<0,0001$			NS*		
<b>Location of computer</b>									
Home	39,3	43,6	82,9	35,9	46,6	82,5	39,2	48,5	87,7
School	2,0	2,9	4,9	1,5	3,1	4,6	3,5	0,4	4,0
Internet café	2,8	3,1	5,9	2,7	3,3	6,1	2,6	3,1	5,7
Gender difference	NS*			NS*			NS*		
<b>Hours of Internet use daily</b>									
0<h<3	27,0	38,6	65,0	26,5	41,2	67,6	27,8	41,3	69,1
3<=h<6	12,6	10,7	23,3	10,4	11,1	21,5	13,5	10,0	23,5
h>=6	7,4	3,7	11,2	6,7	4,2	10,0	4,3	3,0	7,4
Gender difference	$\chi^2=56,9, df=2, p<0,0001$			$\chi^2=28,47, df=2, p<0,0001$			$\chi^2=6,06, df=2, p<0,0001$		
<b>Academic performance</b>									
Mark<5	4,0	2,1	6,0	4,1	2,1	6,2	2,1	2,1	4,2
5<=mark<6,5	20,4	16,6	37,0	19,2	18,3	37,5	20,2	14,4	34,6
6,5<=mark<8	19,6	27,7	47,3	17,4	30,2	47,7	18,1	27,7	45,7
8<=mark<=10	3,6	5,9	9,5	3,1	5,4	8,5	6,9	8,0	14,9
Gender difference	$\chi^2=45,66, df=3, p<0,0001$			$\chi^2=34,40, df=3, p<0,0001$			NS*		

NS\* = non-significant

University students have achieved better marks in the last semester than Technological Educational Institution students ( $t=2.41$ ,  $p < 0.1$ ). This is due to the better marks which they have achieved in the entrance exams than the students at Technological Educational Institutions ( $t=-11.73$ ,  $p < 0.001$ ). Pearson's Correlation Coefficient ( $r$ ) between the marks at the entrance exams and the marks achieved at last semester between all 1876 students was statistically significant ( $r=0.25$ ,  $p < 0.001$ ). This is in agreement with the results of Efron (1979). On the other hand, students at the Technological Educational Institutions have obtained a diploma ECDL (European Driving Computer Licence) for knowledge of the basic function of Windows, Microsoft applications and the Internet at a striking 84 % whereas University students have obtained the same diploma at a 12% only. The students at the TEIs spent more time than University students on Internet applications such as e-radio.gr ( $t=4.2$ ,  $p < 0.001$ ), advertisement pages ( $t=4.82$ ,  $p < 0.001$ ), e-mail ( $t=0.06$ ,  $p < 0.001$ ) and games ( $t=2.45$ ,  $p < 0.1$ ).

### 3.3. Social Relationships

Using Multivariate Analysis of Variance (MANOVA), on heavy (HIUS) and non-heavy Internet users (NHIUS), we found significant differences of these two groups with respect to their relations with parents (Wilk's Lambda = 0.99,  $F=4.88$ ,  $p < 0.001$ ), their relationships with teachers ( $F=3.64$ ,  $p < 0.1$ ) and their relationships with fellow students and friends ( $F=10.9$ ,  $p < 0.001$ ). This result supports previous studies by Chen and Peng (2007), suggesting that deterioration of interpersonal relationships is a consequence of heavy internet use.

Heavy Internet users (HIUS) are used to building relationships with friends through the Internet. The likelihood was that they could conceal their true identity, their habits and other characteristics of their personality and when the subjects of their virtual relationships might discover their true identity, they could be very disappointed.

### 3.4. Psychosocial Profile of Heavy Internet User

The overall percentage of heavy Internet Users in the sample of 1876 students is a striking 16.8% or 288 users of 1714 students who have answered the question about the weekly time of using the Internet. Heavy Internet users were more likely than non heavy Internet users to be depressed ( $F=31.68$ ,  $p < 0.001$ ), to feel that they have been abandoned ( $F=36.17$ ,  $p < 0.001$ ) and the differences in the way of facing problems of life (initiative, patience, work –oriented character) between heavy Internet users and non heavy Internet users were statistically significant (Wilk's Lambda=0.976,  $p < 0.001$ ), Hotelling's Trace = 0.024,  $p < 0.001$ ).

Heavy Internet Users were more likely than non heavy Internet Users to be low self-esteem persons ( $F=21.55$ ,  $p < 0.001$ ), not to have objectives in their lives ( $F=21.16$ ,  $p < 0.001$ ) and to have a pessimistic point of view about life ( $F=20.27$ ,  $p < 0.001$ ). Heavy Internet Users have the same degree of lack of security about their job as non heavy Internet users ( $F=0.002$ , Non significant). Heavy Internet Users are more likely than non heavy Internet Users to do things in order to show off ( $F=15.42$ ,  $p < 0.001$ ).

The likely explanation of the above findings is that the preoccupation of users with the Internet reduces their ability to form social relationships and, therefore makes them depressed and low self-esteem personalities.

### 3.5. Academic Performance

Ten percent of the heavy Internet Users were likely to fail in their studies during the last Academic semester, whereas only 5% of the non heavy Internet Users were likely to fail in their studies of the last semester. This result agrees with Young's findings (Young, 1998). The likely explanation for this is that students who spent excessive time on the Internet have difficulty completing work assignments, they have lack of sleep and, usually they do not follow closely their studies, appearing physically tired every day in the classrooms to listen to their teachers' lectures.

### 3.6 Identification of the social, occupational, psychological and academic dimensions of the users' personality which determine Internet addiction.

We applied Exploratory Factor Analysis in order to identify the major dimensions which determine the phenomenon of a user preoccupied with Internet which leads eventually to Internet addiction. We used rotation method "Varimax" and all the calculations were performed on the Statistical Package for the Social Sciences (SPSS ) v.17.0 (Tabachnick and Fidell, 2007). The following nine factors were found, which explain 54,13% of the total variance:

- a. *Social relationships with teachers, friends, parents*, explaining 16,24 of the total variance.
- b. *Uncontrollable and damaging use of Internet*, explaining 8,65 % of the total variance.



- c. *Applications of the Internet (chatrooms, sexpages, e-mail, games) and length of time using them*, explaining 5,91% of the total variance.
- d. *Overlapping addictions (alcoholism, smoking, drinking coffees, taking substances)*, explaining 5,35% of the total variance.
- e. *Psychological characteristics (loneliness, low self esteem, lack of initiative)*, explaining 4,10% of the total variance.
- f. *Deep psychological feelings (deep disappointment from life, belief that user has been abandoned from everybody)*, explaining 3,93% of the total variance.
- g. *Job uncertainty*, explaining 3,48% of the total variance.
- h. *Academic performance*, explaining 3,34% of the total variance.
- i. *Demographic elements and University where the user is studying*, explaining 3,14% of the total variance.

#### 4. DISCUSSION

The Internet has enriched our civilization with immediate access to an enormous source of academic, business and social literature and a reliable way for communication, entertainment and making friends. At the same time, the excessive use of the Internet can lead to antisocial behaviour, loss of confidence, depression and disappointment from life. This paper has focused on the differences of heavy and non heavy Internet users with respect to their psychosocial characteristics. This study aims in helping parents and educators to understand the psychological changes which are linked with excessive Internet use. Parents need to know more about the Internet applications, the dangers of Internet's excessive use and the safeguards against them.

More research is needed in order to determine the impact of the excessive Internet use in the workplace, between employees, and the deeper causes of Internet addiction in the student population. A further study will focus on the differences of Internet excessive use between the students in the main cities and the students in the country side. In future papers, we shall examine the percentage and intensity of Internet addiction in Internet cafés. We shall investigate also the intercollegiate differences with respect to Internet addiction.

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# FACTORS PREDICTING PROBLEMATIC INTERNET USE AMONG UNIVERSITY STUDENTS IN GREECE: NEW RESULTS OF A SAMPLE SURVEY

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## Abstract

*The aim of this paper is to investigate the relationships between Problematic Internet Use among University Students in Greece and factors such as Age, Gender, Academic Performance, Location of the Computer (Home, Internet Cafe, University), Time of Internet Use per week, additional dependencies and the change in psychological attitudes of Internet users. Data were gathered from 2358 University Students from all over Greece. The results indicated that factors such as age, gender, academic performance, location of Computer, additional dependencies, changes in psychological attitudes and health, present a statistically significant relationship in a Stepwise Multiple Regression model with dependent variable Problematic Internet Use. Cronbach's alpha and Guttman Split – half reliability coefficients were derived and their range was between 0.67 and 0.82 . The prevalence rate of Internet addiction was 13.1% . Correlation analysis revealed that there were statistically significant correlations at the 0.01 level, between excessive Internet use and other co-existing addictions such as alcoholism, smoking, drinking coffees, playing systematically games and taking substances.*

## INTRODUCTION

Internet has become an indispensable tool for communication, academic research, information and entertainment. However, the following paradox exists: excessive and problematic or pathological use of the “social” technology of Internet can lead to “antisocial” phenomena such as fewer friends, quarrels with parents and teachers, compulsive behavior and unhealthy psychological attitudes. *Problematic Internet use (PIU) is defined as Internet addiction (IA) plus at risk Internet use (ARIU).*<sup>1-4</sup> According to Young's Diagnostic Test for Internet Addiction (YDTIN) Internet users who meet 5 to 8 diagnostic criteria are “Internet addicted” and users who meet 3-4 diagnostic criteria are “at risk Internet users” (ARIU). Several studies have examined the relationship between Problematic Internet Use (PIU) and characteristics such as gender, age, academic performance, location of computer, excessive use of Internet and psychological attitudes.<sup>5-9</sup>

According to a substantial volume of recent research,<sup>10-15</sup> University students are considered as a group in high risk for PIU for the following reasons: (a) Students have huge blocks of unstructured time, (b) Schools and Universities provide free and unlimited access to Internet, (c) Students at the age of 18 – 22 years are for the first time away from parental control without any monitoring or censoring of what they say or do online, (d) Young students experience new problems of adapting to the University life and finding new friends. For this reason, students seek help by using different applications of the Internet, (e) Students receive full encouragement from faculty and administrators in using the different applications of Internet, (f) Adolescents are more trained to use the different applications of technological inventions and especially the Internet, (g) Students desire to escape University sources of stress resulting from their obligations to pass the exams, to deliver essays and to fulfill their purpose of getting their degrees in the prescribed time with reasonable marks, and (h) Students feel that university life is alienated from social activities and when they finish their studies, the job market with all its uncertainties is a field where they must participate and succeed in getting a job.

In Greece there exists no study concerning the predictors of PIU among University students The aim of this paper is to identify, using Stepwise Multiple Regression Analyses, the most statistically significant predictors

of PIU for University students who are studying in certain Universities at Athens and other cities of mainland Greece. For this purpose, it was investigated whether Greek University students' gender, age, academic performance in the last Semester of their studies, location of the computer where they use Internet, length of time of Internet use per week, additional dependencies such as number of coffees, alcoholic drinks which are drunk per day, taking substances, cigarettes smoked per day, and psychological attitudes and health, are significant predictors of their Problematic Internet Use (PIU). An additional purpose of the sample survey was to measure the prevalence rate of Internet addiction among Greek University students and to investigate, using correlation analyses, the degree of association between different overlapping addictions which a University students may present.

## METHODS

### Participants

The sample survey was conducted among a random sample of 2358 students, drawn randomly from the University of Athens, Agricultural University of Athens, Economic and Business University of Athens, Technological Educational Institute (TEI) of Athens, Technological Educational Institute (TEI) of Piraeus, and Technological Educational Institute (TEI) of Epirus in Northern Greece. The sample consisted of 46.1% males and 53.9% females. 34.1% of students were 18 – 20 years old, 36.6% students were 20 – 22 years old, 16.9% students were 22-24 years old and 12.4% were aged more than 24 years old. It is interesting to note that the percentage of married students was 3.1% and the percentage of the divorced students was 3.2%.

### The Questionnaire

Students were asked to fill a questionnaire consisting of the following six parts: (a) demographic elements, (b) length of time of Internet use per week, (c) length of time using various applications of the Internet per week, (d) conditions of relations with parents, teachers, friends and fellow students, (e) Young's Diagnostic Test of Internet Addiction and, (f) psychological Attitudes of Internet users and additional dependencies.

### Problematic Internet Use Diagnostic Test (PIUDT)

The PIUDT includes the following domains :

- Problematic Social Relations Domain (PSOCREL)*. This domain consisted of questions in a Likert type scale from one to seven, concerning the degree of influence of the use of Internet in the daily program of work, studies, relations with parents, teachers, friends, personal health and psychological attitudes (10 items).
- Youngs' Diagnostic Test for Internet Addiction (YDTIA)* consisting of 8 items concerning absolute devotion to Internet, tolerance, unsuccessful attempts to reduce the use of Internet, compulsive conditions when attempting to stop increased use, loss of opportunities because of use, lies to parents concerning use of Internet and view of Internet as a way of avoiding problems (8 items).
- Problematic use of certain Applications of Internet (PUCAPP)*, namely chatrooms, sexpages, advertising pages, games and e – mail (5 items).
- Negative Psychological Attitudes (NPA)*, namely low self esteem, weak will to work, uncertainty about job security, absence of objectives in life and sense that everything is trivial (6 items).
- Excessive Internet Use and Deeper Psychological Problems (EIUDP)*, namely hours of Internet use daily, Years of Internet use, feelings of loneliness or being abandoned and deep disappointment from life (10 items).

Table 1 contains the Coefficients of Internal Consistency and Reliability for the five domains of PIUDT.

**Table 1.** Coefficients of Internet Consistency and Reliability for PIUDT: Cronbach's alpha, Standardized item alpha, Split – half Guttman Coefficient and Spearman – Brown Coefficient.

Domains of PIUDT	Cronbach's alpha coefficient	Standardized item alpha coefficient	No. of items	Split – half Guttman coefficient	Spearman – Brown coefficient
PSOCREL	0,88	0,87	10	0,84	0,86
YDTIA	0,70	0,72	8	0,69	0,69
PUCAPP	0,70	0,71	5	0,67	0,67
NPA	0,67	0,67	6	0,64	0,64
EIUDP	0,78	0,82	10	0,66	0,69

## Methods and Data Analysis

The questionnaire and the Problematic Internet Use Diagnostic Test were filled by 2358 University students attending various undergraduate programs in 6 Universities and Technological Educational Institutes of Greece. The data were analyzed and  $p < 0.001$  was taken as the level of significance.

## RESULTS AND DISCUSSION

### A. Results

All the statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS), version 17.0. The prevalence rate of Internet addiction over all the 2358 students was, according to Young's (8) diagnostic criteria, 13.1%. The prevalence rate of Internet addiction for students at the Technological Educational Institute (TEI) of Athens was 12.1%, whereas the one for students of the Technological Educational Institute (TEI) of Epirus, which is located at a remote and one of the most poor regions of Europe, Epirus, was 13.6%. We found statistically significant Correlation Coefficients between excessive Internet use and other overlapping addictions such as alcoholism, systematic smoking, heavy drinking of coffees, playing systematically games and taking narcotic substances. The results are shown in Table 2.

**Table 3. Overlapping Dependencies.** Pearson's Correlation Coefficients between excessive Internet use, alcoholism, systematic smoking, heavy drinking of coffees, playing systematically games and taking substances. All the values of the Correlation Coefficients are statistically significant at the 0.01 level, for a two-sided test.

	Excessive Internet use	Alcoholism	Heavy smoking	Heavy drinking of coffees	Playing Games
Alcoholism	0,42				
Heavy Smoking	0,42	0,30			
Heavy drink of coffees	0,44	0,56	0,30		
Playing Games	0,20	0,16	0,20	0,17	
Taking substances	0,10	0,10	0,06	0,13	0,24

Stepwise Multiple Regression was applied to determine the factors influencing the total scores of Problematic Internet Use (PIU) of the students and the total scores of the (5) different domains of PIU, namely Problematic Social Relations (PSOCREL), Youngs' Diagnostic Test for Internet Addiction (YDTIA), Problematic use of certain Applications of Internet (PUCAPP), Negative Psychological Attitudes (NPA), and Excessive Internet Use and Deeper Psychological Problems (EIUDP).

The results are shown in Tables 3a and 3b.

**Table 3a** Stepwise Multiple Regression Analysis with predictors: demographic and psychosocial characteristics and dependent variable: Problematic Internet Use and its (5) domains.

Predictors	Problematic Internet Use (PIU)			Problematic Social Relations (PSOCREL)			Youngs' Internet Addiction Diagnostic Test (YIADI)		
	Estimates B	t-test	Significance of (t)	Estimates B	t-test	Significance of (t)	Estimates B	t-test	Significance of (t)
Constant	54,26	24,31	$p < 0,005$	6,21	7,74	$p < 0,001$	1,24	13,99	$p < 0,001$
Gender	-1,95	-3,43	$p < 0,005$	-0,06	-0,31	NS*	0,06	3,93	$p < 0,001$
Age	-0,80	-3,28	$p < 0,005$	0,01	-0,03	NS*	0,01	0,95	NS*
Academic Performance	0,72	-1,89	NS*	-0,54	-3,86	$p < 0,001$	0,01	0,84	NS*
Place where Internet is used	-0,06	-0,24	NS*	0,14	-1,46	NS*	-0,028	-0,73	NS*
Length of time of Internet use	2,31	22,75	$p < 0,004$	-0,03	-0,75	NS*	-0,01	-5,73	$p < 0,001$
Additional dependencies	1,90	7,53	$p < 0,005$	-0,01	-0,03	NS*	-0,01	-6,66	$p < 0,001$
Psychological attitudes	2,00	10,71	$p < 0,004$	2,28	33,55	$p < 0,001$	0,11	2,72	$p < 0,001$
Psychological health	2,78	16,87	$p < 0,005$	3,10	49,75	$p < 0,001$	0,01	0,98	$p < 0,001$
Adjusted R <sup>2</sup>	0,40			0,78			0,17		
F-test (df <sub>1</sub> , df <sub>2</sub> )	251,9			2376,5			44,34		

Predictors	Problematic Internet Use (PIU)			Problematic Social Relations (PSOCREL)			Youngs' Internet Addiction Diagnostic Test (YIADI)		
	Estimates B	t-test	Significance of (t)	Estimates B	t-test	Significance of (t)	Estimates B	t-test	Significance of (t)
df <sub>1</sub>	1			1			1		
df <sub>2</sub>	1789			1790			1690		
Significance of F-test	p<0,001			p<0,001			p<0,001		

note: NS\*: non significant , p>0,001

**Table 3b. (Continuation of Table 3a)** Stepwise Multiple Regression Analysis with predictors: demographic and psychosocial characteristics and dependent variable: Problematic Internet Use and its (5) domains.

Predictors	Problematic Use of certain Applications of Internet (PUCAPP)			Negative Psychological Attitudes (NPA)			Excessive Internet Use and Deeper Psychological Problems (EIUDP)		
	Estimates B	t-test	Significance of (t)	Estimates B	t-test	Significance of (t)	Estimates B	t-test	Significance of (t)
Constant	8,81	10,65	p<0,001	10,99	40,57	p<0,001	15,20	10,64	p<0,001
Gender	-1,17	-5,54	p<0,001	0,10	1,50	p<0,001	-1,12	-3,06	p<0,001
Age	0,38	-4,23	p<0,001	0,02	0,61	NS*	-0,51	-3,23	p<0,001
Academic Performance	0,26	1,82	p<0,001	0,07	1,42	NS*	-0,78	3,18	p<0,001
Place where Internet is used	0,19	1,83	p<0,001	-0,15	-4,48	NS*	-0,11	-0,65	NS*
Length of Time of Internet Use	0,53	14,1	p<0,001	-0,06	-4,77	p<0,001	1,99	30,69	p<0,001
Additional Dependencies	1,23	13,06	p<0,001	-0,31	-	p<0,001	1,31	8,09	p<0,001
Psychological Attitudes	-0,03	-0,36	NS*	-0,04	-1,76	p<0,001	-0,20	-1,72	p<0,001
Psychological Health	-0,27	-4,07	p<0,001	0,14	6,68	p<0,001	-0,30	-2,72	p<0,001
Adjusted R <sup>2</sup>	0,26			0,12			0,43		
F-test (df <sub>1</sub> ,df <sub>2</sub> )	16,53			47,32			7,39		
df <sub>1</sub>	1			1			1		
df <sub>2</sub>	1721			1789			1790		
Significance of F-test	p<0,001			p<0,001			p<0,001		

Note: NS\*: non significant , p > 0,001

## B. Discussion

The results indicate that factors such as Gender, Age, Length of time of Internet use, Academic performance, Psychological Attitudes and Psychological health, Location of the computer, and additional dependencies are significant predictors, with  $p < 0.001$ , of Problematic Internet Use (PIU). The results of the sample survey indicate that male students are Problematic Internet users at a higher percentage than female students. This finding is consistent with the findings of other studies in the literature.<sup>1-4</sup> The possible reasons for this result is that men are at a higher pressure than women to form social relations and to become members of social networks, to form intimate relationships and to develop themselves. This pressure results in a tendency of men to use the Internet in order to succeed in their social relations.<sup>18</sup>

The psychological factor is also a significant predictor of Problematic Internet Use. This is consistent with the theories of Davis,<sup>19</sup> Caplan,<sup>20</sup> Song,<sup>10</sup> and McGlinchey.<sup>2</sup> In accordance with the findings of Young,<sup>17</sup> we found that loss of opportunity to use the Internet results in Impulse Control Disorder and Depression. Some other researchers, such as Shapira et al<sup>12</sup> arrive to the same conclusion. This shows that Internet addiction is a purely psychiatric phenomenon and, as such, it requires a psychiatric treatment, as Davis<sup>19</sup> points out.

A significant predictor of Problematic Internet Use (PIU) is bad academic performance. This result is consistent with the findings of Kubey et al<sup>21</sup> and Young.<sup>17</sup> Problematic Internet Use causes lack of sleep because the user stays awake during late night hours in order to surf through the different web pages. The lack of sleep causes lack of concentration and loss of interest to the lectures of every day. The loss of interest causes reduced reading of the course material and, as a consequence bad marks in the examinations of academic courses. Wang<sup>22</sup> stresses the high degree of association between psychosocial maturity and problematic Internet use.

According to Yang et al.<sup>23</sup> students who use the Internet excessively, exhibit more psychiatric symptoms than students who use the Internet less frequently. Our study found a similar result for Greek University students. According to Table 3b, there is a significant association between excessive Internet use and

psychological attitudes. The relevant coefficient has a value -0.30, the t-test has a value of -2.72 and the p-value is less than 0.001.

Our results are also in accordance with the cognitive behavioral model for Internet addiction developed by Davis.<sup>19</sup> Davis suggested that psychiatric symptoms are necessary and adequate to lead to Internet addiction. A pre-existent psychiatric disorder (e.g. depression) is necessary to be present to develop Internet addiction; and a proximal negative psychological feeling (e.g. low self-esteem) is enough to trigger the symptoms of this addiction disorder. Additionally, Kraut et al.<sup>24</sup> pointed out the coexistence of Problematic Internet Use with depression and loneliness.

According to some studies<sup>25-27</sup> and Shapira et al.,<sup>12</sup> the description of the Problematic Internet User is the following: he is a male University student 18-20 years old, with substantial psychiatric co-morbidity, who spends 30-35 hours per week on computer use that is not essential to his work or well being, resulting in significant subjective distress and functional impairment. E-mail, chat rooms, auction houses, gambling casinos, the "blogosphere", and pornography sites are only a few of the Internet venues that have been associated with Problematic Internet Use.

Our Correlation analysis revealed a clear tendency among college students to become addicted to more than one common substance or activity. The results of Table 2 revealed a tendency of an individual to develop more addictive behaviours if he already presents one and there is a statistically significant association between the six addictive behaviors: excessive Internet use, alcoholism, heavy smoking, heavy drinking of coffees, playing games and taking substances.

Current research<sup>28-34</sup> supports our findings. As a final comment, we would like to stress the responsibilities of parents, teachers, the media and the Governmental Departments of Health to take preventive measures such as counselling and social campaigns to restrict the new phenomenon of Internet addiction among young men and women.

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# PARTISAN POLITICIANS AND ECONOMIC POLICY

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## Abstract

*This paper seeks to identify the causal effect of governor party affiliation on state tax burden and tax legislation from 1975-2000. This helps shed light on whether policy making by different political parties diverge or converge. We employ parametric and nonparametric regression discontinuity approaches. Our results indicate that when a state has a closely elected Democratic governor, the state has a significantly higher total tax burden than it would have had if the Republican candidate would have won instead.*

## 1. INTRODUCTION

This is an empirical investigation of differences in tax policies set by Democratic and Republican governors in the U.S. states. The political economy literature has recently renewed its interest in the role played by party affiliation for politicians' choices and behaviors (Lee et al.<sup>[7]</sup>; Lee<sup>[6]</sup>). While a considerable body of theory suggests that competition between office-seeking politicians will push policymaking towards the middle (Downs<sup>[3]</sup>), Besley and Case<sup>[2]</sup> point out that this result hinges crucially on the ability of politicians to commit to campaign promises. Alesina<sup>[1]</sup> finds that partisan politicians with different policy preferences may be unable to commit to middle-of-the-road policies if her promises are not perceived by voters as credible.

The empirical evidence on the role of party affiliation is mixed. While Ferreira and Gyourko<sup>[4]</sup> find no impact of the party affiliation of U.S. mayors' on e.g. spending, Lee et al.<sup>[7]</sup> report that members of the U.S. House from the two main parties vote differently. They find that voters "pick policies" (policy platform) rather than "affect policies" by pushing politicians towards the middle. At the state level, Besley and Case<sup>[2]</sup> establish that a higher share of Democratic state legislators results in higher state spending, while Knight<sup>[5]</sup> and Reed<sup>[8]</sup> find that Democratic control of state legislatures raises the tax burden. Knight<sup>[5]</sup> and Reed<sup>[8]</sup> find little effect of governor party affiliation on state tax rates.

The current paper contributes to the state tax policy literature by utilizing recently developed regression-discontinuity approaches. These are designed to deal appropriately with the endogeneity associated with governors' political affiliations as they mimic a random assignment of the governor's party affiliation (Lee et al.<sup>[7]</sup>; Lee<sup>[6]</sup>). Utilizing 1970-2000 data, we study the effect of party affiliation on the change in several tax policy measures four years subsequent to a governor's election victory (in particular, total tax revenue per capita; sales tax receipts per capita; income tax receipts per capita; corporate income tax revenue per capita).

## 2. EMPIRICAL METHODOLOGY

To begin, let  $Y_1$  and  $Y_0$  denote two variables of tax policies to be compared, in particular if a governor is a Democrat or Republican, respectively,

$$Y_{1i} = x_i \beta + \delta + u_{1i} \quad (1)$$

$$Y_{0i} = x_i \beta + u_{0i} \quad (2)$$

where  $x$  is a vector of observable characteristics of state  $i$  (including an intercept) and  $u$  is the error term as usual. The difference in tax policy between Democratic and Republican governors is captured by  $\delta$ . Note that we never observe both  $Y_1$  and  $Y_0$  for the same governor as the governor cannot be a Democrat and Republican at the same time. The observed tax policy for governor  $i$  could be expressed as  $Y_i = Y_1D_i + (1 - D_i)Y_0$  where  $D_i$  is the party membership of the governor in state  $i$ ,  $D_i = 1$  if Democratic,  $D_i = 0$  if Republican. Thus, we may write the observed outcome as a regression model,

$$\begin{aligned} Y_{it} &= Y_1D_{it} + (1 - D_{it})Y_0 \\ &= D_{it}(\beta + \delta + u_{1it}) + (1 - D_{it})(\beta + u_{0it}) \\ &= x_{it}\beta + \delta D_{it} + u_{it}, \end{aligned} \tag{3}$$

where  $u_{it} = u_{0it} + D_{it}(u_{1it} - u_{0it})$ . Eqn. (3) is a common regression model. If  $E[u|D] = 0$ , we can consistently estimate the effects of party ideology on tax policy by Ordinary Least Squares (OLS). If we take advantage of the panel structure and further assume that the error term consists of two parts; a time-variant  $\varepsilon_i$  and a time-invariant  $v_i$ , (3) becomes

$$Y_i = x_{it}\beta + \delta D_{it} + v_i + \varepsilon_{it}. \tag{4}$$

If party ideology  $D$ , conditional on  $x$ , is uncorrelated with time-variant shocks to tax policy, fixed-effect OLS estimation of yields a consistent estimate. While plausible, such an assumption may still be too restrictive and potentially fail to hold. For example, an adverse economic shock that impacts a particular state may lead to a need to reduce tax burden in the state. If a particular party, say the Democratic party, is more likely to be elected during difficult times, there exists a negative correlation between Democratic party and unobservable determinants of environmental policies. In this case, the negative correlation leads to underestimated effects of party on policies. As a result, we may not find any significant evidence of policy divergence, as the estimates are biased toward zero. Although we can alleviate the bias by controlling for those (observable) variables that are commonly regarded as the determinants of tax policy, it still may not be sufficient to identify the causal effect of party ideology. As a result, recent studies of the party effects on policy outcomes have utilized the regression discontinuity (RD) method (Lee et al.<sup>[7]</sup>). This method exploits the fact that the election rule is a deterministic function of vote margin ("sharp" RD design),

$$D_i = I(m_i > 0), \tag{5}$$

where  $m_i$  is vote margin. Note that in the sharp RD design,  $E[u|D, m] = E[\varepsilon|m] = f(m)$ , which implies that we could include and explicitly model the conditional expectation  $E[u|D, m]$  in (3). Equation (3) becomes

$$\begin{aligned} Y_{it} &= x_{it}\beta + \delta D_{it} + v_i + \varepsilon_{it} \\ &= x_{it}\beta + \delta D_{it} + v_i + E[\varepsilon_{it}|D, m = m_{it}] + \varepsilon_{it} \\ &= x_{it}\beta + \delta D_{it} + v_i + f(m_{it}) + \varepsilon_{it} \end{aligned} \tag{6}$$

where  $\beta$  is a constant,  $\delta$  is the coefficient of interest,  $f(\cdot)$  is a flexible function of  $m$ , and  $\varepsilon_{it}$  is the error term.  $\delta$  can be consistently estimated via OLS.

The vector  $x$  includes measures of a state's real income, the log of its population, the percentage of the population aged above 65 and below 18, respectively, and dummy variables whether the state House and the state Senate, or both, are controlled by Democrats. All specifications also include state- and year-fixed effects.

### 3. RESULTS

Column (1) in Table 1 suggests that if we utilize fixed-effects OLS, the only significant effect discovered is a *negative* effect on sales tax receipts per capita four years after a Republican governor is elected, relative to if

a Democrat would have won. Turning to the RD design estimates in column (2), we find evidence that total taxes per capita four year after the election is approximately \$31.85 higher if a Democrat won the governorship. Taking the endogeneity problem seriously by using an RD design thus changes our results dramatically. However, for the remaining estimates, we find few differences in policymaking across parties.

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## Tables

**Table 1. Four year change results**

Variable	OLS-FE (1)	RD Design (2)
Total Tax per Capita	2.377 (4.594)	31.854** (16.174)
Sales Tax per Capita	-4.605** (2.322)	0.265 (10.332)
Income Tax per Capita	0.899 (2.626)	12.372 (11.017)
Corporate Tax per Capita	0.779 (1.001)	3.589 (4.085)

Notes: Robust standard errors in brackets. \*\*\*(\*\*)[\*] indicates significant at the 1(5)[10]% level, respectively.

# UNDERSTANDING FRAME OF TRAINING EVALUATION IN MANAGEMENT DEVELOPMENT: AN ANALYSIS IN TWO PROCEDURES IN A GREEK CASE STUDY

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## Abstract

**Purpose:** *The present global business life offers an increasingly important place in management training development. Employing the performance management theory perspective on training, the paper develops and analyzes a functional model of measurement training effects, using both managerial knowledge and behavioral skills as criteria. The main objective of this paper is to verify the concept that "the training attempt as a whole together with its effects can develop middle managers' effectiveness".*

**Design/methodology/ approach:** *The research achieves this objective by the use of two alternative statistical analyses, where, under arbitrary destinations, their compatibility is demonstrated. Specifically, the primary data has been generated through a survey research based on open-ended questions as well as through face-to-face structured interviews based on the principle of controllable projection. A total of 190 responses are identified.*

**Findings:** *In this particular research, some useful results have emerged. The proposed evaluation model (consisted of 6 levels), enhances the viable option that training improves the work. The analysis of the items in this current research exhibited that the training contributes positively to the managers' expectations in relevance to the technical conditions of the teaching and their personal targets. Moreover, the managers' training contributes to the essential change of their knowledge.*

*The research shows that middle managers' organizational commitment is not crucially affected by the training procedure. In addition, middle managers' job satisfaction is positive up to an extent. According to the analysis of the data middle managers' performance of their work is slightly affected by their training. Also, the morale of the middle managers is improved by training whereas their stability remains unchanged. As regard their self-actualization, self-confidence and prestige, training has a positive effect on them.*

**Research limitations/implications:** *Other criteria should be subjects of future research in relation to managers' training are their participation in training-related decisions, organizational climate and diversity of training methods. The comparison of the effects of training interventions tactics of mid-level managers in large and small organization, in state-owned and private companies in countries with different economies should also be studied.*

**Originality/value:** *The study addresses provides us with an implemented frame training evaluation through which the job effectiveness of managers and all other types of employees is observed.*

**Keywords:** *Training evaluation, training effectiveness, management development, statistical methods*

**Paper type:** *Research paper*

## Introduction

Rapid and discontinuous change within organizations, flatter organizational structures, broader spans of control, and self-managing work groups, combined with network structures and looser business relationships have emphasized the importance of human capital as a crucial competitive advantage. In the intensifying war of talent, management development is seen as an important method of attracting and retaining high-quality employees. Management development is a dynamic and complex process by which individuals learn to perform effectively in managerial roles (Baldwin & Padgett, 1994; Longenecker & Fink, 2001). Management development and training activities linked to the needs of the business is one of the key high-performance work system that improves the financial performance of organizations (Becker & Huselid, 1998). Martin (2002), points out that managing people requires skills such as analysis of self and others, motivating teams to complete tasks, delegating and decision making. Most of these skills can be acquired through effective management development programs. However, there is much evidence suggesting that a considerable part of organizations' investment in training does not result in optimal transfer (Burke &

Baldwin, 1999). To improve job performance, the skills and behaviors learned and practiced during training have to be transferred to the workplace, maintained over time, and generalized across contexts (Holton & Baldwin, 2003). As the transfer of training remains an important issue for researchers and practitioners (Holton & Baldwin, 2003), it becomes essential to test models that include central, but less frequently studied training effectiveness factors. For the purpose of the current study, training can be defined as “the systematic acquisition of skills, rules, concepts, or attitudes that result in improved performance in another environment”.

There are calls of studies, where they have investigated the importance and potential impact of training on managers and the costs associated with the development and implementation of training as well as the relationship between design and evaluation features and the effectiveness of training and development (Salas & Cannon-Bowers, 2001; Tannenbaum & Yukl, 1992).

Concerning the assessment of training outcomes, the paper is consistent with current trends in the literature, and view training effectiveness as a multidimensional construct (Colquitt et al, 2000).

Researchers have called for more integrative models of training effectiveness, in an effort to include both individual and organizational contextual factors as antecedents of transfer of training (Baldwin & Ford, 1988; Colquitt et al., 2000; Kozlowski & Salas, 1997; Mathieu & Martineau, 1997; Quinones, 1997).

The present study takes these suggestions into account and propose a model connecting a type of evaluation criteria of training with training effectiveness dimensions. In the paper, a comprehensive analysis of six aspects of management training is conducted in measuring its effectiveness. Management development interventions can yield desired results only when the knowledge and skills acquired in management development programs is actually transferred to the workplace. These activities include systematic follow-up evaluation of participants and provide opportunities to utilize the new knowledge and skills in the workplace. Philips and Philips (2001) present a comprehensive discussion on evaluation process. These authors argue that executives and managers who fund training and development programs need evaluation data. In addition, factors of training programs to deliver the desired results, wish to link training to organizational strategy, growth in training budgets and greater focus on return on investment have resulted in a much greater emphasis on evaluation (Philips and Philips, 2001). The process is necessary to assess whether or not participants' knowledge, skills and attitudes have been changed and can improve the realization of organizational objectives.

Unfortunately, many organizations do not have adequate follow-up systems once management development programs are completed (Lien et al., 2007; Melum, 2002). Some organizations measure the quality of management development by using four levels of rigors, i.e. Reaction, Learning, Behavior and Results (Kirkpatrick, 1983). Although past research indicated that management development is important, no powerful intervention tool of evaluation exists for clarifying outcomes.

The present research will attempt to propose a model of training evaluation, which identifies six key aspects, and provides relevant present-day information for the impact of management training into two distinct stages based on the principle of controllable projection.

### **Designing a tool to measure the management development effectiveness**

This study developed a model of management development effectiveness that involves assessment of development needs and evaluating the program. This “staged approach” is adopted to build the model. Specifically, it focuses on what happens after learning occurs. So, it postulates that the group of variables, i.e. post-program components, which deals with follow-up activities, is associated with the dependent variable, management development effectiveness (Figure 1). Post-program components for training evaluation, include: Reactions of process training, Learning, Job behavior, Job performance, Organizational team and Society.

Taking all of these issues raised into consideration, this study addresses the following hypotheses:

H1. Management development will be positively related with the expectations of the participants from the courses that they attended, the context and the technical conditions of the courses.

H2. Management development improves managers' knowledge over basic functions of the management.

H3. Management training has an effect on the enbettering of the professional behaviors of managers.

H4. Management development implies a positive relationship between managers' efficiency and their job performance.

H5. Management training is likely to enhance the effectiveness of the team that the managers belong to which may have relative effects on the team's morale, its coherence and its adaptability.

H6. Management development will be linked more closely to managers society for the greatest satisfaction of their needs.

## Methodology

### Sample

The sample in this study comprised the managers in Emporiki Bank in Greece as identified by the organizational structure of the branches of the institute.

A semi-structured questionnaire was distributed to collect data from the managers by use of a web-based internal communicational tool of the Emporiki Bank, which resulted in data from 190 managers. Respondents were drawn from 250 managers, who had attended at least three management development program (on subjects of any managerial nature) within the past 5 years. A covering letter accompanied each questionnaire. Respondents were assured that all responses would be kept confidential and that the data were for research purposes only. The sampling rate of the total population was approximately 17 per cent. The response rate of the sample was approximately 63,3 per cent. Of the respondents, 46 were women and 144 were men. Approximately, 32 per cent were managers in Full Service Branches, 24 per cent held managerial positions in Medium- Sized Businesses and Individuals Branches and 44 per cent held managerial positions in Individual Customers Service Branches. With regard to education level, approximately 76,8 per cent held a university degree of 3-year study or more. Their average age and tenure were 45 and 13 years, respectively.

### Measures and procedure

The study used a construction of authentic questionnaire borrowing, of course, some parts from the human resource management or psychology literature, conforming them to the needs of the current research. A self-esteem questionnaire instrument was used for this research in measuring the constructs of a management training process. Self-report instruments are appropriate when non-ability-related traits or attributes are measured (Caroche et al., 2001; Mayer, 2001). The analysis suggests the six dimensions have acceptable reliability estimates (coefficient Alpha ranges from 0,75 to 0,9). The six-factor structure also found the empirical data fit reasonably well.

Training programs can be evaluated on a number of different criteria including participants' satisfaction with training, learning during training, and skills at applying material covered in training (e.g., D. Kirkpatrick, 1994; Kraiger, 2002). What is most important to the design of training evaluation measures is that the content of the measures be logically linked to the training content (Kraiger, 2002; Kraiger, Ford, & Salas, 1993). Description of the measures/dimensions of training evaluation follow:

*Reactions of process training (the first dimension)*, was handled by 12 items (questions) designed to assess three criteria/variables (X1= Expectation of the training courses, X2= Training course content, X3= Technical conditions) which were considered as countable standards for the evaluation of the reactions in the process of training changes. *Learning (the second dimension)*: Participants' retention of the key information covered in training was measured in a 4-item exam (questions). *Job behavior (The third dimension)* was assessed by 13 items (questions) designed to assess four criteria/variables (X5= Values and Organizational Commitment, X6= Job Satisfaction) which were considered as countable standards for the evaluation of the degree that the professional behavior is influenced by training. *Job Performance (The fourth dimension)* consisted of 8 items (questions) focused on measuring three criteria/ variables (X7= Creative productivity and X8= Attendance) for the evaluation of the changes caused by training in the performance of the work of managers. *Organizational team (The fifth dimension)* consisted of 5 items (questions) designed to assess three variables (X9= Morale of team, X10= Stability) which were considered as countable standards for the evaluation of the results in the Organizational Team that the trainee managers belong to. In measuring *the section sixth* of the evaluation of the training results in *the Society*, there were 5 items (questions) focused on measuring two variables (X11= Self-actualization, X12= Safety) that were considered as countable standards for the evaluation of social goals of the managers' training.

To fulfill the objectives, the research was completed in two stages : face-to- face structured interviews based on the principle of controllable projection (stage 1) and research based on open-ended questions (stage 2), (Stolin, 1983). So, the questionnaire consisted of 46 closed questions in a 5-point Likert scale on various issues and 6 open questions.

## Results

### Data analysis

*Descriptive analysis:* First, a descriptive analysis is carried out to examine the behavior of the variables used. From there the attention was directed at testing the hypotheses. Table 1 shows the means, standard deviations, reliabilities and the intercorrelation matrix. Analysis of the intercorrelation matrix indicates that none of the correlations are above 0,70. Hence, the problem of multicollinearity is quite low. In addition, the internal reliability of the scales used in the questionnaire was determined by computing Cronbach's (1951) alpha coefficient. The scales used in this study had a high internal reliability with Cronbach's alpha coefficient for all the scales in the questionnaire between 0,70 and 0,90 (Nunnally, 1994). The data in table 1 indicates that none of the variables had high mean scores.

*Regression analysis:* What is being searched for at this point, is a statistical model that will verify the role of improvement in the research, that is "the managers' training can develop their effectiveness=basic hypothesis". In other words, how the  $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}$  (= the factors loading/variables that were defined in this current research in order to count the allocated 6 hypotheses, see Figure 1) affect Y (= basic hypothesis).

the Factor Analysis was used, setting the dimensionality equal to unity for the arbitrary chosen variables-open questions to account as the responding variable Y and make these questions one variable that would be Y(multivariate data).

The open questions are considered as categorical and ordinal variables. For more clarification, the selection of the questions is considered to be logically ordinal. Consequently, so as to use the questions in the quantitative analysis, they were regarded as categorical.

The methodology procedure of this part of the analysis is divided in two logical approaches of the original hypothesis.

a) It is examined how much *each variable*  $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}$  separately contributes positively to Y (basic hypothesis)

It is attempted to evaluate some univariate regression models for each of the 6 levels/dimensions (reaction towards the training process, learning, job behavior, job performance, organizational team and society) to the Basic Concept "The managers' s training improves their effectiveness".

In the univariate regression procedure, a dependent variable (Y) is estimated by more independent variables ( $x_1, x_2, \dots, x_{12}$ ), in order to produce the knowledge which will be able to contribute to the support of the relationship among the variables.

For a better understanding of the explanatory behavior of these variables it is attempted on quadratic or/and cubic expressions. The results drawn from the regression and quantitative analysis are showed in Table 2.

b) A multivariate regression is being examined, taking into consideration *all the variables*  $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}$  together, and it is evaluated how much they contribute positively to Y (basic hypothesis) (Chatfield C.,1989)

The research examines 6models step by step and estimates that with Model No 6 the variability of Y (basic hypothesis) can be translated to a percentage of 55% from the variables that are contained in this model, which  $x_2, x_3, x_4, x_6, x_9, x_{11}, x_{12}$ . This percentage may not be very high but it is found in a respected and acceptable level.

The Regression analysis was carried out. First of all the overall performance was examined from the linear model ( $Y=a +bx$ ), that is, it was the null hypothesis which was examined so all coefficients are equal to zero (in this case  $a=b=0$ ). This test was carried out with the F statistic and its corresponding p-value. The second step was taken to examine separately the performance of each variable by examining separately the performance of each coefficient in the linear model. This was done by the t-statistic test for each variable. So, the variables  $x_2, x_3, x_4, x_6, x_9, x_{11}$  and  $x_{12}$  seem to be statistical significant, throw the stepwise method. Moving from one model to the next, the results of the review are presented in table 3.

## Discussion

This study sought to identify the variables associated with management training effectiveness. Management development interventions can yield desired results only when management development is effective. A model of training evaluation is developed and tested to measure the dimensions that are influenced by the training and identified ways in which the benefits of training process can be reported. The findings of the

study are similar to the results from past research on training and development, which found that effectiveness of training evaluation impacts on transfer of training (Chiaburu & Marinova, 2005; Gordon, 1991; Ostroff, 1991). What is of great interest in this analysis for training evaluation criteria (dimensions), is the fact that three statistical ways are presented which verify the positive results of training. Summarizing, in this particular research, some useful results have emerged. That is, the training evaluation is a measurement technique that examines the extent to which the training programs meet the goals intended. The evaluation measures used, depend on goals and can include evaluation of training content and design, changes in learners, and organizational payoffs (job performance, transfer climate and attitude, results).

The analysis of the items in this current research exhibited that training contributes positively and the variables Training course Content, Knowledge, Self-actualization, Safety play a leading role in the explanation of the effectiveness of management training (because they are produced and are repeated by the most presented models).

It should be noted that the study limited its analysis to variables which practitioners and researchers have a reasonable amount of control. Other criteria should be subjects of future research in relation to managers' training evaluation, are their participation in training-related decisions, organizational climate and diversity of training methods. The comparison of the effects of training interventions tactics of mid-level managers in large and small organizations, in state-owned and private companies in countries with different economies should also be studied.

In a shrinking labor market, management development will increasingly be used as a method of attracting and retaining talent employees. As organizations increase their investments in management development, it is believed that researchers need to focus a lot more on evaluation of managers development. Only effective programs will justify a significant investment. Additional research can help to improve management development effectiveness and enable organisations and individuals to achieve their desired goals.

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Figure 1. Evaluation Influences on Training and development

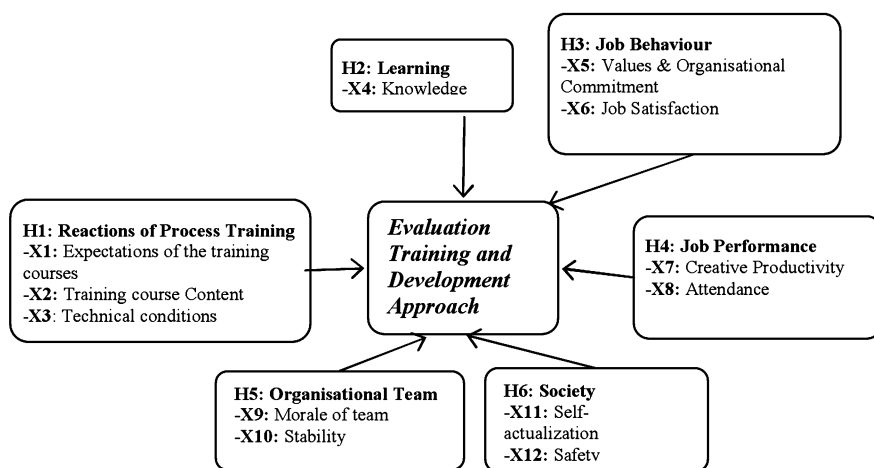


Table 1: Means, standard deviations (SD), reliabilities and intercorrelation matrix

		Mean	S.D.	1	2	3	4	5	6
<b>Levels/Dimensions</b>	<b>Variables</b>								
<b>1. REACTION TOWARDS THE TRAINING PROCESS</b>	X1= Expectations of the training courses	4,56	0,87	<b>(0,86)</b>					
	X2= Training course content	4,27	1,03	<b>(0,91)</b>					
	X3= Technical conditions	4,43	0,75	<b>(0,84)</b>					
<b>2. LEARNING</b>	X4= Knowledge	4,55	1,09	0,35**	<b>(0,87)</b>				
<b>3. JOB BEHAVIOUR</b>	X5= Values and Organizational Commitment	5,05	1,002	0,38**	0,63**	<b>(0,70)</b>			
	X6= Job Satisfaction	3,53	0,766	0,22**	0,38**	<b>(0,77)</b>			
<b>4. JOB PERFORMANCE</b>	X7= Creative productivity	4,35	1,14	0,42**	0,70**	0,60**	<b>(0,83)</b>		
	X8= Attendance	4,03	0,94	0,32**	0,45**	0,53**	<b>(0,68)</b>		
<b>5. ORGANISATIONAL TEAM</b>	X9= Morale of team	4,55	1,09	0,51**	0,63**	0,63**	0,69**	<b>(0,83)</b>	
	X10= Stability	3,956	1,10	0,44**	0,48**	0,70**	0,70**	<b>(0,95)</b>	
<b>6. SOCIETY</b>	X11= Self-actualization	4,05	1,03	0,24**	0,36**	0,34**	0,30**	0,32**	<b>0,80</b>
	X12= Safety	4,43	0,82	0,32**	0,36**	0,48**	0,53**	0,53**	<b>0,69</b>

Note: Alpha coefficients are on the diagonal in parentheses

N= 190

\* p<0,05; \*\*p< 0,01

Table 2: Results of univariate regression analysis

		<b>R-sq , per linear relation <math>Y = \alpha + \beta\chi_1</math></b>	<b>R-sq, per quadratic relation <math>Y = \alpha + \beta\chi_1 + \gamma\chi_1^2</math></b>	<b>R-sq, per cubic relation <math>Y = \alpha + \beta\chi_1 + \gamma\chi_1^2 + \delta\chi_1^3</math></b>
<b>Levels/ Dimensions</b>	<b>Variables</b>			
<b>1. REACTION TOWARDS THE TRAINING PROCESS</b>	<b>X1= Expectations of the training courses</b>	<b>R<sup>2</sup>= 13.8 %</b>	<b>R<sup>2</sup>= 28.5 %</b>	<b>R<sup>2</sup>= 31.1 %</b>
	X2= Training course content	R <sup>2</sup> = 0.4 %	R <sup>2</sup> =5.6 %	R <sup>2</sup> =7.8 %
	<b>X3= Technical conditions</b>	<b>R<sup>2</sup>= 12 %</b>	<b>R<sup>2</sup>= 18 %</b>	<b>R<sup>2</sup>= 21 %</b>
<b>2. LEARNING</b>	<b>X4= Knowledge</b>	<b>R<sup>2</sup>= 16.5 %</b>	<b>R<sup>2</sup>= 29.7 %</b>	<b>R<sup>2</sup>= 39.3 %</b>
<b>3. JOB BEHAVIOUR</b>	X5= Values and Organizational Commitment	R <sup>2</sup> = 0.1 %	R <sup>2</sup> = 0.4 %	R <sup>2</sup> = 0.6 %
	X6= Job Satisfaction	R <sup>2</sup> = 1.4 %	R <sup>2</sup> = 1.4 %	R <sup>2</sup> = 3%
<b>4. JOB PERFORMA NCE</b>	X7= Creative productivity	R <sup>2</sup> = 0 %	R <sup>2</sup> = 1 %	R <sup>2</sup> = 2,1 %
	X8= Attendance	R <sup>2</sup> = 1.1 %	R <sup>2</sup> = 2 %	R <sup>2</sup> = 4,3 %
<b>5. ORGANISA- TIONAL TEAM</b>	<b>X9= Morale of team</b>	<b>R<sup>2</sup>= 8.6 %</b>	<b>R<sup>2</sup>= 13,2 %</b>	<b>R<sup>2</sup>= 16,6 %</b>
	X10= Stability	R <sup>2</sup> = 0.6 %	R <sup>2</sup> = 12,2 %	R <sup>2</sup> = 18,4 %
<b>6. SOCIETY</b>	X11= Self-actualization	R <sup>2</sup> = 0 %	R <sup>2</sup> = 8,1 %	R <sup>2</sup> = 15,6 %
	<b>X12= Safety</b>	<b>R<sup>2</sup>= 7.7 %</b>	<b>R<sup>2</sup>= 20,1 %</b>	<b>R<sup>2</sup>= 21.2 %</b>

Note: Standardized regression coefficients are shown in each equation. N=190

Table 3: Multivariate Model Summary

<b>Model 1</b> (12 variables)	[ enter method ]	
$Y = \alpha_0 + \alpha_1 \chi_1 + \dots + \alpha_{12} \chi_{12}$		→ R <sup>2</sup> = 28 %
<b>Model 2</b> (12 variables)	[ stepwise ]	
$Y = \alpha_0 + \alpha_1 \chi_4 + \alpha_2 \chi_{11} + \alpha_3 \chi_{12}$		→ R <sup>2</sup> = 23.2 %
<b>Model 3</b> (24 variables)	[ enter method ]	
$Y = \alpha_0 + \alpha_1 \chi_1 + \alpha_{12} \chi_{12} + \beta_1 \chi_1^2 + \dots + \beta_{12} \chi_{12}^2$		→ R <sup>2</sup> = 49,7 %
<b>Model 4</b> (24 variables)	[ stepwise ]	
$Y = \alpha_0 + \alpha_1 \chi_4 + \alpha_2 \chi_1 + \alpha_3 \chi_4^2 + \alpha_4 \chi_{11}^2 + \alpha_5 \chi_2^2 + \alpha_6 \chi_3^2 + \alpha_7 \chi_6^2 + \alpha_8 \chi_1$		→ R <sup>2</sup> = 46.4 %
<b>Model 5</b> (36 variables)	[ enter method ]	
$Y = \alpha_0 + \alpha_1 \chi_1 + \dots + \alpha_{12} \chi_{12} + \beta_1 \chi_1^2 + \dots + \beta_{12} \chi_{12}^2 + \gamma_1 \chi_1^3 + \dots + \gamma_{12} \chi_{12}^3$		→ R <sup>2</sup> = 60.4 %
<b>Model 6</b> (36 variables)	[ stepwise ]	
$Y = \alpha_0 + \alpha_1 \chi_4 + \alpha_2 \chi_4^3 + \alpha_3 \chi_{11} + \alpha_4 \chi_{11}^2 + \alpha_5 \chi_{11}^3 + \alpha_6 \chi_2^2 + \alpha_7 \chi_6^2 + \alpha_8 \chi_3^3 + \alpha_9 \chi_9 + \alpha_{12} \chi_{12}$		→ R <sup>2</sup> = 54,8 %

# CAN ALTMAN Z-SCORE MODEL PREDICT BUSINESS FAILURES IN GREECE?

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## Abstract

*This paper analyses whether Altman Z-score models, can predict correctly company failures. The empirical analysis examines all listed in the Athens Exchange companies, during the period 2002-2008 and discontinuations of operation for these companies during the same period. It is investigated whether Z-score models can predict bankruptcies for a period up to three years earlier. Our study shows that Altman model performs well in predicting failures. This is in line with other findings. The empirical results are interesting since they can be used by company management for financing decisions, by regulatory authorities and by portfolio managers in stock selection.*

*Keywords: Valuation, Altman, Regulation, Share price, Capital markets, bankruptcy*  
*JEL Classification: G33:G14*

## 1. Introduction

### 1.1 Examined issues

In the study we examine if z-score alone can predict business failure for the examined companies in the examined period. To examine this we investigate whether z-scores one up to four years before bankruptcy can predict business failures or financial problems. Our study is interesting because if discriminant analysis is useful, then financial analysts and portfolio managers can use it for stock picking and asset allocation. Discriminant analysis can also be a valuable tool for investors. Companies that have high probabilities to bankrupt should trade at a discount to their value. If this is correct, then our paper makes an interesting contribution to bankruptcy literature, by linking z-score with business failure prediction and asset allocation in Greece.

### 1.2 Previous research

Multivariate prediction of bankruptcy as established by using univariate analysis of bankruptcy predictors was initially developed by Beaver (1967, 1968) who found that a number of indicators could discriminate between matched samples of failed and nonfailed firms for as long as five years prior to failure. Altman (1968) defines five predicted factors and sets the base for other researchers to examine the validity of multivariate models. Following to the Beaver and Altman research seems to verify the validity of Altman models, but their prediction ability is found gradually lower. Begley et.al (1996) examines the altman z-model and concludes that the model performs better in US data during the 1980s than during the 1990-1995 period. Similar are the findings of Grice and Ingram (2001), who also find better performance for manufacturing companies.

## 2. Data Issues and Methodology

### 2.1 Data

In order to test the credit risk of the construction companies in Greece, we examine two Z-score models, in particular the z-score model developed in Altman (1993) .

The financial data used are annual and cover the period of 1999-2006. To compute the market value used, we take the market value of the company on 31 December of each year. The prices were taken by EFFECT S.A. database and we use the Athens stock exchange daily report to identify when the company share price was suspended. From our sample we exclude companies that were listed for less than three years, and companies that merged.

On total, the examined sample consists of 373 companies, listed on the Athens Stock exchange in the examined period, 45 of them bankrupted or their shares were suspended permanently and 328 companies did not bankrupt or had their shares permanently suspended.

The examined cases of companies that **bankrupted or their shares were suspended permanently** are the following (Table 1).

**Table 1. Companies that their shares were suspended permanently, or get bankrupt**

	<b>COMPANY NAME</b>	<b>SECTOR</b>
1	Alfa Alfa	Diversified
2	Connection	Apparel
3	Datamedia	Information Technology
4	Elephant	Retail
5	Ipirotiki	Publishing
6	Microland	Retail
7	Rainbow	Information Technology
8	Sea Farm Ionian	Fisheries
9	Stabilton	Real Estate
10	Alte	Metal Products
11	Alisida	Footwear
12	Mesochoritis	Construction
13	Betanet	Construction
14	Leventakis	Construction
15	Gener	Construction
16	Galis	Leisure
17	Daios Plastics	Chemicals
18	Daring	Metal Products
19	Diekat	Construction
20	Dinamiki Zois	Fitness
21	Hellenic Fisheries	Fisheries
22	Empedos	Construction
23	Ergas	Construction
24	Etma	Chemicals
25	European Technical	Construction
26	Themeliodomi	Construction
27	Ideal	Information Technology
28	Intersat	Construction
29	Kerameia Allatini	Building Materials
30	Korasidis	Retail
31	Korfil	Textiles
32	Lannet	Communications
33	Multirama	Retail
34	Balafas	Real Estate
35	NEL	Ferries
36	Plias	Information Technology
37	Pouliades	Wholesale
38	Promota	Promotion
39	Saos	Ferries
40	Space	Information Technology
41	Corinth Pipeworks	Metal Products

	COMPANY NAME	SECTOR
42	Tasoglou	Wholesale
43	Texnodom	Construction
44	Steel Sheet Co	Metal Products

The number of companies that get bankrupted and/or their shares were suspended permanently are the following (Table 2).

**Table 2. Number of Companies that get bankrupt and/or their shares were suspended permanently**

Year	No of Companies
2003	12
2004	9
2005	9
2006	4
2007	10
Total	44

Companies belonging in the financial sector (banks, investment companies) were excluded.

## 2.2 Examined model

The most well-known quantitative model for predicting bankruptcy is Altman's Z-score, which was developed in 1968 by Edward I. Altman, professor at Stern School of Business. The Z-score is a set of financial ratios in a multivariate context, based on a multiple discriminated model, for the firms where a single measure is unlikely to predict the complexity of their decision making or the scope of their entire activities.

Altman examined a list of twenty two possible ratios, and finally has chosen five that had the best results when they were applied together were selected after numerous tests for the discriminant function. This model was later modified to the Altman (1993) model that uses the same variables multiplied by different, however, factors.

The discriminant function is:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

Given that

$X_1$  = Working Capital / Total Assets, (WC/TA)

$X_2$  = Retained Earnings / Total Assets, (RE/TA)

$X_3$  = Earnings Before Interest and Taxes / Total Assets, (EBIT/TA)

$X_4$  = Market Value Equity / Book Value of Total Liabilities, (MVE/TL) and

$X_5$  = Sales / Total Assets, (S/TA)

Altman defined a "grey area" which is between 1.81 and 2.99. Firms, with z-scores within this range, are considered uncertain about credit risk and considered marginal cases to be watched with attention. Firms with Z scores below 1.81 indicate failed firms. Although, the cut-off point was set at 2.675, Altman advocates using the lower bound of the zone-of-ignorance (1.81) as a more realistic cut-off Z-Score. So if  $Z < 1.81$ , then the company has a high probability of default. On the other hand, the company is solvent, meaning that it is financial healthy. Some credit analysts, private underwriting agents, financial analysts, auditors and firms themselves were concerned that since the original model requires stock price data ( $X_5$ ), it was only applicable to publicly traded entities.

## 3. Results

We examine the validity of the model by examining the percentage of cases that fall within the predictable range of companies. For example, bankrupted companies must fall within the price range that is expected to be for these companies (e.g. smaller than 1.8), while non-bankrupted companies must fall within the price

range that is expected to be for those companies. Cases not predicted correctly are defined as Type 2 error cases. Our results show some support for Altman model.

#### Altman model findings

Examining the Altman (1993) model we find out that it can predict the majority of companies that will get bankrupt, even when the z-scores of these companies are computed up to six (2) years earlier.

**Table 3. Altman z score prediction statistics, Bankrupted Companies**

Bankrupted Companies				
Year	All	Correctly Classified	Type 2 error	% correct
-4	44	9	35	20%
-3	44	17	27	39%
-2	44	23	21	52%
-1	44	29	15	66%

Success rate for failed companies varies from 66% (year -1) and gradually diminishes to 52%, 39% and 20% for year -2, -3 and -4 respectively. Therefore, z-score gives a good indication of problems, at least one year before the company will exhibit financial problems. However, the model performs poorly when prediction time horizon increases. Data for non-banrupted companies are illustrated on the following table.

**Table 4. Altman z score prediction statistics, Non Bankrupted Companies**

Non Bankrupted Companies				
Year	All	Correctly Classified	Type 2 error	% correct
-4	244	190	54	78%
-3	215	149	66	69%
-2	193	121	72	63%
-1	168	91	77	54%

The model gives a good indication for companies that will not face problems even in longer span time-horizons. The model has been successful in classifying the majority of non-banrupted companies in all the examined periods (-1, -2, -3 and -4 years). In particular, 78% of companies are correctly classified for the long time span (4 years) a percentage that gradually diminishes to 54% for a year time span.

Overall the model succeeds to identify bankrupted and non-bankrupted companies. Aggregated data are illustrated on the following table.

**Table 5. Altman z score prediction statistics, All Companies**

All Cases				
Year	All	Correctly Classified	Type 2 error	% correct
-4	288	199	89	69%
-3	259	166	93	64%
-2	237	144	93	61%
-1	212	120	92	57%

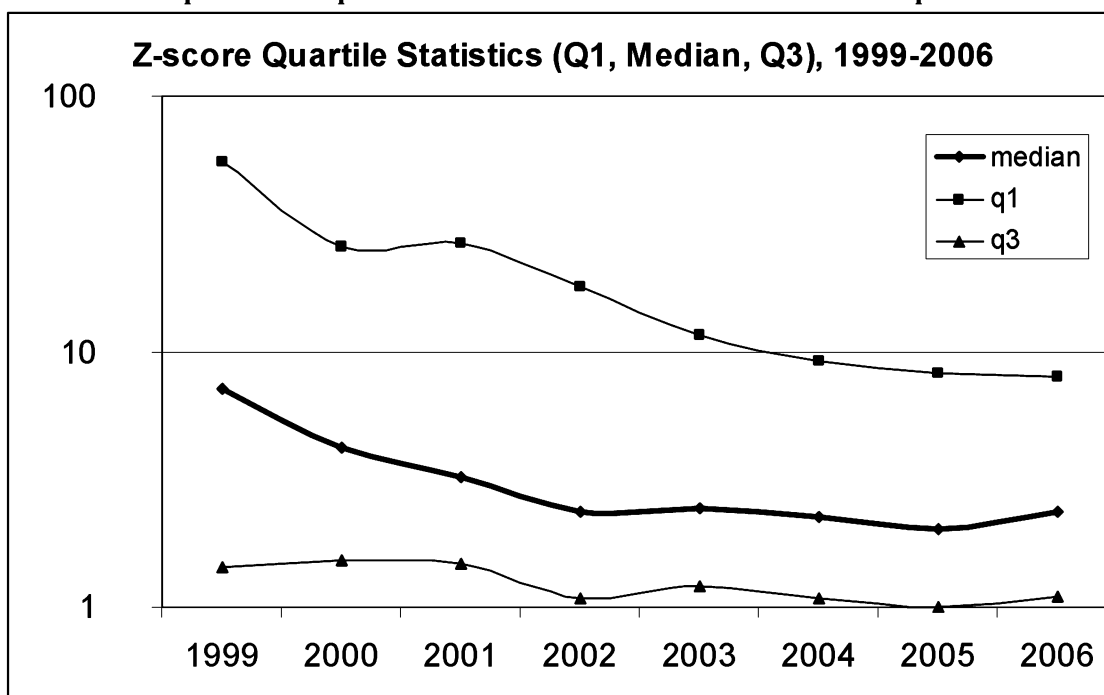
The model succeeds to identify bankrupted and non-bankrupted companies by 57%-69% depending on the time horizon examined (1-4 years).

It is noted that the model takes account of market values. The ability of the model to take account of market values, together with redefined beta factors, seems to give it an additional strength. However, the model also has weaknesses, main being its volatile results.

#### Volatility of z-scores

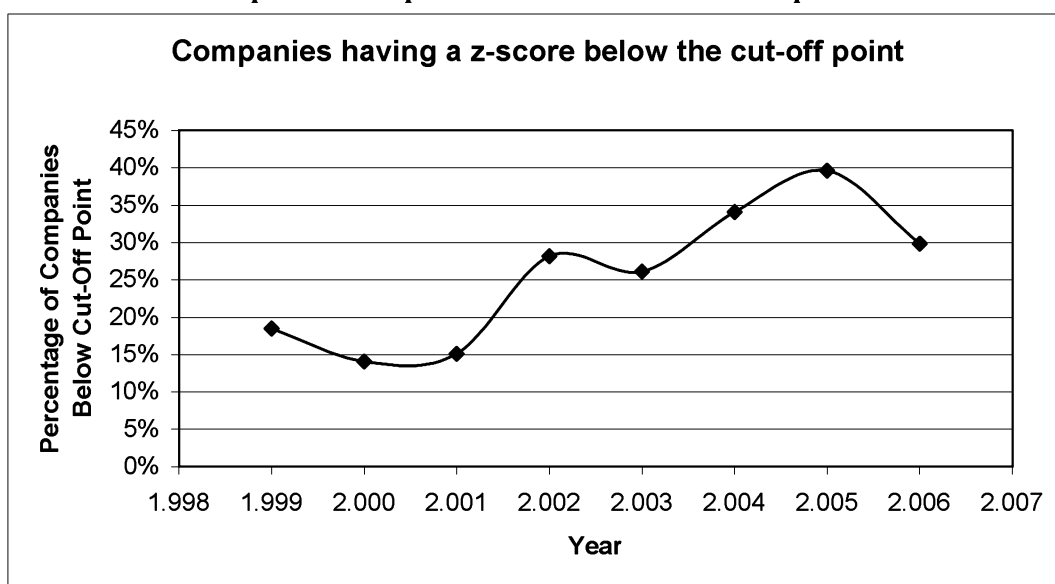
The estimated Z-factors vary over time. Z-scores appear higher during bullish markets, while they appear lower during bearish years. As seen on the following graph, average z-scores of both failed and non-failed compaies are high in 1999, and then they gradually decrease, to reach by 2005 the lowest levels.

**Graph 1. Development of z-score for failed and non-failed companies**



This development is universal among the examined companies. The examined companies z-score gradually increases or decreases at similar pace. This affects the percentage of companies that fall within illustrated on the following table.

**Graph 2. Development of z-score for failed companies**



Our results may indicate that bullish markets give even to financially distressed company the ability to survive. It is evidently correct, according to our opinion, since during bullish markets, financially distressed companies can raise capital easier, something that gives them the ability to cover their need in capital for the next 1-2 years. However, as these companies do not generate positive operating cash flows, the capital raised is not a panacea, so financial problems appear again whenever the macroeconomic conditions are bad and the companies can not raise capital.

It seems, therefore, that the ability of companies to raise capital does not improve significantly their financial prospects.

If companies have the ability to improve their financial position during good years in capital markets, while being unable to improve them in the long run, then Altman z-scores are useful tool for the company



management, either to proceed in company restructuring, or to proceed to a merger with other companies. At the same time, if Altman z-scores tend to return to historically low levels over a business cycle (6-10 years), then good financial and market years should provide the opportunity to portfolio managers to decrease their position in companies they identify to have low altman z-scores.

#### 4. Conclusion

Nearly 15% of the listed companies bankrupt or the trading of their shares was suspended during the examined period. This high percentage of failure makes the investigation and prediction of company failures a useful tool for both financial managers and analysts, since the ability to predict these failures is valuable. For this scope in this paper we examine whether z-score model, developed by Altman 1993 can predict bankruptcies. We find evidence that this model is useful in identifying financially troubled companies that may fail up to 2 years before the bankruptcy. The model is useful, probably because it matches both accounting data and market value, having so an information content as identified in Dichev 1998. Overall model success rate is not statistically significant, but when it comes to failure cases it can predict 54% of them one year before failure. The predictive ability of Altman model is in line with findings by other researchers in Greece and in the United States. Christopoulos et. Al. (2007) finds that Altman is useful in predicting Greek telecom company failures, while Altman (2002) find supportive evidence in the US market. Vergos et al (2006) and Christopoulos et al (2006) also show that analysts' predictions and company announcements may affect considerably market prices up to 18 months before the announcement of negative financial results, something that leads to incorporation of probability of failure in company prices, and respective company altman z-score that are affected by market price of shares, well before the company will declare bankruptcy. In other words, analysts recommendations, as well as market rumors, that affect the company price may explain why Altman model is more useful than mere traditional financial analysis.

The empirical results are interesting for both portfolio managers and company management. If companies have the ability to improve their financial position during good years in capital markets, while being unable to improve them in the long run, then Altman z-scores are useful indication to the company management to proceed to a merger with other companies, so as to preserve the company value. Besides, if Altman z-scores tend to return to historically low levels over a business cycle, then bull markets should provide the opportunity to portfolio managers to decrease their position in companies they identify to have low Altman z-scores.

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# FACTORS AFFECTING INTERNET BANKING USAGE BEHAVIOR: AN EMPIRICAL INVESTIGATION OF GREEK CUSTOMERS

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## Abstract

*This study deals with the factors affecting customers to continue to be users of internet banking. The context of the research framework is based on the extension of the Technology Acceptance Model with concepts from Innovation Diffusion Theory. Theory was developed to identify factors that influence customers' behavioral intentions and actual usage. The conceptual framework includes latent variables formulating customers' perception on service's usefulness, easy of use, risk and compatibility, which are operating as predictors of customers' behavioral intentions to continue to use internet banking services. Survey was conducted to internet banking customers of a major Greek banking institution to gather data. Partial least square was used to examine pattern of inter-correlations among the six proposed constructs and to test related propositions empirically. Results show that service compatibility is the most important factor shaping customers' behavioral intentions, followed by TAM constructs and perceive risk. Moreover, TAM and perceived risk constructs are operating as mediators between compatibility and customers' behavioral intentions, while perceived usefulness mediating the relationship between perceived easy of use and customers behavioral intentions. Finally, theoretical contributions and practical implications of the findings are discussed and suggestions for future research are presented.*

*Keywords: Internet banking, extended TAM, compatibility, risk, partial least squares*

## 1. Introduction

Internet banking (IB) becomes a major trend in the financial marketplace and the number of users of the internet banking has been increased significantly. Internet banking is a new type of information system that uses the Internet's innovative resources to enable customers to perform their financial activities in virtual space (Shih and Fang, 2004). Internet banking is extremely beneficial to customers because of the savings in costs, time and space it offers, its quick response to complaints, and its delivery of improved services, all of which benefits make for easier banking (Turban et al. 2000). Bank customers, now, perform their banking transactions at the place and time of their choice because of internet banking. The benefits of Internet banking from the banks' side are that they can lower their operational costs, be more responsive to customers' requests and provide value-added services (Tan and Teo, 2000). In addition, internet banking may enhance customer loyalty, drive customers to carry higher balances, and be willing to refer their banks to others (Market Research, 2006).

The internet banking situation in EU-15 is illustrated in Figure 1 (Eurostat, 2008). The figure shows that internet banking is well established in Europe since more than 30% of internet users are using internet for their financial activities.

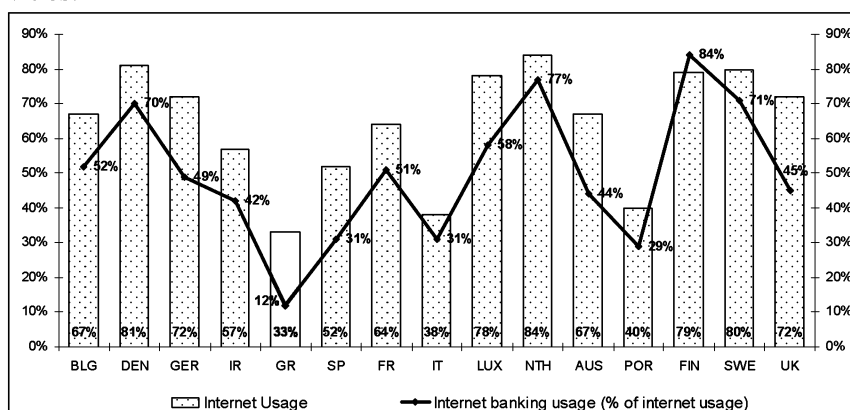


Figure 1: Internet and Internet Banking Usage in EU-15 (2007Q2) (Eurostat 2008)

The penetration of internet banking in Greece is not as high as in other European countries since 12% of internet users are using internet banking services. One of the main reasons of low penetration levels is that Greeks are not familiar with the usage of new technologies since only 33% are internet users resulting in low levels of trust in doing financial transactions through internet. However, online banking transactions continue to increase because Greek customers are seeking for convenience. According to the Hellenic Bank Association, the daily turnover is about 100 million Euros and the number of transactions was about 7 million. Moreover, there are 20 credit institutions and 10 branches of foreign banks in Greece with presence on the Internet. Although the numbers are constantly changing, in the Greek market the Internet offers an alternative distribution channel. However, soon more Greek banks are expected to follow, which shows that Internet banking is poised for rapid growth in the country.

Although the adoption of internet banking has been extensively studied, relevant studies concentrate on initial adoption and neglects continuity. Continuous use is very important, particularly in the web-based industry, because companies make their profits mainly from customers continuously using their services. Service continuance in the internet environment is not entirely novel concept (Aladwani, 2001), but until now few studies investigated what encourage adopters to continuously using internet banking. Research on the determinants of internet banking usage may enhance the understanding of a customer's intention to use internet banking, and show how this intention affect internet banking usage behavior. Understanding of Internet Banking usage behavior can help banks to formulate appropriate marketing strategies for internet banking in Greece. These considerations are also very vital to the practitioners who plan and promote internet banking in the current competitive market.

This paper is a comprehensive research in terms of using a theoretical model to understand internet banking usage behavior in Greece. The purpose of this research is to test the ability of an extended theoretical model to predict and explain user acceptance and usage continuance of internet banking services.

## 2. Theoretic Basis

A review of prior studies provides the theoretical foundations of the hypotheses formulations. This section elaborates on the related theory for deriving the research model and hypotheses. Significant body of the literature investigating the adoption of internet banking employed the theory of reasoned action (TRA), technology acceptance model (TAM), or innovation diffusion theory (IDT), or mixtures of two/three theories as their theoretical basis. Motivated by prior literature, this work takes TAM and IDT as a theoretical basis for designing a research framework to exploring what influences adopters to continue bank online.

TAM proposed by Davis in 1986 (Davis, 1989; Davis et al., 1989) originates from the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980) to forecast individual computer acceptance. According to TAM, behavioral intention of individuals in adopting a technology-based product/service can be explained by their perceived usefulness (PU) and perceived ease-of-use (PEOU). For perceived usefulness and for perceived ease of use antecedents have been suggested including personal characteristics (Teo et al., 1999), and risk (Lee et al., 2001). Perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance, while perceived ease of use is defined as the degree to which a person believes that using a particular system would be free of effort.

Among the beliefs, perceived ease of use is hypothesized to be a predictor of perceived usefulness. (Venkatesh and Davis, 2000).

IDT was introduced by Rogers in 1962 (Rogers, 2003), and applies a process-oriented viewpoint to explain how an innovation is accepted and diffused within a social system (Rogers, 2003). According to IDT innovation adoption or rejection begins with consumer awareness of the innovation, and diffusion is a process through which an innovation is communicated via certain channels over time among members of a social system. IDT has been widely applied in predicting IT adoption behavior (e.g., Chen et al., 2002). It posits a set of innovation attributes to explain the rates of adoption by users: relative advantage, compatibility, complexity, trialability, and observability. However, previous studies found that only relative advantage, compatibility and complexity were consistently related to innovation adoption (Tornatzky and Klein, 1982; Wang and Liao, 2008). Since internet banking is an innovation, these three attributes can be used in predicting and explaining the customers' behavioral intentions.

### 3. Research Model and Hypotheses

The research model used to guide the study is shown in Figure 2, which suggests that perceived usefulness, perceived ease of use, perceived compatibility and perceived risk are potential determinants of behavioral intention to use internet banking services.

**Perceived Usefulness:** There is extensive research in the IS community that provides evidence of the significant effect of perceived usefulness on usage intention (Agarwal & Prasad, 1999; Venkatesh, 1999, 2000; Venkatesh & Davis, 1996, 2000). The ultimate reason that people exploit internet banking service systems is that they find the systems useful to their transactions. Thus, the following hypothesis is tested:

*H1: Higher perceived usefulness of internet banking users will lead to higher behavioral intention for service usage continuance.*

**Perceived Compatibility:** As mentioned earlier, among the innovation diffusion factors, only relative advantage, compatibility and complexity are potential determinants of innovation adoption (Tornatzky and Klein, 1982). However, relative advantage and complexity are conceptually overlapped with TAM's perceived usefulness and perceived ease of use, respectively (Moore and Benbasat, 1991). Thus, the two innovation attributes were excluded from the current research model. Perceived compatibility in this study is defined as the extent to which service under investigation is perceived to be consistent with the users' existing values, previous experiences, and needs. Previous empirical research also indicate that perceived compatibility has a significant positive influence on perceived usefulness, easy of use (Wu and Wang, 2005; Agarwal and Karahanna, 2000), and behavioral intention to use electronic/mobile commerce systems (Chen et al., 2002; Wu and Wang, 2005). Moreover, Sohail and Shanmugham (2003) assert that the lower requirement to change existing customers habits, such as current method of banking, the higher likelihood that customers will continue to use internet banking services. Thus, the following hypotheses are tested:

*H2: Higher perceived compatibility will lead to higher perceived usefulness of internet banking services.*

*H3: Higher perceived compatibility will lead to higher perceived easy of use of internet banking services.*

*H4: Higher perceived compatibility will lead to lower perceived risk regarding internet banking usage.*

*H5: Higher perceived compatibility will lead to higher behavioral intention for service usage continuance.*

**Perceived Ease of Use:** Extensive research over the past decade provides evidence of the significant effect of perceived ease of use on usage intention, either directly or indirectly through its effect on perceived usefulness (Agarwal & Prasad, 1999; Venkatesh, 1999, 2000; Venkatesh & Davis, 1996, 2000). In order to prevent the "under-used" useful system problem, internet banking service systems need to be both easy to learn and easy to use. Thus, the following hypotheses are tested:

*H6: Higher perceived ease of use will lead to higher perceived usefulness of internet banking services.*

*H7: Higher perceived ease of use will lead to higher behavioral intention for service usage continuance.*

**Perceived Risk of Usage:** Perceived risk, another subjective concept in social relations, is critical for e-commerce acceptance (Gefen, 2002; Pavlou and Gefen, 2004). Perceived risk refers to individual's subjective belief about the likelihood of a loss in pursuit of a desired outcome (Pavlou, 2003). It is expected that perceived risk negatively affects customers' intentions to continue internet banking usage. Additionally, easy of use has a negative impact on perceived usage risks for service continuance (Featherman and Pavlou, 2002). Thus, the following hypotheses are tested:

*H8: Higher perceived risk will lead to lower perceived usefulness of internet banking.*

*H9: Perceptions of internet banking services' ease of use ascertained from hands-on trial significantly reduces perceived risk of usage.*

*H10: Higher perceived risk will lead to lower behavioral intention for service usage continuance.*

**Actual Use:** In prior studies intention to use is found to be a predictor of actual usage. Therefore it is presumed that a person with a positive intention for service use continuance will actually use internet banking more frequently. In other words, positive intentions will increase the number of time the service is being used within a period of time. Thus, the following hypothesis is tested:

*H11: Perceived behavioral intention for service usage continuance will have a positive effect on the frequency of internet banking usage.*

#### 4. Research Methodology

**Measures of the Constructs:** Items for perceived ease of use, perceived usefulness and behavioral intentions were measured using items adopted from the original TAM instrument (Davis, 1989; Davis et al., 1989) and subsequent applications of TAM to internet banking and other technology acceptance studies (Agarwal & Prasad, 2000; Tan and Teo, 2000). Measures of perceived risk were adapted from studies on internet banking (Tan and Teo, 2000), e-services (Featherman and Pavlou, 2002) and e-shopping. Items for the construct compatibility were adopted from studies of Moore and Benbasat (2001) and Tan and Teo (2000). Items for demographic variables such as gender, age, education, computer, internet and internet banking experience, were adopted from Tan and Teo (2000). Table 1 indicates the list of items used for developing each construct in the internet banking users' questionnaire. Likert scales (1–7), with anchors ranging from “strongly disagree” to “strongly agree” were used for all items to ensure statistical variability among survey responses for all items measured.

PU1	Using IB site improves my performance of banking activities
PU2	IB site makes it easier for me to do my banking
PU3	Using IB enables me to accomplish banking activities more quickly
PEOU1	It was easy to become skilful at using IB
PEOU2	I find IB easy to use
PEOU3	My interaction with IB site is clear and understandable
COMP1	IB is compatible with my lifestyle
COMP2	Using IB fits well with the way I like to manage my finance
COMP3	Using IB suits my current situation
RISK1	Using IB may expose me to fraud or monetary loss
RISK2	Using IB may jeopardise my privacy
RISK3	IB is insecure
BI1	I intend to continue to use IB within the near future
BI2	I plan to continue to use IB
BI3	I expect to continue use IB in the near future
AU1	In the last 30 days, approximately how often have you used IB?
AU2	In the last 30 days, approximately how many times have you used IB?

**Table 1:** List of Items by Construct

**Data Collection:** To determine user's intention to continue to use internet banking, a survey was conducted during the second quarter of 2008. Questionnaires were distributed to 500 randomly selected personal

internet banking customers of a Greek banking institution. Participation in the study was voluntary. A total 137 usable, complete responses were obtained resulting in a response rate of 27,4%. Detailed descriptive statistics related to the respondents' characteristics are shown in Table 2

		Frequency (N=137)	Percent (%)
Gender	Male	91	56
	Female	46	44
Age	15-24	10	7
	25-39	63	46
	40-54	46	34
	55-69	16	12
	> 70	2	1
PC experience	< 1	3	2
	1-2	1	1
	3-5	16	12
	6-10	28	20
	> 10	89	65
Internet experience	< 1	3	2
	1-2	6	4
	3-5	51	37
	6-10	56	41
	> 10	21	15
Internet banking experience	< 6	7	5
	6-12	8	6
	1-2	38	28
	3-5	66	48
	>5	18	13

Table 2: Demographic Information of the Respondents

## 5. Data Analysis and Results

**Measurement Model:** The loadings of the total set of all items were estimated using Partial Least Squares (PLS) (Gefen, Straub and Boudreau 2000). PLS is suitable for this kind of a project because it fits both exploratory and confirmatory research, places less restriction on the data, and requires smaller sample sizes. Table 3 presents the measurement model. The results demonstrate that the loadings of all items exceeded the required threshold of 0.7, and, therefore, explain over 50% of the variance in an observed item. At the same time, the instrument showed high internal reliability since the Cronbach's Alphas were above 0.7 for all scales. In order to test for discriminant validity, a matrix of loadings and cross-loadings was constructed (see Table 4). By using this matrix, the loadings of an item with its associated factor (or construct) to its cross-loadings were compared. All items had higher loadings with their corresponding factors in comparison to their cross-loadings. Therefore, it was concluded that there is enough confidence in the discriminant validity of the measures and their corresponding constructs. Table 5 presents construct statistics. First, tests for reliability of the measurement items relating to four constructs were conducted by estimating the Cronbach's Alpha. Based on the results, it was concluded that all scales behaved consistently. Secondly, internal consistency and convergent validity measures were calculated. The analysis demonstrated high internal consistency and convergent validity since the scores exceeded 0.7 and 0.5 threshold respectively (Fornell and Larcker 1981).

Construct	Indicator	Mean	Stdev	Loading	Residual	Weight
PU	PU1	6,481	0,932	0,896	0,196	0,338
	PU2	6,379	1,022	0,922	0,149	0,363

Construct	Indicator	Mean	Stdev	Loading	Residual	Weight
	PU3	6,445	0,938	0,933	0,127	0,387
PEOU	PEOU1	6,240	0,989	0,931	0,131	0,393
	PEOU2	6,270	0,943	0,923	0,147	0,420
	PEOU3	5,941	0,937	0,839	0,294	0,293
Compatibility	COMP1	5,532	1,388	0,964	0,070	0,346
	COMP2	5,613	1,486	0,964	0,069	0,347
	COMP3	5,489	1,500	0,971	0,056	0,341
Risk	RISK1	2,788	1,203	0,919	0,154	0,364
	RISK2	2,693	1,074	0,946	0,103	0,450
	RISK3	3,021	0,966	0,844	0,286	0,282
BI	BI1	6,416	0,944	0,944	0,108	0,449
	BI2	5,956	1,076	0,862	0,255	0,322
	BI3	5,912	1,107	0,883	0,219	0,338
AU	AU1	5,474	1,367	0,900	0,188	0,653
	AU2	4,583	0,967	0,823	0,322	0,500

Table 3: Estimated Loadings for the Total Set of Measurement Items

	PU	Compatibility	Risk	BI	PEOU	AU
PU1		0,4310	-0,3207	0,6208	0,6922	0,4440
PU2		0,4526	-0,2792	0,6153	0,8005	0,3390
PU3		0,5213	-0,3989	0,6732	0,8144	0,3755
COMP1	0,5135		-0,2450	0,5736	0,4428	0,4818
COMP2	0,4963		-0,2785	0,5761	0,4435	0,4644
COMP3	0,4755		-0,2676	0,5991	0,4137	0,5207
RISK1	-0,3336	-0,2175		-0,3739	-0,2359	-0,2868
RISK2	-0,3890	-0,3094		-0,4575	-0,2897	-0,3903
RISK3	-0,2401	-0,1918		-0,2763	-0,2073	-0,1550
BI1	0,7529	0,6855	-0,4105		0,6955	0,6120
BI2	0,5008	0,3668	-0,3542		0,5087	0,5032
BI3	0,5774	0,5239	-0,3609		0,5067	0,4439
PEOU1	0,7848	0,4292	-0,2677	0,6160		0,3608
PEOU2	0,816	0,4823	-0,2651	0,6381		0,4011
PEOU3	0,6041	0,2632	-0,1995	0,4683		0,3057
AU1	0,4529	0,4711	-0,3349	0,5663	0,3797	
AU2	0,2462	0,3959	-0,2105	0,4337	0,3035	

Table 4: Matrix of Loadings and Cross-loadings

Thirdly, measures of discriminant validity were calculated as the square root of the average variance extracted compared to the construct correlations. All values were greater than those in corresponding rows and columns. Table 6 offers the correlation matrix and discriminant validity assessment.

	PU	Compatibility	Risk	BI	PEOU	AU
Composite Reliability	0,941	0,977	0,931	0,925	0,927	0,853
Avg. Variance Extracted	0,842	0,935	0,818	0,805	0,809	0,744
Cronbach Alpha	0,905	0,965	0,888	0,875	0,883	0,636

**Table 5: Construct Statistics,**

	PU	Compatibility	Risk	BI	PEOU	AU
PU	0,918					
Compatibility	0,508	0,967				
Risk	-0,362	-0,271	0,905			
BI	0,689	0,598	-0,417	0,897		
PEOU	0,834	0,445	-0,273	0,642	0,899	
AU	0,416	0,502	-0,322	0,582	0,397	0,863

**Table 6: Correlation Matrix of the Constructs and Discriminant Validity Assessment**

**Structural Model:** Bootstrapping was performed, using Visual-PLS software, with 2000 replications to derive t-statistics, assess the significance level of the model's coefficients and test the hypotheses. Table 7 and Figure 2 present the structural model paths as well as their significance measures. As such, ten out of eleven hypotheses were supported (H1, H2, H3, H4, H5, H6, H8, H9, H10, H11) and one hypothesis were rejected (H7). In order to further confirm the insignificance of the rejected hypothesis, the linkages corresponding to that hypothesis was dropped, and the PLS model was re-estimated. The analysis revealed that the beta coefficients and t-values of the remaining model were strong and significant. In addition, none of the R-squared values changed that manifests the statistical validity of the remaining linkages.

Path	Entire Sample Estimate	Mean of Subsamples	Standard Error	t-statistic
PEOU->PU	0,735	0,737	0,044	16,629
COMP->PU	0,148	0,146	0,048	3,064
COMP->PEOU	0,445	0,445	0,084	5,323
COMP->RISK	-0,186	-0,184	0,084	-2,220
PEOU->BI	0,217	0,223	0,114	1,899
PU->BI	0,290	0,297	0,128	2,267
RISK->BI	-0,170	-0,164	0,070	-2,439
BI->AU	0,582	0,584	0,067	8,635
COMP->BI	0,309	0,306	0,085	3,623
RISK->PU	-0,121	-0,123	0,059	-2,040
PEOU->RISK	-0,190	-0,196	0,092	-2,074

**Table 7: Structural Model Path Coefficients and Bootstrap Results**



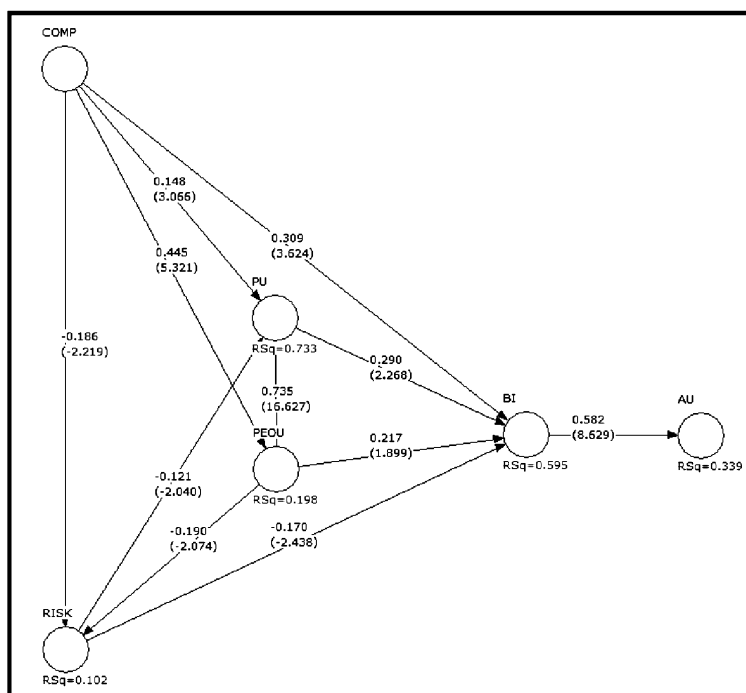


Figure 2: Proposed Model and Hypotheses Testing Results

Altogether, the proposed model accounted for 59,5% of the variance in behavioral intentions, 33,9% of the variance in the actual usage, 73,3% of the variance in perceived usefulness, 19,8% of the variance in perceived easy of use and 10,2% of the variance in perceived risk. Perceived compatibility exhibit the stronger direct effect on behavioral intentions followed by TAM constructs and perceived risk.

### 5. Implications and Discussion

Summarizing, the results of the proposed model indicate that Compatibility, PU and Risk are significantly directly associated with behavioral intentions.

Consistent with the work of Wu and Wang (2005), perceived compatibility had the strongest direct effect on behavioral intention among the determinants of internet banking retention. Making internet banking environment more compatible with potential users' lifestyle and needs is critical for banking institutions in ensuring users' retention rate of the service. Moreover, the enhancement of perceived compatibility reduces the fears that customer may have about their security and privacy in doing financial transactions through internet.

Perceived usefulness had the second strongest direct impact on behavioral intention. Therefore, in addition to providing users with rich platforms and useful functions to transact online, it is crucial for service providers to promote constantly users' perception of usefulness of internet banking service.

Perceived easy of use was observed to have no direct effect on behavioral intention but have an indirect effect influence on behavioral intention through its effect on perceived usefulness and perceived risk. This result probably is caused by the fact that a big portion of our sample consists of mature internet banking users who are not facing problems in using the system given the usefulness of the system properties. The impact of perceived easy of use on perceived risk is appeared to be significant meaning that the system friendliness lowers customers' fears about the problems that may have about their transactions security and personal privacy.

Finally, perceived risk was observed to negatively affect usage continuance. Despite the fact that our sample consists of mature internet banking users, they always have in mind the problems that may arise in terms of their transaction security and personal privacy. Therefore, constantly enhancement in the quality of security and privacy mechanisms should take place in order to avoid trust loss towards internet banking credibility.

### 6. Conclusions

Based on the available technology acceptance literature, this study presented and validated an extended model for predicting users' intention to continue to use internet banking services in Greece. The results indicated that perceived usefulness, perceived ease of use, perceived compatibility, and perceived internal

risk had direct or indirect influences on behavioral intention of service retention. The findings of this study provided several crucial implications for banking institutions and researchers.

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# DEVELOPING AND TESTING A MODEL EXPLAINING CUSTOMER CONATIVE LOYALTY FORMATION IN THE MOBILE TELECOMMUNICATIONS SERVICES

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## Abstract

*Customer retention and loyalty are concepts gaining more and more attention in today's business when loyal customers are considered as essential components to organizational survival and success. Therefore, organizations strive to identify and apply effective methods to retain their customers. Based on the relevant bibliography and practitioners' perception, customer loyalty is the main driver of company's retention rate improvement, resulting in profitability and market share improvements, since in nowadays the cost to acquire new customers is bigger than the cost to retain at least the most valuable customers.*

*This study attempts to consider the relationship between customers' perception on product and service quality provided by mobile telecommunication operators and customer perception of service value and customer satisfaction and further explain customer behavioral intentions, identified as conative loyalty, based on the above mentioned constructs plus two additional constructs representing main customers' switching barriers. Partial least square was used to examine the pattern of inter-correlations among the seven proposed constructs and to test related propositions empirically. The research subjects were customers of the three Greek mobile telecommunication services providers. The survey was conducted to a random sample of 985 post-paid and pre-paid residential mobile telecommunication services users, who were asked to respond to an appropriately prepared questionnaire. The results showed that both product and service quality level of service providers affect service's perceived value but only product quality affects customer satisfaction formation. Then product quality, service value perception, customer satisfaction, perceived switching cost and attraction of alternatives determines customers' conative loyalty. Moreover, switching barriers constructs acts as mediators between customer satisfaction and service value perception and customers' behavioral intention adjusting their conative loyalty. Finally, theoretical contributions and practical implications of the findings are discussed and suggestions for future research are presented.*

**Keywords:** *conative loyalty, customer satisfaction, corporate image, product and service quality, switching barriers, mobile services*

## 1. Introduction

As market growth slows down or as competition becomes fiercer, mobile telecommunication firms are tending to adopt a strategy aiming to protect their market share by focusing on retaining their current customer base at least the most valuable part. The main reason for that is that acquisition cost for attracting new customers is much higher than the retention cost (Turel and Serenko, 2006). The new battle for retention is further powered by switching barriers elimination. Systems' standardization allows customers' switching without change their previous terminals, while the option of mobile number portability allows customers to carry-on their mobile phone number when switching service providers.

The above-mentioned changes in this competitive environment revealed the importance of identifying factors affecting customer loyalty in the mobile service industry. The motivation for understating and improve customer's loyalty is based on the empirically validated links between loyalty, retention and firms'

profitability (Dawkins & Reichheld, 1990; Reichheld & Sasser, 1990). Specifically, several mobile service studies took place around the globe attempting to explore the factors affecting customer's loyalty formation such quality, customer satisfaction, brand image etc. (Kim et al., 2004). These studies assume that the investigation of factors affecting customer retention is vital for firms' business success of every product or service (DeSouza, 1992).

Based on these studies customers tend to keep using current service as the level of the customer satisfaction is high. In other word, customer satisfaction is the first factor for customer retention and is mainly formulated by customers' perception about the quality and value of products and/or services they receive by mobile service providers. In the recent research (Jones et al. 2002) however, the customer retention and the churning rate of them were identified to be different in the same level of the customer satisfaction. This means that there are other factors mediating between customer satisfaction and customers' behavioral intentions. These factors are identified as switching barriers representing the difficulty of customers in changing service provider (Jones et al., 2002). More specifically, the level of the switching barriers affects the customer retention as well as the adjustments of the relationship between customer satisfaction and customer retention.

This paper analyses the effects of service quality, service value, customer satisfaction and switching barriers on customer loyalty, and the structural relationship between these factors in the Greek mobile telecommunication services industry. This study has four objectives: first, to identify variables that constitute perceived quality, perceived service value, customer satisfaction and switching barriers, insofar as they affect customer loyalty; second, to carry out an empirical analysis of the relative effects of quality, service value, customer satisfaction and switching barrier on customer loyalty, and the causal relationships between them; third, to analyse the adjustment effect between customer satisfaction, perceived value and customer loyalty that is produced by switching barriers; and, fourth, to examine the strategic implications for mobile carriers attempting to raise the level of customer loyalty.

## **2. Proposed Model and Hypotheses**

### **2.1. Model Formulate**

Many studies have considered the relationships among, perceived quality, service value, satisfaction and behavioral intentions. From these studies, consumer perceptions of service quality affect service value, customer satisfaction and behavioral intentions. Furthermore, consumer perceptions of service value further affect consumer satisfaction and behavioral intentions, and customer satisfaction level also affects behavioral intentions (Dodds et al., 1985; Zeithaml, 1988; Lee and Cunningham, 2001). However, most of these studies confirmed the causal relationships between these four latent variables, but were not sufficient for understanding customers' behavioral intentions. Cornin, et al. (2000) constructed an integrated causal model for describing the relationships between perceived quality, service value, customer satisfaction and behavioral intentions. However, many similar services exist for mobile telephony services' users to choose from, and if customers wish to change to another service provider, they need to collect information about other services, and pay extra costs for using or adapting to new services. These kinds of switching barrier factors also affect behavioral intentions, but have received little attention in the literature.

Consequently, to construct a suitable model for customers' behavior intentions, this study introduces the integrated causal model from Cornin, et al. (2000), and also subsumed switching barriers into the model in order to explain the relationships between perceived value, customer satisfaction and customer's behavioral intentions. According to the model illustrated in Figure 1:

- Perceived service value is affected by perceived quality comprised of product and service quality
- Customers' satisfaction is affected by perceived quality and service value
- Switching barriers including perceived switching cost and attractiveness of the alternatives are affected by customer satisfaction and perceived service value
- Customer's behavioral intentions are affected by service quality, service value, customer satisfaction and switching barriers.

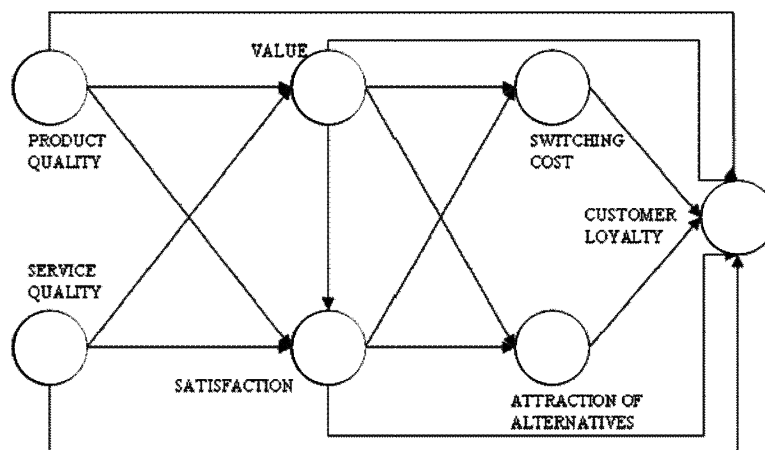


Figure 1: Proposed Model

## 2.2. Hypotheses

According to the model, this study deduces sixteen testable hypotheses.

First, customer's perception of service value represents the perceived level of quality, comprised of two distinct components identified as product and service quality, relative to the price paid or the "value for money aspect" of customer experience (Dodds & Monroe, 1985; Zeithaml, 1988). Hence, this study deduces the first two hypotheses, as follows.

*H1: Customers' perceived product quality is positively and directly related to customers' perceived value.*

*H2: Customers' perceived service quality is positively and directly related to customers' perceived value.*

Second, customer's satisfaction depends on perceptions of perceived quality and service value. When customers are constantly obtaining high quality and value services, they feel satisfied with their service provider (Cronin et al., 2000). From the above, the following hypotheses are tested:

*H3: Customer's perceptions of product quality are positively and directly related to customers' satisfaction.*

*H4: Customer's perceptions of service quality are positively and directly related to customers' satisfaction.*

*H5: Customers' perceptions of service value are positively and directly related to customers' satisfaction.*

Third, many researches have revealed that customer perceptions of service quality, service value, and satisfaction directly and significantly influence customers' behavioral intentions (Sheth et al., 1991; Woodruff et al., 1993; PZB, 1996; Oh, 1999; Cornin et al., 2000). Consequently, if companies wish to gain loyal customers, or customers who are willing to recommend their service to others, they need to offer good quality, high value and satisfactory service. Based on the above, the following hypotheses are tested:

*H6: Customers' perceptions of product quality are positively and directly related to customers' behavioral intentions.*

*H7: Customers' perceptions of service quality are positively and directly related to customers' behavioral intentions.*

*H8: Customers' perceptions of service value are positively and directly related to customers' behavioral intentions.*

*H9: Customers' perceived satisfaction is positively and directly related to customers' behavioral intentions.*

Despite the pivotal role of customer satisfaction and customer's perceived value on customer's behavioral intentions, many researchers (Jones et al., 2002; Kim et al., 2004) showed that customer retention and the churning rate were identified to be different in the same level of the customer satisfaction according to the level of the switching barriers, which affects the customer retention as well as adjust the relationship between customer satisfaction, service value and customer retention. Besides, the likelihood of customers using a particular service operator should decrease as the perceived costs associated with that service increase. Furthermore, when customers perceive few viable alternatives, the perceived benefits of defecting should be relatively low leading to increased levels of retention. Based on the above, the following hypotheses are tested:

*H10: Customer satisfaction is positively and directly related with customers' perceived switching cost.*

*H11: Customer's perceived value is positively and directly related with customers' perceived switching cost.*

*H12: Customer satisfaction is negatively and directly related with attractiveness of the alternatives.*

*H13: Customer's perceived value is negatively and directly related with attractiveness of the alternatives.*

*H14: Perceived switching costs are positively and directly related to customers' behavioral intentions.*

*H15: Attractiveness of the alternatives is negatively and directly related to customers' behavioral intentions.*

### 3. Research Methodology

#### 3.1 Measures and Constructs

This study employed 27 manifest variables as multiple indicators for seven model constructs. Likert scales (1–10), with anchors ranging from “strongly disagree” to “strongly agree” were used for all items to ensure statistical variability among survey responses for all items measured. The list of measurement items was developed using input from the review of the literature related to our study. All of the measures translated from English to Greeks using double-back-translation (Malhotra, 1996). The items included into the questionnaire can be seen in Table 1.

To measure conative loyalty (CL), the four-item scale developed by Narayandas (1996) was adopted to the Greeks GSM industry. The operational measures in measuring loyalty are:

- Repurchase intentions (next-use)
- Strong preference on current service provider
- Willingness to recommend preferred operator’s product and services to friends and associates

Customer’s perceived service value represents customers’ services or products evaluations from the perspective of gains and losses of services’ usage. That is, service value is determined by a trade-off between perceived benefits and perceived costs (Dodds and Monroe, 1985; Zeithaml, 1988). Most researchers currently agree that perceived value is determined by comparing perceived benefits and perceived costs (Lovelock, 2000). This study measured service value using three items, selected based on reviewing the related literatures (Bolton and Drew, 1991; Brown et al., 1993).

Regarding the measure of customer satisfaction, a three-item scales developed by Fornell (1992) in the ASCI model, were used. The operational measures used in measuring customer satisfactions are:

- General satisfaction
- Expectancy disconfirmation
- Performance vs. customer’s ideal service provider

Perceived switching barriers, reflecting any factor which increases the difficulty for customers in changing provider, were assessed using two constructs identified as switching costs and attraction of the alternatives respectively (Jones et al., 2000). Perceived switching costs refer to consumer perceptions regarding the time, money, and effort associated with changing service provider, measured by two items (Ping, 1993). Attractiveness of alternatives refers to customers’ perceptions regarding the extent to which competitors offer equal or superior services, measured using three items (Rusbult, 1980; Ping, 1993).

In measuring perceived quality level, two constructs are using representing customers’ perception about the provided product and service quality from their current mobile services operator. In the GSM sector, the base technical services are:

- Coverage and sound clarity of calling area
- Value-added services
- New product development

for which quality, operationability, reliability and flexibility are measured.

Services quality refers to staff competences in terms of:

- Knowledge adequacy in problem solving
- Time assignment and prompt service delivery
- Personal attention and customers’ needs understanding
- Politeness, and respect against customers
- General evaluation of customer service provided

#### Product Quality

1. I am not facing coverage problems with my current provider (PQ1)
2. The call quality with my current provider is very high (PQ2)
3. My current provider offers a variety of value-added services which covers my communication needs (PQ3)
4. My current provider offers me flexibility in terms of product adaptation and usage (PQ4)
5. The operationability and reliability of services offered by my current provider are of high level (PQ5)
6. The new products offered by my current provider totally covers my communication needs (PQ6)

#### Service Quality

1. My current provider’s personnel provide prompt services (SQ1)
2. My current provider’s personnel assigning enough time to help me in problem solving (SQ2)
3. My current provider’s personnel enhance my trust in company (SQ3)

4. My current provider's personnel give personal attention to my needs (SQ4)
5. My current provider's are polite and treats me with respect (SQ5)
6. The level of customer service provided by my current provider is of high level (SQ6)

**Perceived Service Value**

1. The price I pay for the mobile services with respect to the quality I receive is fare enough (SV1)
2. The quality I received from my current provider with respect to the price I pay is of high level (SV2)
3. The price I pay for the mobile services compared to the prices offered by other operators is very competitive (SV3)

**Customer Satisfaction**

1. Overall I am very satisfied with my current mobile operator (CS1)
2. My current mobile operator completely covers my communication needs (CS2)
3. My current mobile operator approaches an ideal mobile services provider (CS3)

**Switching Cost**

1. For me, it would take a lot of costs to switch to another mobile operator (SC1)
2. It would be hassle for me to get information about other mobile operators (SC2)

**Attractiveness of Alternatives**

1. If I needed to change mobile service provider, there are other good companies or to choose from (AA1)
2. Compared to my current mobile operator, there are other mobile operators with which I would probably be equally or more satisfied (AA2)
3. It is very easy for me to use other suppliers (AA3)

**Customer Loyalty**

1. I intend to continue to be customer of this mobile operator (CL1)
2. I have strong preference towards my current mobile operator (CL2)
3. I would like to recommend my mobile operator to others (CL3)
4. I would like to encourage my associates to become customers of my current mobile operator (CL4)

**Table 1: List of Items by Construct****3.2. Data Collection**

To determine mobile services users' behavioral intentions and their antecedent factors, a survey was conducted during the fourth quarter of 2007. 1030 questionnaires were collected randomly including customers from the three mobile operators of Greece. Participation in the study was voluntary. Out of 1037 questionnaires 52 were eliminated from the analysis by means of examining control questions in the questionnaire form. Finally, 985 usable complete responses were obtained. Detailed descriptive statistics related to the respondents' characteristics are shown in Table 2.

	Values	Frequency (N=985)	Percent (%)
<b>Gender</b>	Male	519	53%
	Female	466	47%
<b>Age</b>	15-20	193	20%
	20-24	339	34%
	25-34	189	19%
	35-44	112	11%
	45-55	104	11%
	55+	45	5%
<b>Education</b>	Up to high School	353	36%
	College	240	24%
	University	373	38%
<b>Connection Type</b>	Post-paid	545	55%
	Pre-paid	440	45%
<b>Mobile Operator</b>	Cosmote	375	38%
	Vodafone	314	32%
	Wind	296	30%

Table 2: Demographic Information of the Respondents

#### 4. Data Analysis and Results

##### 4.1. Measurement Model

The loadings of the total set of all items were estimated by using Partial Least Squares (PLS) (Gefen, Straub and Boudreau 2000). PLS is suitable for this kind of projects because it fits both exploratory and confirmatory research, and places less restriction on the data than the covariance structure models. Table 3 presents the measurement model. The results demonstrate that the loadings of all items exceeded the required threshold of 0.7, and, therefore, explain over 50% of the variance in an observed item. At the same time, the instrument showed high internal reliability since the Cronbach's Alphas were above 0.7 for all scales (see Table 4). In order to test for discriminant validity, a matrix of loadings and cross-loadings was constructed (see Table 5). By using this matrix, the loadings of an item with its associated factor to its cross-loadings were compared. All items had higher loadings with their corresponding factors in comparison to their cross-loadings. Therefore, it was concluded that there is enough confidence in the discriminant validity of the measures and their corresponding constructs. Table 4 presents construct statistics. First, tests for reliability of the measurement items relating to four constructs were conducted by estimating the Cronbach's Alpha. Based on the results, it was concluded that all scales behaved consistently. Secondly, internal consistency and convergent validity measures were calculated. The analysis demonstrated high internal consistency and convergent validity since the scores exceeded 0.7 and 0.5 threshold respectively (Fornell and Larcker 1981). Thirdly, measures of discriminant validity were calculated as the square root of the average variance extracted compared to the construct correlations. All values were greater than those in corresponding rows and columns. Table 6 offers the correlation matrix and discriminant validity assessment.

Construct	Indicator	Mean	Stdev	Loading	Stdev	Weight
Product Quality	PQ1	7,385	0,059	0,788	0,015	0,174
	PQ2	7,309	0,058	0,807	0,015	0,179
	PQ3	7,419	0,051	0,889	0,008	0,199
	PQ4	7,227	0,051	0,857	0,010	0,196
	PQ5	7,315	0,050	0,895	0,007	0,215
	PQ6	7,271	0,053	0,877	0,009	0,207
Service Quality	SQ1	7,554	0,058	0,850	0,017	0,227
	SQ2	7,511	0,059	0,826	0,013	0,185
	SQ3	7,231	0,059	0,883	0,010	0,187
	SQ4	7,080	0,064	0,902	0,010	0,196
	SQ5	6,794	0,063	0,853	0,014	0,188
	SQ6	7,575	0,052	0,853	0,013	0,178
Perceived Value	SV1	6,696	0,048	0,928	0,006	0,371
	SV2	6,917	0,049	0,919	0,007	0,387
	SV3	7,143	0,051	0,864	0,011	0,347
Satisfaction	CS1	7,035	0,049	0,887	0,009	0,360
	CS2	6,718	0,051	0,912	0,006	0,357
	CS3	6,616	0,052	0,915	0,005	0,388
Switching Costs	SC1	5,619	0,081	0,960	0,004	0,674
	SC2	5,405	0,085	0,882	0,016	0,401
Attraction of Alternatives	AA1	5,236	0,092	0,811	0,021	0,479
	AA2	5,788	0,081	0,818	0,021	0,421
	AA3	5,579	0,086	0,775	0,025	0,345
Customer Loyalty	CL1	7,920	0,065	0,833	0,014	0,259
	CL2	7,237	0,071	0,895	0,008	0,294
	CL3	6,711	0,072	0,898	0,008	0,287
	CL4	6,645	0,072	0,905	0,008	0,291

Table 3: Estimated Loadings for the Total Set of Measurement Items



	Product Quality	Service Quality	Perceived Value	Satisfaction	Switching Cost	Attraction of Alternatives	Customer Loyalty
Constructs' Means	7,320	7,304	6,908	6,795	5,519	5,546	7,131
Composite Reliability	0,941	0,945	0,931	0,931	0,918	0,843	0,934
Avg. Variance Extracted	0,728	0,742	0,817	0,819	0,849	0,642	0,780
Cronbach Alpha	0,925	0,930	0,888	0,889	0,833	0,725	0,906

Table 4: Construct Statistics

Indicator	Attraction of Alternatives	Customer Loyalty	Product Quality	Satisfaction	Switching Cost	Service Quality	Perceived Value
PQ1	-0,153	0,494	<b>0,788</b>	0,543	0,146	0,394	0,486
PQ2	-0,167	0,509	<b>0,807</b>	0,565	0,145	0,424	0,497
PQ3	-0,184	0,526	<b>0,889</b>	0,626	0,220	0,506	0,592
PQ4	-0,171	0,511	<b>0,857</b>	0,620	0,208	0,509	0,584
PQ5	-0,231	0,583	<b>0,895</b>	0,681	0,247	0,562	0,619
PQ6	-0,219	0,558	<b>0,877</b>	0,651	0,240	0,539	0,604
SQ1	-0,129	0,411	0,444	0,437	0,145	<b>0,826</b>	0,495
SQ2	-0,180	0,415	0,485	0,444	0,185	<b>0,883</b>	0,498
SQ3	-0,206	0,440	0,531	0,474	0,170	<b>0,902</b>	0,517
SQ4	-0,186	0,401	0,461	0,466	0,173	<b>0,853</b>	0,503
SQ5	-0,164	0,367	0,479	0,430	0,185	<b>0,853</b>	0,497
SQ6	-0,209	0,532	0,564	0,565	0,245	<b>0,850</b>	0,561
SV1	-0,269	0,628	0,592	0,699	0,323	0,530	<b>0,928</b>
SV2	-0,265	0,632	0,648	0,698	0,298	0,615	<b>0,919</b>
SV3	-0,276	0,602	0,557	0,632	0,335	0,466	<b>0,864</b>
CS1	-0,247	0,643	0,682	<b>0,887</b>	0,280	0,488	0,665
CS2	-0,251	0,671	0,632	<b>0,912</b>	0,262	0,484	0,664
CS3	-0,333	0,750	0,648	<b>0,915</b>	0,333	0,518	0,703
AA1	<b>0,811</b>	-0,369	-0,218	-0,286	-0,535	-0,199	-0,268
AA2	<b>0,818</b>	-0,321	-0,157	-0,251	-0,406	-0,155	-0,241
AA3	<b>0,775</b>	-0,275	-0,147	-0,189	-0,375	-0,142	-0,198
SC1	-0,510	0,435	0,276	0,358	<b>0,960</b>	0,234	0,380
SC2	-0,531	0,254	0,132	0,206	<b>0,882</b>	0,146	0,238
CL1	-0,334	<b>0,833</b>	0,505	0,606	0,318	0,408	0,559
CL2	-0,406	<b>0,895</b>	0,560	0,692	0,373	0,475	0,615
CL3	-0,335	<b>0,898</b>	0,561	0,695	0,348	0,439	0,619
CL4	-0,360	<b>0,905</b>	0,571	0,694	0,355	0,447	0,631

Table 5: Matrix of Loadings and Cross-loadings

	Attraction of Alternatives	Customer Loyalty	Product Quality	Satisfaction	Switching Cost	Service Quality	Perceived Value
Attraction of Alternatives	<b>0,801</b>						
Customer Loyalty	-0,407	<b>0,883</b>					
Product Quality	-0,221	0,623	<b>0,853</b>				
Satisfaction	-0,308	0,762	0,723	<b>0,905</b>			
Switching Cost	-0,556	0,395	0,239	0,324	<b>0,921</b>		
Service Quality	-0,209	0,501	0,577	0,549	0,216	<b>0,861</b>	
Perceived Value	-0,298	0,687	0,664	0,749	0,352	0,597	<b>0,904</b>

**Table 6:** Correlation Matrix of the Constructs and Discriminant Validity Assessment**4.2. Structural Model**

Bootstrapping was performed, using Visual-PLS software, with 2000 replications to derive t-statistics, assess the significance level of the model's coefficients and test the proposed hypotheses. Table 7 present the structural model paths as well as their significance measures. As such, thirteen out of fifteen hypotheses were supported and two hypotheses were rejected (H4 and H7). In order to further confirm the insignificance of the rejected hypothesis, the linkages corresponding to that hypothesis was dropped, and the PLS model was re-estimated. The analysis revealed that the beta coefficients and t-values of the remaining model were strong and significant. In addition, none of the R-squared values changed that manifests the statistical validity of the remaining linkages.

Path	Entire Sample Estimate	Mean of Subsamples	t-statistic	Hypothesis	Hypothesis Validity Test
Product Quality → Perceived Value	0,479	0,480	14,649	H1	Supported
Service Quality → Perceived Value	0,320	0,319	9,873	H2	Supported
Product quality → Satisfaction	0,387	0,387	11,488	H3	Supported
Service Quality → Satisfaction	0,051	0,052	1,880	H4	Not supported
Perceived Value → Satisfaction	0,462	0,462	14,563	H5	Supported
Product Quality → Loyalty	0,090	0,091	2,905	H6	Supported
Service Quality → Loyalty	0,034	0,037	1,437	H7	Not supported
Perceived Value → Loyalty	0,186	0,187	4,922	H8	Supported
Satisfaction → Loyalty	0,473	0,472	13,036	H9	Supported
Satisfaction → Switching Cost	0,137	0,137	2,900	H10	Supported
Perceived Value → Switching Cost	0,249	0,250	5,138	H11	Supported
Satisfaction → Attraction of Alternatives	-0,192	-0,193	4,031	H12	Supported
Perceived Value → Attraction of Alternatives	-0,154	-0,155	3,264	H13	Supported
Switching Cost → Loyalty	0,070	0,070	2,863	H14	Supported
Attraction of Alternatives → Loyalty	-0,140	-0,140	5,489	H15	Supported

**Table 7:** Structural Model Path Coefficients and Bootstrap Results

Altogether, the proposed model accounted for 64,6% of the variance in customer loyalty, 65,3% of the variance in customer satisfaction, 50,9% of the variance in perceived service value, 13,2% of the variance in switching costs and 10,5% of the variance in attraction of alternatives. Customer satisfaction and perceived service value exhibit the stronger direct effect on customer loyalty, however their significance are adjusted by switching barriers. Product quality level directly affects both customer satisfaction and loyalty whereas service quality level impact is a matter of its perceived value by the customer since it does directly affect either customer satisfaction or loyalty.

**5. Conclusions and Managerial Implications**

This paper aimed to expand the integrated service quality measurement causal model of Cronin et al. (2000) by adding the notion of switching barriers in order to explain the relationships between customers perceived value, customer satisfaction and customer's conative loyalty. The role of switching barrier on customer retention is identified by analyzing the relationship between customers' satisfaction, perceived service value and switching barrier in the mobile communication service industry. First, we focused on the analysis of switching cost, and attractiveness of the alternatives, which are mentioned in the precedent studies. The partial least square methodology was used to analyze the main and the adjustment effect of Cronin et al. model constructs and the above mentioned switching barrier factors on customer's retention decision mechanism.

The contribution of this paper is as twofold: First, from the theoretical point of view, the contribution is that this paper review theoretically and verifies empirically the relationship and mechanism between the pivotal concepts of relationship marketing such as perceived quality level, perceived service value, customer satisfaction and switching barrier on customer retention. Especially, this is the first try to study the main and adjustment effect of specific factors composing the switching barrier in Greece.

From the empirical point of view, this paper suggests the practical strategy in terms of switching barriers for the domestic mobile communication service providers which are trying to maintain current growth and profitability in the mature market. Based on the analysis outcome it is obvious that it is not enough the achievement of high level of customer satisfaction without considering the competitors' actions and the customer's position on the lifecycle curve. Customers who declare that they have no problem for the moment with their current mobile operator should not be considered as loyal customers. Depending on customers' lifecycle position (e.g. contractual obligations, upcoming or current benefits) and the future benefits that the customer may receive from the competitors, will probably adjust the impact of customer's evaluation about their current mobile operator. For that reason it is proposed the continuous customers' surveillance though business intelligence methods and classical marketing research methodologies in order to predict customers' behavioral intention and decide the type of customers need to be retained.

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# PREDICTING MULTI-COHORTS' CUSTOMER RETENTION USING LIMITED INFORMATION

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## Abstract

*Customer churn and retention rates are considered as the most important indicators to CRM activities such as modelling customer valuation and budget allocation. Such models, which are trying to predict customer's survival rate, assume that churn rates are constant both over time and across customers. The current practice, however, have shown that these assumptions are not valid and are currently tested in a systematic manner. The practice shows that churn propensity vary dramatically across customers and over time; yet, most models do not account for such differences. This study takes under consideration a number of factors that may underlie customer retention patterns. Specifically a model of mobile services' retention is developed that takes into account: duration dependence, cross-cohort effects, customer heterogeneity, and contractual obligation type. Moreover, a methodology is proposed that easily allows practitioners to evaluate the relative importance of each of these effects based on in-sample and out-of-sample performance using limited information. Using a dataset from a major Greek telecommunication company concerning customers' gross additions for twelve months and the relevant disconnections for the same time period ahead, two models on aggregate data at the monthly level are tested. The proposed modelling approach reveals that the notion of a constant churn rate is rejected. The representation of customer's retention process requires all the proposed components listed above towards improving the retention and churn rate forecasting performance.*

**Keywords:** Retention, heterogeneity, cross-cohorts effects, latent class survival models, CRM

## 1. Introduction

A key characteristic of a contractual business setting is that customers' defection is observed. For example, the customer has to contact the firm to cancel his/her cell phone contract. In this business setting, practitioners are using several metrics such as retention rate for period  $t$ , which is defined as the proportion of customers active at the end of period  $(t-1)$  who are still active at the end of period  $t$ , and churn rate for a given period which is defined as the proportion of customers active at the end of period  $(t-1)$  who dropped out in period  $t$ .

In order to understand the nature of customer behavior in a contractual setting, it is useful to draw on survival analysis. One particularly useful concept for characterizing the distribution of customer lifetimes is that of the survival function, denoted by  $S(t)$ , which is the probability that a customer has "survived" up to time  $t$  (i.e., is still active at  $t$ ). Recalling the definition of retention rate, it follows that,

$$S(t) = \prod_{i=1}^t r_i \quad (1)$$

which means that,

$$r_t = \frac{S(t)}{S(t-1)} \quad (2)$$

In a contractual setting, the empirical survivor function  $S(t)$  is simply the proportion of customers acquired at time 0 who are still active at time  $t$ . A major problem in using the empirical survivor function to compute expected tenure or lifetime value is that the observed time horizon is often quite limited. Suppose a particular cohort of customers over their first twelve months with the firm are observed, which implies we  $S(1), S(2), \dots, S(12)$  can be computed. The quantity  $S(1) + S(2) + \dots + S(12)$  is the expected customer lifetime for the members of the cohort over this period. However, the expected tenure of a new customer would be underestimating, as the remaining life of those customers who are alive at the end of the twelfth month would be ignoring. In order to compute the true expected tenure, we need to be able to project the survivor function beyond the observed time horizon. That is, we need to create estimates of  $S(13), S(14), \dots$  given the data  $S(1), S(2), \dots, S(12)$ . This projected survivor function is also needed if we wish to compute the expected residual tenure value of an individual who has been a customer for, say, two years.

The objective of this paper is to present an approach to the problem of projecting the survivor function for customers belonging to different cohorts, using a parametric duration model. The probabilistic model of contract duration is formulated based on customers' behavior incorporating at the same into the model some effects that influencing customer retention pattern. Such effects are customer heterogeneity accounting for unobserved differences across customers, cross-cohort effects accounting for differences that may exists between customers who subscribed in different periods (cohorts), and finally the type of contractual obligation effect accounting for the type of acquisition offers received by the customer in order to purchase the service. The resulting model offers useful diagnostic insights and is very easy to implement using Microsoft Excel.

In the next section, the probability model of customer lifetime is presented and the value of using a formal model to predict future customer behavior is demonstrated. Several issues that arise from the study are discussed at the end.

## 2. Model Development

To forecast the number of subscribers retaining service in future periods, a parametric form for the "survival" probability,  $S(t)$  (i.e., the probability that a customer has maintained service until time  $t$ ) is proposed. That is, after calibrating the model on  $n$  periods of data, the likelihood of maintaining service until time  $t$  can be forecasted by calculating  $S(t)$  for any  $t > n$ . The availability of survival probability provides the opportunity of estimating other related measures of interest, such as, the predicted number of customers who still have the service at time  $t$ ,  $(N_0 \times S(t))$ , where  $N_0$  are the number of customers who acquired at time 0 and  $(N_0 \cdot [S(t) - S(t-1)])$  the number of customers expected to drop service between time  $t$  and  $t + 1$ .

The conditional rate of defection given that the customer is still "alive", known as hazard rate, will be utilized as base for the model development. A latent class proportional hazard model, able to account for various effects, will be used in order to incorporate the previously described effects into the proposed model. We do so within a mixture model specification to incorporate heterogeneity, in which the probability that a randomly selected customer has not dropped service by time  $t$  is given by

$$S(t) = \int S[t|\theta_i, b, X(t)] \cdot g(\theta_i) d\theta_i \quad (3)$$

where  $\theta_i$  is an individual-specific set of latent parameters,  $X(t)$  is a vector of covariates at time  $t$ , and  $b$  is the effect of these covariates. Eq. (3) could be considered as a mixed-effects hazard model with both fixed and random components. The model in Eq. (3) consists of two main components:  $S[t|\theta_i, b, X(t)]$  and  $g(\theta_i)$ . The term  $S[t|\theta_i, b, X(t)]$  specifies the probability that a consumer maintains the service until time  $t$ , which can be written in terms of its hazard function as:

$$S[t|\theta_i, b, X(t)] = \exp \left[ - \sum_{v=1}^t \left( \int_{v-1}^v h(u|\theta_i, \beta, X(t)) du \right) \right] \quad (4)$$

Rather than assuming that all subscribers are homogeneous, the mixing distribution  $g(\theta_i)$  allows for unobserved differences in subscribers' tendencies to discontinue service, because some may be inclined to do so after only a few months whereas others may be more reluctant.

Next, we describe how each of the four effects that are considered is formulated within the mixture model presented in Equations (3) and (4).

### 2.1. Duration Dependence

The likelihood that a subscriber will drop service may change according to the length of time for which he or she has had it. Therefore, the Weibull distribution for the baseline hazard is adopted, which is flexible and commonly used in proportional hazards models (Morrison & Schmittlein 1980; Seetharaman & Chintagunta, 2003):

$$h_0(t|\lambda, c) = c \cdot \lambda \cdot t^{c-1} \quad (5)$$

The Weibull distribution nests the “strawman” exponential distribution when  $c = 1$ ; if subscribers do not exhibit duration dependence in their likelihood to drop service, the model collapses to a constant hazard rate  $\lambda$ . Values of  $c > 1$  yield an increasing hazard rate, implying that subscribers are more likely to discard service the longer they have had it. Conversely,  $c < 1$  leads to a decreasing hazard rate, such that subscribers become less likely to discard service as their tenure increases. Depending on the nature of duration dependence, managers may want to allocate their marketing efforts toward “older” or “younger” subscribers.

### 2.2. Cross-Cohort Effects

The baseline hazard function given in Eq. (5) is independent of the time at which subscribers began service (or the cohort to which they belong to). To allow for systematic differences across cohorts, we incorporate a cohort-specific effect (Fader and Hardie, 2008; Schweidel et al., 2008)

$$h_0(t|\lambda, c) = c \cdot \lambda \cdot \exp(\phi(j-1)^\tau) \cdot t^{c-1} \quad \text{for } j = 2, 3, 4, \dots \quad (6)$$

where  $t$  is the time that has elapsed since customers began service in month  $j$  of the observation period. The parameter  $\phi$  governs the direction of the shift relative to the first cohort, where  $\phi > 0$  implies that other cohorts have higher hazard rates relative to the first observed cohort, while  $\phi < 0$  implies that other cohorts have lower hazard rates comparatively. If  $\phi = 0$ , then all cohorts have the same baseline hazard rate. The magnitude of the shift on cohort  $j$  is affected by the parameter  $\tau$ , where  $\tau > 0$  suggests that the magnitude of the shift increases with  $j$  (cohort), while  $\tau < 0$  suggests that the magnitude decreases. For  $j=1$ , we use the baseline hazard rate given in (5), implying that the cross-cohort effect can be interpreted as a shift in the baseline hazard rate relative to the baseline hazard rate of the first cohort, where the ratio of the baseline hazard rates is:

$$q(j, \phi, \tau) = \frac{h(t, j|\lambda, \phi, \tau)}{h(t, 1|\lambda, \phi, \tau)} = \exp(\phi(j-1)^\tau) \quad \text{for } j = 2, 3, 4, \dots \quad (7)$$

This simple two-parameter model component, as given in (7), should be sufficient to capture (or at least adequately approximate) any cross-cohort dynamics present in our dataset (Schweidel et al., 2008).

Combining the cross-cohort effects with the individual-level baseline hazard function from Eq. (4) yields the conditional probability of a subscriber from cohort  $j$  of a particular service maintaining it until time  $t$  given by

$$S(t, j|\lambda, \Theta) = \exp\left(-\sum_{v=1}^t \int_{v=1}^v c \cdot \lambda \cdot q(j, \phi, \tau) \cdot u^{c-1} du\right) \quad (8)$$

$$S(t, j|\lambda, \Theta) = \exp(-\lambda \cdot t^c \cdot \exp(\ln(q(j, \phi, \tau)))) \quad (9)$$

### 2.3. Subscriber Heterogeneity

The likelihood of dropping a particular service is not the same for all customers. In order to model such a process a mixture distribution is specified, which accounts for unobserved subscriber heterogeneity in the likelihood of dropping a particular service. If all subscribers have the same propensities for discarding a service, the mixing distribution would simply be a spike [ $g(\theta_i) = \lambda$ ], but this would be an extremely restrictive assumption. Instead, we allow for heterogeneity across service subscribers by assuming that each subscriber’s  $\lambda_i$  is drawn from a gamma distribution:

$$g(\lambda|r, a) = \frac{a^r \cdot \lambda^{r-1} \cdot e^{-a\lambda}}{\Gamma(r)} \quad (10)$$

The gamma distribution is chosen not only for its flexibility, but also because it is the conjugate prior for the Weibull distribution and therefore is commonly used as a mixing distribution for this purpose (e.g., Follman and Goldberg 1988). As such, the marginal probability of a customer in cohort  $j$  surviving until time  $t$  is found by integrating (9) over the mixing distribution (10), as shown in detail in (3), and is given by,

$$S(t, j|r, a, c, \phi, \tau) = \left( \frac{a}{a + t^c \cdot \exp(\phi \cdot (j-1)^\tau)} \right)^r \quad (11)$$

#### 2.4. Contractual Obligation Type

We postulate the existence of discrete segments of customers, where within each segment, individual level time-to-churn is Weibull-distributed with parameters  $\lambda_s, c_s$ .  $\lambda_s$  is distributed across segment members according to the Gamma distribution with parameters  $r_s$  and  $a_s$ . In the specific study we assume the existence of two segments expressing customers who received terminal subsidization for service activation (e.g. 12 month contract obligation) vs. customers who preferred to take the subsidy as bill discount (they are allowed to switch any time they wish). The parameters expressing the cross-cohort effect are assumed to be the same for both segments since for all cohorts the subsidization policy was the same. Based on the above the probability that a randomly selected customer has not dropped service by time  $t$  is given as a finite mixture of survival functions given by:

$$S(t, j|r, a, \phi, \tau) = 1 - \sum_{i=1}^2 p_i \cdot (1 - S(t, j|r_i, a_i, \phi, \tau_i)), \quad (12)$$

$$\sum_{i=1}^2 p_i = 1$$

### 3. Empirical Analysis

The data used in our empirical analysis were provided by a major telecommunications operator that offers a broad range of mobile services to its customers. To evaluate the importance of the four factors, we fit two models to the data the company offered. The first model (named WGCC) does not consider the contractual obligation type determined by the acquisition offers, while the second model named (WGCC-2S) considers all four effects described above. The models calibration and forecasting performance are tested using the Bayesian Information Criterion (BIC)

$$BIC = -2 \cdot LL + q \cdot \ln(D) \quad (13)$$

and the Mean Absolute Percentage Error

$$MAPE = \frac{1}{k} \sum_{i=t+1}^{t+k} \left| \frac{N_t - E_t}{A_t} \right| \quad (14)$$

respectively, where  $q$  is the number of parameters,  $D$  the number of observations,  $N_t$  the actual number of customers survived up to time  $t$ ,  $E_t$  the expected number of customers survived up to time  $t$  and  $k$  the forecasting horizon.

The company provided subscription information from Sept 2006 to September 2008, indicating (in aggregated monthly data) the number of customers subscribing at the end of each month. Thus, the first group that we observe from the time that it begins service is the Oct 2006 cohort. The company noticed that around 50% of the subscribers were received terminal subsidization in order to activate the service. The chosen models calibration period is 12 months e.g. up to Sep 2007. Then using the parameters provided during the model calibration the models' forecasting ability is tested in terms of service retention numbers from the period between Oct 2007 and Sep 2008. Figure 1 illustrates the empirical survival function for the available data considering the full time period of 24 months, while Figure 2 provides the relevant empirical hazard function for the same time period.

From the customers that maintain service and those that churn during the calibration period, we can construct the log-likelihood of the observed behavior of customers from cohort  $j$ :

$$LL(\Theta|j) = N_{T-j+1,j} \cdot \log(S(T-j+1, j)) + \sum_{t=1}^{T-j} [(N_{t,j} - N_{t+1,j}) \cdot \log(S(t, j) - S(t+1, j))] \quad (15)$$

where the first term accounts for customers that maintain service through the entire calibration period and the second term accounts for households that churn during the calibration period, summing over all intervals in which the customers could discard service. The log-likelihood for the full data set, consisting of all cohorts that began service during the calibration period, is as follows:

$$LL(\Theta) = \sum_{j=1}^{T-1} LL(\Theta|j) \quad (16)$$

#### 4. Results

For models' calibration, the Solver Add-In of MS Excel was used. A procedure provide by Billo (2001) was utilized to obtain the standard deviations of the coefficients. Table 1 presents the results of models' calibration and forecasting performance. Both models parameters are statistical significant. With respect to model WGCC formulation, it can be seen that the value of parameter  $c$  is greater than 1, implying that subscribers are more likely to discard service the longer they have had it. The values of parameters  $\phi$  and  $\tau$  imply decreased hazard for all cohorts relative to  $j=1$  with an increasing effect with respect to  $j$ . The second model, which considers acquisition type offers in order to construct a two latent class model, presents a better calibration and forecasting performance (lower BIC and MAPE indices). WGCC-2S formulation implies that the provided customer base consists of two segments which have different behavior in terms of churn propensity. The first segment accounting for 50,6% of the population are more likely to discard service the longer they have had it, while the other 49,4 % are more likely to retain service as the time goes by. In terms of cross-cohorts effects the values of model's parameters imply that all cohorts presents decreased hazard relative to  $j=1$  but the effect diminishes with  $j$ . The fitting and forecasting performance of the two models are illustrated in Figures 1 and 2 which presents the aggregate survivors and churners over time respectively. It's obvious that WGCC-2S provides a better representation of customers' decision process in terms of retention/churn propensity.

#### 5. Conclusions

The problem of predicting customer retention rate is very vital for organizations. A reliable forecasting methodology of this customers' measure provides better estimations of customer lifetime value (CLV) which in turns is used for customer segmentation and CRM budget allocation. The current study proposed a two latent class finite mixture probability model aiming to represent customers' decision mechanism in terms of retain or discard a mobile service over time. The proposed model includes four external effects which affect the customers' behavior represented by quantities such as P(alive), mean residual lifetime and (residual) CLV, all conditional on the customer's observed behavior, which can be used for policy development. The proposed methodology could be implemented very easily in spreadsheet environment and become a very good tool for CRM policy development.

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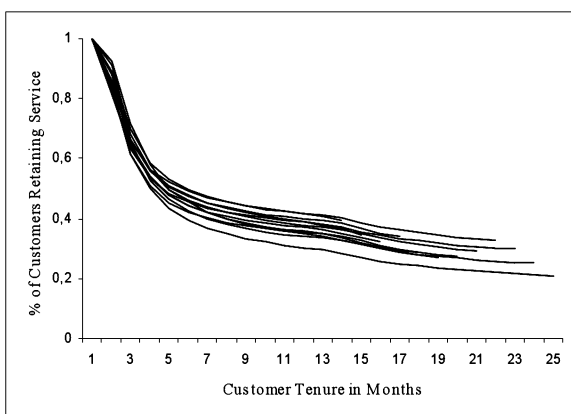
### Appendix

#### Tables

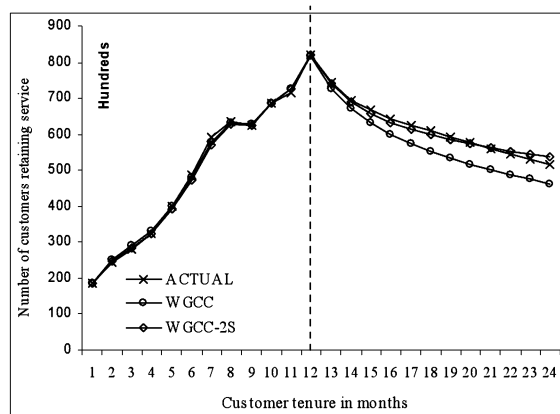
**Table 1: Models Parameters and Performance Measures for the two Modes**

Parameters	WGCC		WGCC-2S	
	Estimate	St. Error	Estimate	St. Error
$a_1$	0,0631	0,0018	1,6890	0,0325
$r_1$	0,0662	0,0034	0,2816	0,0122
$c_1$	6,2031	0,7809	4,3154	0,5340
$\phi$	-0,6977	0,0299	-0,3583	0,0104
$T\alpha$	0,0729	0,0192	-0,0319	0,0109
$a_2$			4,5373	0,2259
$r_2$			1,2487	0,1213
$c_2$			0,4067	0,0141
$P$			0,5061	0,0085
$LL$	-255.800,06		255.214.64	
$BIC$	511.622,63		510.469,77	
$MAPE$	0,744%		0,038%	

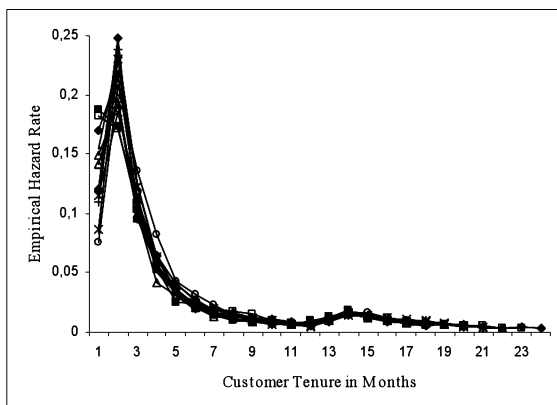
#### Figures



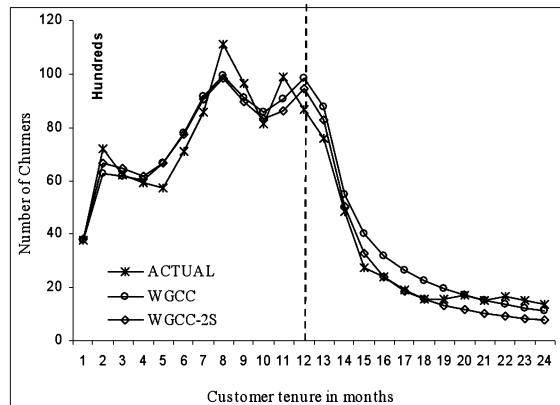
**Figure 1: Cohort-Level Retention Behavior**



**Figure 3: Actual vs. Projected Aggregate Number of Survivors**



**Figure 2: Cohort-Level Empirical Hazard Rate**



**Figure 4: Actual vs. Projected Aggregate Number of Churners**

# PRODUCT INNOVATION AND INNOVATION PERFORMANCE OF ENTERPRISES: THE CASE OF GREECE WITHIN E.U.

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## Abstract

*The aim of this paper is to examine the product innovation with regard to cooperation for innovative activities and innovative performance. Contemporary management and economic literature argues that product innovation is potentially related to firm performance (Kitsos, C. P, Hatzikian, Y., 2006). The innovative performance of Greek firms will be examined in terms of the potential relationship between the product innovation, cooperation and direct innovative output (sales) during the period 1994 to 2004. We study where innovations are developed, whether they are exclusively developed within the enterprise, whether they come from co-operation agreements or whether they are developed externally by other enterprises or organisations. In the economy of knowledge (OECD, 2001), theory and statistical data point out that innovation does not constitute an individual activity of enterprise. On the contrary the new technologies influence the total of operations and the organisation. (Kitsos, et. al., 2006). The analysis is based on the conceptual frame that developed by the EUROSTAT and the OECD (Handbooks Oslo and Frascati) and on the empirical data of CIS2, CIS3, CIS4. Therefore, we probe deep into considerations which influence the advancement of the innovation activity, through empirical evidence and statistical methodology.*

*Keywords : Innovation, performance, cooperation.*

## 1. Introduction

In the context of this paper, we examine the Greek innovating enterprises in the manufacturing and services sectors in their efforts to develop innovating activities. Furthermore, we analyze the methods of cooperation for innovation activities by partner, as a percentage of innovative enterprises, concerning Greece in comparison to E.U. Member States. The statistical data are based on Eurostat : Community Innovation Survey – CIS. The innovative performance of Greek firms is compared to EU member states, based on CIS 2, 3, 4 results, in order to identify similarities and differences in that research topic. We study where innovations are developed, whether they are exclusively developed within the enterprise, whether they come from co-operation agreements or whether they are developed externally by other enterprises or organisations. In the knowledge-driven economy, European Commission. (2004), management should strive to develop and attain a variety of objectives in all the areas where activity is critical to the operation and success of the management system. Attempting to define the concepts of innovation and based on the “Oslo Manual”, OECD (1997) and the “Innovation Results of CIS”, the main terms used are the following (Kitsos and Hatzikian, 2008) :

I. *Innovation*. An innovation is a new or significantly improved product (good or service) introduced to the market or the introduction within an enterprise of a new or significantly improved process. Innovations are based on the results of new technological developments, new combinations of existing technology or the utilisation of other knowledge acquired by the enterprise.

II. *Product innovation*. A product innovation is a product (good or service) which is either new or significantly improved with respect to its fundamental characteristics, technical specifications, incorporated software or other immaterial components, intended uses, or user friendliness. Changes of a solely aesthetic nature are not included.

III. *Process innovation*. A process innovation includes new and significantly improved production technology, methods of supplying services and of delivering products. The outcome (of the process) should be significant with respect to the level of output, quality of products or costs of production and distribution.

IV. *Research and Development Activities (R & D)*. Comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge of man, culture and society, and the use of this stock of Knowledge to devise new application.

V. *Invention*. It is an object, process or technique which displays an element of novelty. In certain circumstances, legal protection may be granted to an invention by way of a patent. By default, an ( R & D)

enterprise is an innovative firm. However, an innovative enterprise is not necessarily either an R&D performer or entrepreneur.

VI. Enterprises with innovation activity. Enterprises that have had any kind of innovation activity during the survey period, i.e. have introduced or implemented new products and/or processes, had abandoned innovation activity, or had on-going innovation activity.

VII. Enterprises without innovation activity. Those enterprises that had no innovation activity.

In the framework of this paper, the sources of information for innovation are classified as a result of a technological push from within the enterprise (internal sources) or a commercial push from suppliers and competitors or a commercial pull from customers (external sources). Thus, the precise sources of information studied in the context of this paper are the following (Kitsos and Hatzikian, 2006) :

In the framework of this paper, the different types of cooperation for innovation activities are classified as a result of a technological push from within the enterprise (internal sources) or a commercial push from suppliers and competitors or a commercial pull from customers (external sources). Thus, the precise types of partners of cooperation for innovation activities studied in the context of this paper are the following :

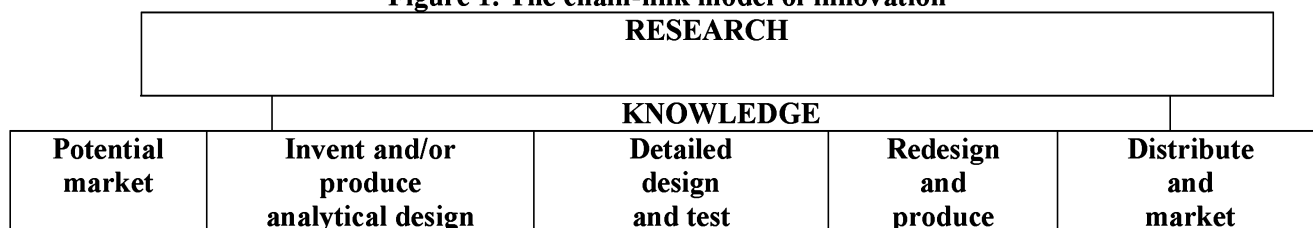
- a. Internal partners : Other enterprises within the enterprise group.
- b. Market partners : Suppliers of equipment, materials, components or software, Clients or customers and Competitors and other enterprises from the same industry.
- c. Institutional partners : Universities or other higher education institutes, Government or public research institutes.
- d. Other partners : Consultants, commercial labs or private R&D institutes.

## 2. The Theoretical Framework

Technological innovation is vital for firm's competitive advantage. One of the features of the New Economy is that in the transformation process, the major input is intellectual property: knowledge, research, information and design. These inputs have supplanted (in value) the material inputs required to build physical units. Therefore, there is no doubt that in 'knowledge-based economy' essential role plays the systematic application of the scientific knowledge to new product, process or service. The emphasis in the literature is clearly on an increasing relevance of knowledge and innovation as an input to production and innovative processes (OECD, 2001). As to innovation management, the first explicit theory is the "technology push theory or engineering theory of innovation". According to this theory, basic research and industrial R&D are the sources of new or improved products and processes. An alternative view, in the 1960s, gave birth to the "market pull theory of innovation". This theory still gives a central role to research as a source of knowledge to develop or improve products and processes. Moreover adopts the first recognition of organisational factors, as contributors in innovation theory; the technical feasibility was still considered as a necessary condition of innovation, but no longer sufficient in itself for successful innovation (Schmookler, 1996; Myers and Marquis, 1969).

A new generation called the "chain-link theories" of innovation then emerged to explain the fact that linkages between knowledge and market are not as automatic as assumed in the engineering and market pull theories of innovation (Von Hippel, 1994). At the end of the 1980s and during the 1990s, a technological networks theory of innovation management was developed by a new group of experts under the title of "systems of innovation". This view stressed the importance of sources of information that are external to the firm: clients, suppliers, consultants, government laboratories, government agencies, universities, etc (Nelson, 1993; OECD, 1999).

Figure 1. The chain-link model of innovation



Source : OECD, (1997), Oslo Manual : The Measurement of Scientific and Technological Activities , OECD-EUROSTAT, p.24.

The Chain Link model and the National Systems of Innovation (NSI) approach are the main streams on which the analysis regarding the sources of information for innovation is based, in the context of this paper.

The chain-link model conceptualises innovation in terms of interaction between market opportunities and the firm's knowledge base and capabilities. A key element in determining the success (or failure) of an innovation project is the extent to which firms manage to maintain effective links between phases of the innovation process: the model emphasizes, for instance, the central importance of continuous interaction between marketing and the invention/design stages (Freeman, C. 1982). Finally, "the social network theory" of innovation management states that knowledge plays a more crucial role in fostering innovation. The growing importance of knowledge as a production factor and as a determinant of innovation can be explained by the continuous accumulation of technical knowledge over time, and by the use of communications technologies that make that knowledge available very rapidly on a worldwide scale (Foray, 2000).

### 3. The innovation context and cooperation in Greece

In this section, we analyze the Greek innovating enterprises in the manufacturing and services sector in their efforts to develop innovating activities. The statistical data concerning innovation, R&D expenditure etc are based on Eurostat : Community Innovation Survey - CIS 2, 3, and 4. The innovation indexes are rather a new discipline in the Greek statistical system, when measuring industrial indexes. That is why only recent data can be provided and analyzed.

The results of the innovation context in Greece presented in Tables 1 and 2 are based on the Greek Community Innovation Survey (CIS 2, 3, 4). In Table 1 the size of companies included varies with smaller companies included in the survey for the period 1998-2000 and for 2002-2004.

**Table 1 : Innovation Indicators: Manufacturing enterprises : Greece**

Indicators	1994-96*	1996-98*	1998-00**	2002-2004**
	% Share in total population	% Share in total population	% Share in total population	% Share in total population
Enterprises with innovation activity	26,50	30,30	27,3	35,1
Product innovators	22,5	25,2	18,4	24,9
Process innovators	18,5	23,7	17,5	30,9
Intramural R&D	20,6	21,2	25,3	18,1
Research and experimental development - R&D	15,8	18,9	20,0	na
Continuous R&D	5,1	7,1	9,4	10,6
Occasional R&D	10,7	11,8	na	na
Enterprises with Cooperation arrangements on innovation activities	4,7	6,5	5,1	20,6
Product innovators that introduced new or improved products to the market	10,4	14,0	10,3	15,6

Sources : CIS 2, 3, 4, Eurostat

\*>20 employees ; \*\*> 10 employees

The statistical data "enterprises with innovation activity", "product innovators", "process innovators", etc., show a decline. This decline is related to more small enterprises being included in the survey for the period 1998-2000. The small enterprises in Greece with more than 10 and less than 20 employees do not tend to innovate and, therefore, affects the percentage of the Greek firms with innovation activity. Each of the indicators is the percentage (share) of the total population of the CIS of each period. We present the main figures we collected concerning the Greek industry, as far as innovation concerns. The statistical analysis of innovation has been extensively discussed by Kitsos *et al.* (2006) and Kitsos and Hatzikian, (2005).

Table 1 indicates that there is a small improvement for the Greek industry, as far as competitiveness concern. The innovative manufacturing enterprises represent the 26,5% in the first period (1994-96), the 30,3% in the second period (1996-98), the 27,3% in the third period (1998-00) and the 35,1% in the fourth period (2002-2004). Product innovators represented the 22,5% in the first period, the 25,2% in the second period, the 18,4% in the third period, and the 24,9% in the fourth period. Process innovators represented the 18,5% in the first period, the 23,7% in the second period, the 17,5% in the third period and the 30,9% in the fourth period. These estimators might provide evidence for a contradiction to the above mentioned result. But when

new or improved products are entering to the market the innovation indexes are relatively low: 10,4% in the first period, the 14,0% in the second period and the 10,3% in the third period and the 15,6% in the fourth period.

**Table 2 : Innovation Indicators : Service enterprises with 10 or more employees : Greece**

Indicators	1994-96	1996-98	1998-00	2002-2004
	% Share in total population	% Share in total population	% Share in total population	% Share in total population
Enterprises with innovation activity	11,1	15,50	31,9	36,7
Intramural R&D	4,2	6,2	6,6	19,2
Research and experimental development - R&D	8,3	13,0	16,1	na
Continuous R&D	5,6	5,6	10,5	10,1
Occasional R&D	2,8	7,5	na	na
Enterprises with Cooperation arrangements on innovation activities	6,3	5,6	12,8	9,5

Sources : CIS 2, 3, 4, Eurostat

Only a small number of Greek private companies (from the collected data 16 in number!) are adopting innovation for products and processes successfully commercially and technically. The public funds improved innovation, without successful consequences, see Table 1. This might be called as a “Greek innovation paradox”, and it extensively discussed by Kitsos *et al.* (2006) and Kitsos and Hatzikian, (2006).

In Table 2 the share of innovative enterprises in the Greek service industry increased significantly. It was 11,1% the first period and increased to 15,5% in the second period and there is a sharp increase to 31,9% the third period and keeps on increasing to the 36,7% in the fourth period of the enterprises with 10 or more employees. The service industry shows the low increase of 15% from 1994-1996 to 2002-2004 while the industry performs a 28% increase for the same period. Still it is worth mentioning that from 1994-1996 to 2002-2004 the total increase is better for services than manufacturing (see Tables 1 and 2). Greece is lagging behind comparing to all 15 member states for 2000 and for 2004 (Table 3). The position of Greece was drastically improved exceeding only Spain (34,7%), France (32,5%), and the Netherlands (34,3%). This is evident that the Greek industry improves its competitiveness and tries to reduce the gap with the European industry.

**Table 3: Percentage (%) of enterprises with innovation activity in total. E.U. member states : 1998-2004**

E.U. member states	1998-2000	2002-2004	Change (%)
<b>Country -15</b>	44,0	45,1	2,5
Austria	49,0	52,5	7,1
Belgium	50,0	51,3	2,6
Denmark	40,0	52,0	30,0
Finland	45,0	43,3	-3,8
France	41,0	32,5	-20,7
Germany	61,0	65,1	6,7
<b>Greece</b>	27,3	35,8	31,1
Ireland	65,0	52,5	-19,2
Italy	36,0	36,3	0,8

E.U. member states	1998-2000	2002-2004	Change (%)
Luxembourg	48,0	52,2	8,8
The Netherlands	45,0	34,3	-23,8
Portugal	46,0	40,9	-11,1
Spain	33,0	34,7	5,2
Sweden	47,0	50,0	6,4
The United Kingdom	36,0	43,0	19,4

Sources : EUROSTAT -CIS 3 & 4.

Nevertheless, the gap with the other European countries remains (and is more probable that will remain) statistically significant. The average of European Union is at 44,0% for 2000 and 45,1% for 2004. Ireland holds the maximum percentage (65,0%) and Greece the minimum one (27,3%) for 2000. In 2004, Germany holds the maximum percentage (65,1%) and France the minimum one (32,5%).

In total, from table 3, although Greece is still well behind, it shows an improvement of its innovation performance, while other countries reduce the innovation activity.

#### 4. Empirical results of cooperation for innovation activities

In this section, we analyze the methods of cooperation for innovation activities by partner, as a percentage of innovative enterprises, concerning Greece in comparison to E.U. Member States. The statistical data are based on Eurostat : Community Innovation Survey – CIS. One very efficient form of knowledge transfer is cooperation. "Innovation cooperation" means active participation with other enterprises or non-commercial institutions on innovation activities. There is no need for both partners to benefit commercially, but pure contracting-out of work with no active cooperation is excluded.

The CIS 4 questionnaire draws a distinction between seven different partners for cooperation:

- Other enterprises in your enterprise group;
- Competitors or other enterprises in the same sector;
- Clients or customers;
- Suppliers of equipment, materials, components or software;
- Universities or other higher education institutions;
- Government or public research institutes;
- Consultants, commercial labs or private R&D institutes.

Table 4 show the percentages of innovative enterprises by country for each category of partner.

The proportion of innovative enterprises that cooperate with other enterprises in the same group varies between 23% in Finland and 3% in Italy. In Greece, only the 3,5% of the innovative enterprises cooperate with other enterprises in the same group. In Finland more than one out of every three enterprises (34%) cooperate with competitors or other enterprises in the same sector. Behind Finland, the highest scores for this kind of cooperation were recorded in Denmark (15,0%) and in France (14,0%). The proportion of the Greek innovative enterprises that cooperate with competitors or other enterprises in the same sector is 12,0%. The smallest score for this category of partner was found in Spain with 2,5%.

**Table 4:** Methods of cooperation by partner, as a percentage of innovative enterprises, by country, EU-15, 2002- 2004

	Other enterprises within group	Competitors	Clients	Suppliers	Universities	Government	Consultants
E.U. average	11,7	10,8	14,9	19,9	11,1	6,8	12,4
Austria	7,0	4,0	7,5	7,5	10,0	5,0	7,5
Belgium	17,0	10,0	10,0	26,0	17,0	8,0	15,0

	Other enterprises within group	Competitors	Clients	Suppliers	Universities	Government	Consultants
Cyprus	6,0	12,5	4,0	25,0	2,5	2,0	16,0
Denmark	18,0	15,0	7,5	27,0	18,0	6,5	18,0
France	17,0	14,0	20,0	20,0	10,0	7,5	12,5
Germany	5,0	4,0	7,5	7,0	8,0	4,0	2,5
Greece	3,5	12,0	7,5	11,0	6,5	2,5	6,5
Ireland	17,0	6,0	25,0	23,0	10,0	6,0	10,0
Italy	3,0	5,0	5,0	7,5	5,0	1,5	6,5
Netherlands	17,5	12,5	22,0	30,0	12,5	9,0	15,0
Portugal	6,0	7,0	12,0	14,0	7,5	5,0	8,0
Spain	4,0	2,5	4,0	10,0	5,0	5,0	4,0
Sweden	17	11,0	27,5	32,0	17,5	6,0	20
Finland	23,0	34,0	41,0	40,0	37,0	26,0	32,5
Un. Kingd	15,0	12,0	23,0	22,5	10,0	7,5	12,5

Sources : EUROSTAT -CIS 4.

Whereas in Spain only 4% of the enterprises with innovative activities cooperate with their clients or customers, in Finland 41% do so. In Greece, only the 7,5% of the innovative enterprises cooperate with suppliers of equipment, materials, components or software. The most successful form of cooperation seems to be with suppliers of equipment, materials, components or software. Finland is in the lead with 40%, followed by Sweden (32%), Netherlands (30%), Denmark (27,0%), Belgium (26,0%) and Cyprus (25,0%). In Greece, only the 11,0% of the innovative enterprises cooperate with suppliers of equipment, materials, components or software. By contrast, the lowest figures for cooperation with suppliers was recorded in Italy (7,5%), Austria (7,5%) and Germany (7%). Compared with suppliers, universities or other higher education institutions are in less demand as cooperation partners.

Finland's innovative enterprises – which are very active in all types of cooperation and recorded the highest scores for all categories of cooperation partner – were also in the lead for cooperation with higher education on 37,0%. Behind Finland, the highest scores for this kind of cooperation were recorded in Denmark (18,0%), Sweden (17,5%), and in Belgium (17,0%). This form of cooperation is almost non-existent in Cyprus, where it is practised by just 2% of the innovative enterprises. In Greece, only the 6,5% of the innovative enterprises cooperate with higher education.

Worse still are the results for cooperation with government or public research institutes. 26% of Finnish innovative enterprises use this type of cooperation, but in most other countries the percentages are very low. In Italy the share of this category of partner does not even reach 2%. In Greece, only the 2,5% of the innovative enterprises cooperate with government or public research institutes.

Table 4 demonstrates the weak cooperation between the public and private sectors on innovation. Nevertheless this kind of cooperation is very important for knowledge transfer, a key component of innovation. It seems necessary to strengthen cooperation between the business enterprise sector and both the government and the higher education sectors.

Inside the private sector cooperation seems to be easier because more enterprises choose consultants, commercial labs or private R&D institutes as partners. In Finland nearly one third of the innovative enterprises do so (32,5%). Behind Finland, the highest scores for this kind of cooperation were recorded in Sweden (20,0%), and in Denmark (18,0%). In Greece, only the 6,5% of the innovative enterprises cooperate with consultants, commercial labs or private R&D institutes. By contrast, only 2,5% of German innovative enterprises and 4,0% of Spain innovative enterprises are involved in this form of cooperation.

To summarise the results on cooperation and the different methods, it should be said that the innovative enterprises do cooperate but could do to a much greater degree. As the situation with cooperation varies

along with the methods and across countries, it needs to be studied in detail. It is important to identify the barriers to cooperation in order to introduce the necessary reforms and other action to encourage cooperation (Kitsos and Hatzikian, 2005).

## 5. Conclusions

Knowledge transfer must improve in order to accelerate the exploitation of research and the development of new products and services. To that end, European universities and other public research institutions should be given incentives to develop skills and resources to collaborate effectively with business and other stakeholders, both within and across borders. A major hindrance is the inconsistent, and often inadequate, rules and approaches for managing intellectual property rights (IPR) resulting from public funding. The Commission has identified good practice and models of knowledge-sharing between the public research base and industry which will serve to inspire further action at both EU and national levels. Besides and closely linked to information, another key topic has emerged in the ongoing discussion on innovation: knowledge transfer. There is no doubt that knowledge creation, the main business of higher education, is essential. However, if this knowledge is to be useful it has to be applied to the walks of life where it can make a difference. Knowledge needs to be transferred. The main way in which knowledge is transferred from higher education to the wider world is via the expertise and experience built up by graduates. However, small companies which could benefit from the knowledge of a highly skilled graduate but have a small workforce are reluctant to take on graduates. Knowledge is transferred whenever the findings or works of academics are disseminated more widely (Hatzikian, 2007).

There are many ways in which this can be done. One key way that knowledge can be spread is via the training that higher education offers to industry. Creating stronger links between universities and businesses is a major aim of Europe's innovation policy. One step in this direction is commercialisation of research. This is the process of getting ideas which have a commercial application out of the laboratories and into the marketplace. Commercialisation does not exclusively concern technology. Creative arts and social sciences also have the potential to generate profitable commercial activity.

Interactions between the public research base and industry have been gradually increasing over the past decade. These can vary from contractual research to collaborative research or even to structured partnerships. Most of these interactions involve the transfer of knowledge between the stakeholders concerned and enhance the socio-economic impact of publicly funded research, e.g. by creating new useful products, new jobs and sometimes new companies (Bouris J. and Chatzikian Y., 2006). The analysis set out in this paper constitute a starting point for discussions on a common framework for knowledge transfer in order to create a level playing field and a more coherent landscape for knowledge transfer. Furthermore, the results presented in this paper are intended to help research institutions identify shared interests with industry and facilitate mutually beneficial knowledge transfer arrangements. Major policy initiatives in this area should taken by Greece and other Member States and should be reflected in the planning and the implementation in action reform plans, promoting the exchange of good practice in the innovation an cooperation subject area.

The knowledge economy represents new opportunities and requires some design actions to support and take advantage of this economy and the Greek firms have to realize this. It is the firm that organizes the creation of value (Kitsos and Hatzikian 2006). In principle, the shortening of product cycles, firms face the need for more capital-intensive investment and must put more emphasis on the ability to react quickly. For the Greek firms, innovation is a crucial means to create competitive advantage and superior customer value. Except for certain types of technology-based firms, the focus is not on the technological aspects of new product development, but on innovative ways to improve their position in the market. Innovation takes many forms (Hatzikian, 2007). There is technological innovation, but also innovation through new business models and new ways of organizing work, innovation in design and in marketing. Innovation can also consist of finding new uses and new markets for existing products and services.

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# ASSESSING THE GLOBAL TRADE COMPETITIVENESS OF GREEK WINE

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## Abstract

*This paper deals with an ex-post evaluation of the long-term competitiveness performance (years 1961-2006) of Greek wine on the basis of foreign trade information.*

*Methodologically, competitiveness assessment is estimated by the calculation of global trade indices, i.e. trade flows, trade balance, import coverage index, relative comparative advantage or Balassa index, import penetration index, etc. and by examining of the evolution of their size. For the research needs, FAOSTAT time-series compiled data is used.*

*These indices are presented in diagrams and their trends are investigated by employing the ordinary least squares regression method and by examining various algebraic forms in order to select the best fitted ones.*

*Finally, an overall discussion of the Greek wine competitiveness findings is presented and strategic global trade future orientations are proposed.*

*Key-words: Analysis of time-series, competitiveness indices, exterior trade, wine.*

## 1. Introduction

“From the earliest times, wine has been exported from one country to another. Evidence has been found that the ancient Greeks transported their wine by ship in the 3<sup>rd</sup> century B.C.” (Wagner, Olsen and Thach 2007, p. 283)

Wine, although is a traditional product in the agro-food economy of Greece, faces serious competitiveness problems in the international context due to economic globalisation and trade liberalisation.

This product is exportable and used to be important for the balance of payments and foreign trade.

However, wine is still generating local value added and employment in rural areas of Greece.

Greek wine competitiveness adaptation is necessary, together with concentration on quality and specialty products, by making best use of the comparative advantages of the country.

The meaning of competitiveness is wide and varies. Competitiveness analysis depends mainly on the target and on the level of investigation, e.g. for the overall economy, for a particular sector and for a specific product (or a product mix) (Maclaren 1991, McFetridge 1995).

The present approach adopted here is based on the calculation of appropriate indices concerning the capability of a country (Greece) to offer specific product (wine), in a particular market (domestic), at the same price or at better prices than those from the other supplier countries (aggregate data of export and import values are used) (Frohberg and Hartmann 1997, Porter 1998, Oster 1999, Baltas 2000). For this purpose, the external trade performance is studied.

## 2. Methodology

The measurement of the wine sector's competitiveness is based on calculation of the trend of twelve (12) representative indices showing the external trade dynamism and its performance.

These are, as follows: trade flows in quantities, trade flows in values, trade balance in quantities, trade balance in values, the import quantities coverage index, the import values coverage index, the import quantities penetration index, the import values penetration index the relative comparative advantage in quantities, the relative comparative advantage in values (Balassa indices), excess value of imports vs. value of exports per unit and terms of trade (Kaldis 2003).

Trade flows is the algebraic equivalent of exports quantities (or value) plus imports quantities (or value) for a particular year of reference. It shows the sector's supply chain of external trade continuity and level of importance in terms of volume (or currency).

Trade balance is the algebraic equivalent of exports quantities (or value) minus imports quantities (or value) for a particular year of reference. It shows gains or losses from external trade. A positive trade balance contributes to the national economy from various points of view, e.g. strengthen the productive basis and

bring foreign currency. A negative trade balance means expatriation of foreign currency in order to cover local needs, as well as dependence of the country on foreign productive bases.

The import coverage index is a percentage index showing the dynamism of exports quantities (or value) performance in order to cover the country's spending for imports for a particular year of reference (= exports quantities or value/imports quantities or value \* 100).

The import penetration index shows the performance of imports quantities (or value) in a specific country in relation to the country's "resistance" expressed on the sum of exports and imports. It is equal to: imports quantities or value/(exports quantities or value + imports quantities or value).

The relative comparative advantage index (also known as Balassa Index in honour of the person who introduced it in trade analysis) is a specialisation index and is calculated by the formula: (exports quantities or value - imports quantities or value)/(exports quantities or value + imports quantities or value). Prices range between -1.0 (exports quantities or value is zero) to +1.0 (imports quantities or value is zero). When import quantities or value is equal to the quantities or value of exports, the index's figure is 0. Negative sign of the index means lack of competitiveness.

Excess value of imports vs. value of exports per unit index is the algebraic equivalent of exports value per unit minus the exports value per unit for a particular year of reference. It shows the value significance of exports or imports value per unit.

Terms of trade shows the performance of imports values per unit in relation to the corresponding exports values per unit (=imports values per unit/exports values per unit).

The data used for the above calculations derive from FAOSTAT/FAO Statistics Division (29-09-2009).

In order to estimate the trendline of the above referred trade indices in Greece for the period 1961-2006, based on FAOSTAT data, it is assumed that these variables are related – ceteris paribus – with time (Intriligator, 1983, pp. 120-121).

Then, the relationship is estimated by applying a simple regression analysis (Robinson 1998).

The simple regression analysis is the widely used statistical procedure for the estimation of the average relationship between a dependent variable (Y: specific trade index) and an independent one (time).

This analysis, which is based on the method of ordinary least squares, attempts to find a line (regression line) where the sum of the squares of the errors takes the smallest possible value.

The simple regression analyses were conducted by simple means, i.e. EXCEL trendline routine (Papathanasiou 2005).

The estimation, of the statistically significant parameters of the derived functions, permits projections (Chalikias 2001). This helps the risk minimisation for the Greek wine global trade decision-making prospects.

### 3. Findings

The equations of the fitted models for the Greek wine competitiveness indices are as follows:

Competitiveness Index	Trend Line Algebraic Form
Trade Flows - Volume (th. tonnes)	$y = 0,0025x^6 - 0,3357x^5 + 17,005x^4 - 381,71x^3 + 3328,8x^2 - 1376,2x + 13954$ $R^2 = 0,3912$
Trade Flows - Value (th. US \$)	$y = 1008,6x^{1,1012}$ $R^2 = 0,9081$
Trade Balance - Volume (th. tonnes)	$y = 0,0016x^6 - 0,2131x^5 + 9,978x^4 - 194,63x^3 + 1086,4x^2 + 7955,3x + 4754,9$ $R^2 = 0,4398$
Trade Balance - Value (th. US \$)	$y = 1287,7x^{0,9542}$ $R^2 = 0,7934$
Import Coverage Index - Volume (%)	$y = 73121e^{-0,1199x}$ $R^2 = 0,6524$
Import Coverage Index -	$y = 8972,3e^{-0,0772x}$

Competitiveness Index	Trend Line Algebraic Form
Value (%)	$R^2 = 0,7264$
Import Penetration Index - Volume (%)	$y = 0,1444e^{0,1137x}$ $R^2 = 0,6619$
Import Penetration Index - Value (%)	$y = 1,1712e^{0,07x}$ $R^2 = 0,732$
Relative Comparative Advantage - Volume (Balassa Index)	$y = -5E-09x^6 + 8E-07x^5 - 5E-05x^4 + 0,0014x^3 - 0,0167x^2 + 0,0688x + 0,9325$ $R^2 = 0,6547$
Relative Comparative Advantage - Value (Balassa Index)	$y = -5E-09x^6 + 7E-07x^5 - 4E-05x^4 + 0,0011x^3 - 0,0129x^2 + 0,0543x + 0,9101$ $R^2 = 0,7348$
Terms of Trade	$y = -3E-07x^6 + 4E-05x^5 - 0,0024x^4 + 0,0645x^3 - 0,8146x^2 + 3,895x + 4,2428$ $R^2 = 0,5823$
Excess value of imports vs. value of exports per unit (US \$/tonne)	$y = -6E-08x^6 + 9E-06x^5 - 0,0004x^4 + 0,0102x^3 - 0,102x^2 + 0,3528x + 0,6021$ $R^2 = 0,4457$

It is known that the estimations and examination of the competitiveness indices can show the performance of an industry and the degree to which it can cope with differentiated commercial challenges (Salinger 2000). The derivation of these indices (appendix: Table 2 and 3) is based on the relevant Greek wine trade data presented in appendix: Table 1.

The evolution of these indices is also illustrated in a diagrammatic form in appendix: Figures 1 and 2.

It is obvious, that the evolution of the competitiveness indices of Greek wine showed a negative trade performance and a dramatic degradation of trade performance due to an effective and rapid import penetration for the period of reference 1961-2006.

#### 4. Conclusions and Recommendations

The overall analysis shows the deep problems of the Greek wine global trade performance. The Greek wine sector had to face a competitive trade environment.

The response of the Greek wine trade to the wider market is rather problematic and distressing.

This response is the result of inadequate preparation of the Greek wine industry to deal with the challenge of a wider and more competitive wine market that operates with higher standards concerning quality, price competition and availability of wine compared to the domestic market of Greece.

Due to these defects, imports displacing domestic products and the competitiveness indices declined.

For reversing this situation and for achieving competitiveness, there is a need for structural changes aiming at the modernisation of the wine production and marketing system, the best use of cooperative action and the employment of activities that result in differentiated and high quality wine products that embody value added services.

This must be based on a well-balanced sectoral strategic plan, concerning the mobilisation and coordination at all components across the Greek wine value chain.

If a concerted action to that effect is not undertaken, one can reasonably expect that under the conditions of the globalised market the situation of the Greek wine sector will deteriorate.

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## Appendix

**Table 1: Greek Wine External Trade Data, Years 1961-2006**

Year	Exports Quantities (th. tonnes)	Exports Value (th. US \$)	Exports Value per Unit (US \$/tonne)	Imports Quantities (th. tonnes)	Imports Value (th. US \$)	Imports Value per Unit (US \$/tonne)
1961	21915	2412	0,11	52	50	0,96
1962	25172	2876	0,11	50	47	0,94
1963	32980	3496	0,11	70	74	1,06
1964	26935	3672	0,14	70	64	0,91
1965	47499	5484	0,12	61	66	1,08
1966	56604	5811	0,10	87	98	1,13
1967	55566	5828	0,10	99	110	1,11
1968	82216	6923	0,08	86	99	1,15
1969	91403	8880	0,10	98	115	1,17
1970	116157	12046	0,10	1830	293	0,16
1971	88776	11159	0,13	2138	316	0,15
1972	76285	11144	0,15	1203	327	0,27
1973	91569	19757	0,22	38893	5542	0,14
1974	57918	16099	0,28	25779	4042	0,16
1975	99488	22694	0,23	613	348	0,57
1976	75022	19191	0,26	230	533	2,32
1977	88612	22928	0,26	274	530	1,93
1978	86231	25974	0,30	422	947	2,24
1979	91811	33638	0,37	280	724	2,59
1980	25502	17802	0,70	270	708	2,62
1981	22335	17893	0,80	250	680	2,72
1982	23754	18136	0,76	320	667	2,08
1983	19947	18314	0,92	352	968	2,75
1984	44023	19052	0,43	468	915	1,96
1985	129078	32496	0,25	700	971	1,39
1986	96030	42110	0,44	496	950	1,92
1987	69477	49263	0,71	929	2432	2,62
1988	41687	30921	0,74	1395	3466	2,48
1989	92067	52186	0,57	3777	7055	1,87
1990	93005	64742	0,70	5428	10642	1,96
1991	58564	52477	0,90	7655	13495	1,76
1992	62107	75714	1,22	5424	11202	2,07
1993	52043	57921	1,11	4959	10898	2,20
1994	54610	58910	1,08	4222	9907	2,35
1995	54411	74543	1,37	3967	11043	2,78
1996	48464	71334	1,47	3957	10624	2,68
1997	46206	69890	1,51	4025	10447	2,60
1998	59342	75782	1,28	4664	10893	2,34
1999	49266	69447	1,41	6984	14521	2,08
2000	42973	58058	1,35	6287	13353	2,12
2001	55261	45125	0,82	7285	15296	2,10
2002	29071	47659	1,64	10718	41564	3,88
2003	36445	72792	2,00	30460	25076	0,82
2004	35044	78605	2,24	24351	30673	1,26
2005	33637	71562	2,13	13315	28821	2,16
2006	31721	69484	2,19	16027	33776	2,11

Source: FAOSTAT Database compiled data

**Table 2: Competitiveness Indices of Greek Wine, Years 1961-2006**

Year	Trade Flows Volume (th. tonne)	Trade Flows Value (th. US \$)	Trade Balance Volume (th. tonne)	Trade Balance Value (th US \$)	Import Coverage Index - Volume (%)	Import Coverage Index - Value (%)
1961	21967	2413	21863	2362	42144,231	4824,00
1962	25222	2877	25122	2829	50344,00	6119,15
1963	33050	3497	32910	3422	47114,29	4724,32
1964	27005	3673	26865	3608	38478,57	5737,50
1965	47560	5485	47438	5418	77867,21	8309,09
1966	56691	5812	56517	5713	65062,07	5929,59
1967	55665	5829	55467	5718	56127,27	5298,18
1968	82302	6924	82130	6824	95600,00	6992,93
1969	91501	8881	91305	8765	93268,37	7721,74
1970	117987	12046	114327	11753	6347,38	4111,26
1971	90914	11159	86638	10843	4152,29	3531,33
1972	77488	11144	75082	10817	6341,23	3407,95
1973	130462	19757	52676	14215	235,44	356,50
1974	83697	16099	32139	12057	224,67	398,29
1975	100101	22695	98875	22346	16229,69	6521,26
1976	75252	19193	74792	18658	32618,26	3600,56
1977	88886	22930	88338	22398	32340,15	4326,04
1978	86653	25976	85809	25027	20433,89	2742,77
1979	92091	33641	91531	32914	32789,64	4646,13
1980	25772	17805	25232	17094	9445,19	2514,41
1981	22585	17896	22085	17213	8934,00	2631,32
1982	24074	18138	23434	17469	7423,13	2719,04
1983	20299	18317	19595	17346	5666,76	1891,94
1984	44491	19054	43555	18137	9406,62	2082,19
1985	129778	32497	128378	31525	18439,71	3346,65
1986	96526	42112	95534	41160	19360,89	4432,63
1987	70406	49266	68548	46831	7478,69	2025,62
1988	43082	30923	40292	27455	2988,32	892,12
1989	95844	52188	88290	45131	2437,57	739,70
1990	98433	64744	87577	54100	1713,43	608,36
1991	66219	52479	50909	38982	765,04	388,86
1992	67531	75716	56683	64512	1145,04	675,90
1993	57002	57923	47084	47023	1049,47	531,48
1994	58832	58912	50388	49003	1293,46	594,63
1995	58378	74546	50444	63500	1371,59	675,02
1996	52421	71337	44507	60710	1224,77	671,44
1997	50231	69893	42181	59443	1147,98	669,00
1998	64006	75784	54678	64889	1272,34	695,69
1999	56250	69449	42282	54926	705,41	478,25
2000	49260	58060	36686	44705	683,52	434,79
2001	62546	45127	47976	29829	758,56	295,01
2002	39789	47663	18353	6095	271,24	114,66
2003	66905	72793	5985	47716	119,65	290,29
2004	59395	78606	10693	47932	143,91	256,27
2005	46952	71564	20322	42741	252,62	248,30
2006	47748	69486	15694	35708	197,92	205,72

Source: FAOSTAT Database compiled data

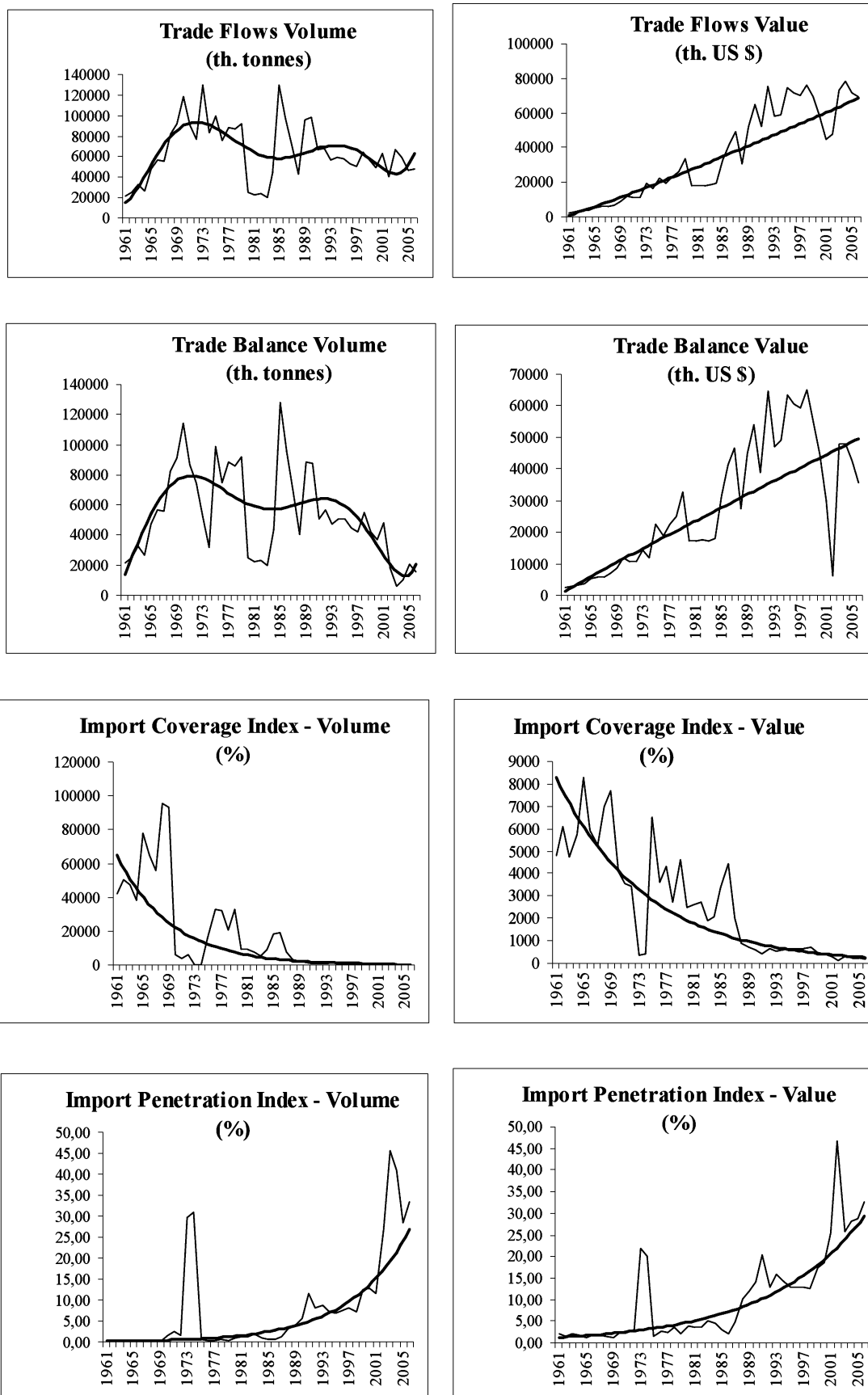
**Table 3: Competitiveness Indices of Greek Wine, Years 1961-2006**

Year	Import Penetration Index - Volume (%)	Import Penetration Index - Value (%)	Relative Comparative Advantage – Volume (Balassa Index)	Relative Comparative Advantage - Value (Balassa Index)	Excess value of imports vs. value of exports per unit (US \$/tonne)	Terms of Trade
1961	0,24	2,03	1,00	0,96	0,85	8,74
1962	0,20	1,61	1,00	0,97	0,83	8,23
1963	0,21	2,07	1,00	0,96	0,95	9,97
1964	0,26	1,71	0,99	0,97	0,78	6,71
1965	0,13	1,19	1,00	0,98	0,97	9,37
1966	0,15	1,66	1,00	0,97	1,02	10,97
1967	0,18	1,85	1,00	0,96	1,01	10,59
1968	0,10	1,41	1,00	0,97	1,07	13,67
1969	0,11	1,28	1,00	0,97	1,08	12,08
1970	1,55	2,37	0,97	0,95	0,06	1,54
1971	2,35	2,75	0,95	0,94	0,02	1,18
1972	1,55	2,85	0,97	0,94	0,13	1,86
1973	29,81	21,91	0,40	0,56	-0,07	0,66
1974	30,80	20,07	0,38	0,60	-0,12	0,56
1975	0,61	1,51	0,99	0,97	0,34	2,49
1976	0,31	2,70	0,99	0,95	2,06	9,06
1977	0,31	2,26	0,99	0,95	1,68	7,48
1978	0,49	3,52	0,99	0,93	1,94	7,45
1979	0,30	2,11	0,99	0,96	2,22	7,06
1980	1,05	3,82	0,98	0,92	1,92	3,76
1981	1,11	3,66	0,98	0,93	1,92	3,40
1982	1,33	3,55	0,97	0,93	1,32	2,73
1983	1,73	5,02	0,97	0,90	1,83	3,00
1984	1,05	4,58	0,98	0,91	1,52	4,52
1985	0,54	2,90	0,99	0,94	1,14	5,51
1986	0,51	2,21	0,99	0,96	1,48	4,37
1987	1,32	4,70	0,97	0,91	1,91	3,69
1988	3,24	10,08	0,94	0,80	1,74	3,35
1989	3,94	11,91	0,92	0,76	1,30	3,30
1990	5,51	14,12	0,89	0,72	1,26	2,82
1991	11,56	20,46	0,77	0,59	0,87	1,97
1992	8,03	12,89	0,84	0,74	0,85	1,69
1993	8,70	15,84	0,83	0,68	1,08	1,97
1994	7,18	14,40	0,86	0,71	1,27	2,18
1995	6,80	12,90	0,86	0,74	1,41	2,03
1996	7,55	12,96	0,85	0,74	1,21	1,82
1997	8,01	13,00	0,84	0,74	1,08	1,72
1998	7,29	12,57	0,85	0,75	1,06	1,83
1999	12,42	17,29	0,75	0,65	0,67	1,47
2000	12,76	18,70	0,74	0,63	0,77	1,57
2001	11,65	25,32	0,77	0,49	1,28	2,57
2002	26,94	46,58	0,46	0,07	2,24	2,37
2003	45,53	25,62	0,09	0,49	-1,17	0,41
2004	41,00	28,07	0,18	0,44	-0,98	0,56
2005	28,36	28,71	0,43	0,43	0,04	1,02
2006	33,57	32,71	0,33	0,35	-0,08	0,96

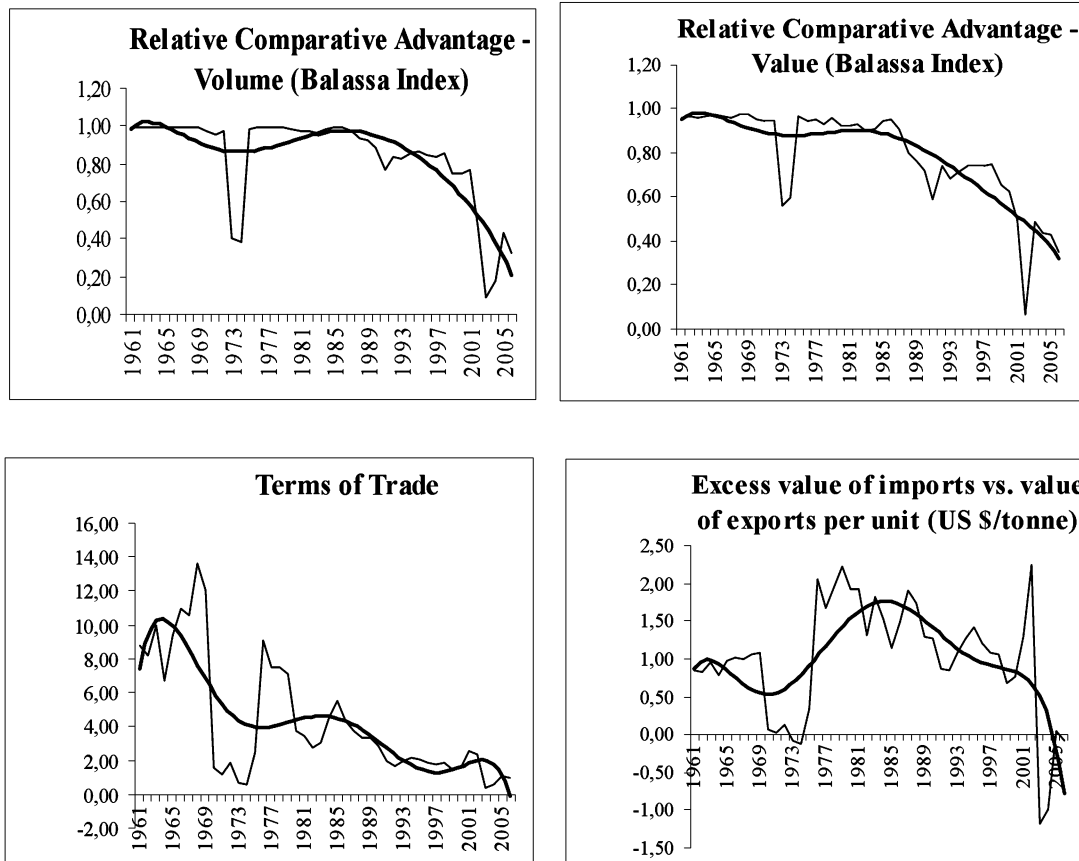
Source: FAOSTAT Database compiled data



Figure 1: Competitiveness Indices of Greek Wine, Years 1961-2006



**Figure 2: Competitiveness Indices of Greek Wine, Years 1961-2006**



# ERP PROJECTS FAILURE: ANALYSIS OF CRITICAL FACTORS BASED ON INTERNATIONAL EXPERIENCE

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## Abstract

*ERP (Enterprise Resource Planning) Projects usually confront many problems at different stages of their implementation process, often leading to partial or complete failure of the implementation itself or their productive operation, with sometimes disastrous results for the enterprise or the organization involved. There are many factors causing these problems. Our research attempts to indicate the most significant, after the analysis of 30 ERP projects failure all over the world. Our analysis, found that the leading factors causing the failure of an ERP project, are the wrong project designing and inadequacies in its management. As important factors have been identified, the lack of the support from the organization staff and the staff training, as well as factors related to inadequacies in the infrastructure and software and the ERP support after its productive operation. Finally, based on our research findings, proposals are suggested, for the successful implementation of ERP project systems, with special account to the characteristics of the Greek ERP market.*

## Περίληψη

*Η υλοποίηση ενός έργου Συστήματος Διαχείρισης Επιχειρησιακών Πόρων (ERP) μπορεί να συναντήσει προβλήματα σε διάφορα στάδια του, που είναι δυνατόν να οδηγήσουν σε αποτυχία της ολοκλήρωσής του ή της λειτουργίας του, με καταστροφικές πολλές φορές συνέπειες για την επιχείρηση ή τον οργανισμό που το υλοποιεί. Αυτά τα προβλήματα οφείλονται σε πολλούς λόγους, οι σημαντικότεροι από τους οποίους αναζητήθηκαν, καταγράφηκαν και αναλύθηκαν στη παρούσα ερευνητική εργασία, μετά από την μελέτη 30 περιπτώσεων αποτυχημένης εφαρμογής έργων ERP συστημάτων διεθνώς. Από την ανάλυση που πραγματοποιήσαμε, διαπιστώσαμε, ότι οι σημαντικότεροι παράγοντες που οδηγούν σε αποτυχία τα έργα υλοποίησης ERP συστημάτων εντοπίζονται, κατά κύριο λόγο στον λανθασμένο σχεδιασμό και σε ανεπάρκειες στη διοίκηση του έργου, κατά δεύτερο στην έλλειψη αποδοχής από το προσωπικό και στην πλημμελή εκπαίδευσή του και τέλος σε αδυναμίες της υλικοτεχνικής υποδομής και του λογισμικού και στην ελλιπή υποστήριξη μετά τη λειτουργία του. Τέλος, με βάση τα ευρήματα της έρευνάς μας, διατυπώνονται προτάσεις για την επιτυχή υλοποίηση έργων ERP συστημάτων, με ιδιαίτερη αναφορά στα χαρακτηριστικά της Ελληνικής αγοράς.*

*Keywords: ERP; Enterprise Resource Planning; ERP failure; ERP projects failure*

## 1. Introduction

ERP is an acronym of Enterprise Resource Planning and is sometimes a confusing term. In simple words an ERP System is a software solution used by companies as a business tool for planning and operating throughout everyday business. An Enterprise Resource Planning System is a cross-functional enterprise system and the most widely implemented business software systems in a wide variety of industries and organizations. ERP is comprised of many modules such as an accounting module, an inventory module, a human recourse management module, a production module etc. Each of these modules shares information that are stored in a common database. ERP systems facilitate the breaking down barriers between departments within a company, as an ERP system allows all departments to have access to valuable and updated information. An ERP system integrates business processes across departments onto a single enterprise-wide information system. The benefits of an ERP system are improved coordination across functional departments and increased efficiencies of doing business. The ERP gives Quality and Efficiency, Decreased Costs, Decision Support, Enterprise Agility. An ERP system is not only an Information Technology project but an organizational project. So, it is necessary to ensure that ERP systems are acquired in accordance with the vision of the company.

The complexity of an ERP system means that there are difficulties in any ERP implementation. Also implementing an ERP can be a difficult, a time-consuming and an expensive project for every company. The technology is tightly integrated and requires a commitment from all divisions and often a shift in the way a company does business to make it work. Usually it can take years to complete and costs as much as millions of euros (€) for a large company. Moreover, there is no guarantee of a successful outcome.

There are two aspects of ERP success or failure: process and outcome. The first aspect, studies the success or failure of an ERP implementation process. Implementing an ERP system often constitutes an enterprise most expensive investment of software ever and a large corporate project. There are many factors that may affect the initial budget. Also depending on the implementation strategy adopted, ERP projects are often long and intense. From surveys, it is found that the average time of implementing an ERP system is about 2 years.

Outcome success or failure aspect, studies the extent of post-implementation ERP benefits. Enterprises implementing ERP expect lots of benefits as transactional, informational and strategic. These benefits include reduction in operations costs, inventory carrying costs, business process cost, operating labor costs. Also ERP systems increase the quality, accessibility and flexibility of information and improve managerial decisions.

An ERP Project Failure is “an implementation that does not achieve a sufficient return on investment identified in the project approval phase”. With this definition, it has been found that failure rates vary from 60 to 70 percent.

What provokes an ERP Project failure? The failure of an ERP project means never actually implementation of ERP system. Also a project can be considered failed if the new system is not fully utilized. Failures of multi-million dollar ERP projects are reported once in a while even after 20 years of ERP implementation.

## 2. ERP Failure: Identifying the Critical Factors

Our research attempts to indicate the most significant factors, causing an ERP project fail. For this reason we examined 30 ERP projects failure all over the world.

It is very difficult to find statistics and evidences for every failure case because these cases usually lead to lawsuits between companies which installed the ERP system and companies which supplied and supported the ERP software. Also these evidences are sensible and valuable data. Also, hundreds of unsuccessful or failure cases for many reasons are never brought forward, usually to avoid any sort of bad advertising. Over the past few years globally it has been noted that large companies gone bankrupted because of an ERP System which has been taken down.

The profile of companies which we examined is large enterprises and organizations from a variety of business sectors.

Even if our sample is not representative, the ERP cases we examined show similarity with ERP systems market share. Therefore the software is not the main cause of ERP project failure. This can be seen in table (1) below.

ERP Software	Number of failures in our Research	percentage of 30 cases in our research	Market Share (2006)*
SAP	12	40,0%	41%
Oracle- Peoplesoft	5	16,7%	21%
Baan (SSA)	2	6,7%	3%
Other	11	36,7%	35%
	30	100%	100%

(\*) AMR Research 2007.

Table 1: ERP Software in Failure cases compared with Market share

The most common implementation methods of an ERP system are the Big-bang method, the method of prototype and the parallel implementation of a new system while the previous one works.

An ERP software can be customized or pre-configured. Table (2) describes the methods of implementation and the type of ERP software in the cases we studied in the present paper. It is noted that most failures occurred when Big-bang implementation is chosen. Also, the type of ERP product is not significant in failures, since customized ones resulted in failures too. That means that the main reasons of failure is project design and inadequacies in its management.

ERP Software	Implementation Method			
	Bing Bang	Prototype	Parallel	
Customized (tailor-made)	12	2	4	18
Off-the Shelf (pre-configured)	5	1	6	12
	17	3	10	30

Table 2: types of ERP Software and implementation methods

An ERP life consists of three major phases: i) pre- implementation ii) implementation and iii) post-implementation. The problems are obvious in post-implementation and the failure usually evident in this phase but the failure could be due to reasons from previous phases or to project design. The table (3) shows this.

Phase		
Pre-implementation	Implementation	Post-Implementation
1	8	21

Table 3: Phase where the problem was obvious.

An ERP System has four components: a) ERP software, b) Business Processes that ERP supports, c) Users, d) Hardware and Operating Systems that save and run ERP applications. The failures in one or more of those four components could cause the failure of an ERP project. But an ERP project often fails when the Design, the Management or the business process reengineering fails. The wrong time of implementation can even cause the failure. We examine analytically 30 failure cases and describe the factors that caused this.

From the results as shown in the tables (4) and (5) the most significant factors causing the failure of an ERP project, are the wrong project designing and inadequacies in its management. As important factors have been identified, the lack of the support from the organization staff and the staff training, as well as factors related to inadequacies in the infrastructure and software and the ERP support after its productive operation.

The factors are summarised in groups according to the component of ERP System they belong to.

In each case there is more than one factor that can cause failure as seen in Table (4). In Table (5) only the main reason is shown.

Factor	numbers	total	Percent.
Insufficient Training	9		
Lack of qualified personnel	4		
Insufficient cooperation between project teams	6		
Personnel rejection or reluctance	4	23	20,00%
Business process reengineering	20		
Project Design	28		
Project Management	16		
Project scope - Object of project	5		
Timing	3	72	62,61%
Data migration	7		
Connectivity, codes, reliability	8		
Unsupported processes or processes mistakes	4	19	16,52%
Hardware	1	1	0,87%
	115		

Table 4: Factors that can cause ERP project Failures

Factor	numbers	total	Percent.
Insufficient Training	2		
Lack of qualified personnel	1		
Insufficient cooperation between project teams	2	7	20,00%
Personnel rejection or reluctance	2		
Business process reengineering	3	18	63,33%
Project Design	9		
Project Management	4		
Project scope - Object of project	1		
Timing	1		
Data migration	1	5	16,67%
Connectivity, codes, reliability	2		
Unsupported processes or processes mistakes	2	0	0,00%
Hardware	0		
	30		

Table 5: Main reason for ERP Project Failure

The table (6) below shows the organizations used in this survey. The resources are from world wide literature so the data in table (6) may not be concise.

ORGANIZATION	IDENTITY	ERP	DAMAGES	YEAR
American LaFrance	construction of specific and security cars	IBM	over \$200 million	2007
Avis Europe	car rental company	PeopleSoft	between €40 and €45 million	2004
Oxford Health Plans Inc.	Health organization	Oracle, Unix	\$81 million	1998
The city of San Diego, USA	Municipality	Axon	over \$1 million	2008
The city of Oak Park, Illinois, USA	Municipality	PeopleSoft	\$1,6 million	2007
Texas State, USA	State Government	IBM	about \$900000	2008
OAED	Greek governmental organization	Intracom	unknown	2008
Overstock.com	Online retailer	Oracle	\$10,3 million	2008
Levi Strauss	clothing company	SAP	98% failure in net incomes compare to 2007	2008
Britain's national tax system	British government	unknown	unknown	2002
Hershey Foods Corporation	food corporation	SAP, Manugistics and Siebel	\$151 million	1998

<b>ORGANIZATION</b>	<b>IDENTITY</b>	<b>ERP</b>	<b>DAMAGES</b>	<b>YEAR</b>
Signal International	Multinational corporation	Global Lease (E-Systems)	unknown	1998
Nestlé usa	food corporation	SAP	\$280 million	2000
FoxMeyer	health and pharmaceutical corporation	SAP R/3, Pinnacle	over \$1billion	1996
Whirlpool	Electrical appliances manufacturer	SAP R/3	67% failure in net incomes compare to 1999	2000
Poolrite	Swimming pool accessories manufacturer	Baan	\$580.000	1999
Dell	Computer manufacturer	SAP	\$115 million	2006
Dow Chemical	chemical company	SAP R/2	\$500 million	2005
Fort Worth	travel corporation	Confirm	\$125 million	2007
LTC Corporation ltd	manufactural and commercial corporation	Orion Advantage (3i Infotech )	\$500.000	2005
Novartis	health and pharmaceutical corporation	SAP	unknown	2005
Sobeys	chain of enterprises	SAP Retail ERP	\$89 million	2000
StoneCo	stone corporation	Movex ERP (Intentia)	\$250000	1999
Technogiki Cliniki	Constructional enterprise	Emetris S.A.	unknown	2007
HewlettPackard	Electronic instruments and computer Manufacturer	SAP	\$160 million	2003
Nike	sportswear and footwear company	i2 Tech, SAP, Manugistics, Siebel	\$48 million	2001
Norfolk Southern Corp.	railway corporation	unknown	\$113 million	1999
Tri Valley Growers	agricultural co-operative company	Oracle	\$6 million	1997
Snap-On Inc.	Commercial and Industrial chain of enterprises	Baan	profits sink 22% compared to 1997.	1998
W. W. Grainger Inc.	industrial supplier	SAP	lost \$19 million in sales and \$23 million in profits	1999

Table 6: The 30 Failure cases we examined

### **3. Conclusions and Recommendations**

The implementation of an ERP project is a complex engagement. It is a high-risk project that needs to be managed and planned properly because it affects nearly every aspect of organizational performance and functioning. In the present paper, we have developed a comprehensive list of ERP project failures all over the world that have been broadly presented and studied in the literature.

Organizations have to learn how to identify the critical factors that affect the implementation process and know what elements in the process can drive them effectively, so as to ensure that the promised benefits can be obtained and potential failures can be avoided. Also they have to develop techniques and approaches for the risk management of the ERP implementation projects.

According to our research outcomes, critical causes of the ERP Failures are: Underestimating complexity of planning, development and training needs, failure to involve users-employees, too much actions too fast, insufficient training in new tasks, failure in data conversion and testing, over-reliance on ERP vendors or consultants support. Another critical factor may be that in the pre- implementation phase (known as the planning phase) the vendor did not estimate the needs of the company sufficiently. Also the vendor in that phase did not involved the company staff to succeed in a good result and proposed a system that finally could not accomplish the p company expectations.

The most significant success factors are: Top Management commitment and Support, Business Process Reengineering, Use of Project management techniques in the implementation, Change Management Culture & Program, Clear Goals, focus and scope (Business Plan and Vision), the right team Selection (competence), Avoidance customization, User Training and Education, Effective Communication, Use of ERP's consultants, Vendor package selection, Integration of the system, Appropriate Management expectation, Appropriate Business & IT Legacy Systems, Software Development, Testing & Troubleshooting, Vendor Partnership, Use of vendors' development tools, Performance Monitoring & Evaluation, Management Structure, Interdepartmental cooperation and communication

Over the past years only large and medium to large enterprises attempted to implement ERP systems. Nowadays the adoption of ERP systems is common even to the SMEs, bringing up problems in ERP implementation projects which are specific to these types of companies and therefore need to be properly analyzed. There is an evidence that inadequate project management leads to short term solutions, resulting from insufficiencies during the implementation phase, with substantial side effects when systems go live.

In Greece 85-90% of the enterprises are small and small to medium-size. They represent an important share in the ERP software market. The problem is to ensure a successful ERP project implementation to SMEs. An aggravating factor is that the small and small to medium-sized enterprises are unable to spend a lot of money and usually don't have specialized personnel. Also, they do not have enough experience in similar projects and they do not easily trust consultants. ERP implementation failure is a major concern for companies resulting to limitations and mistakes.

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# LEARNING CONCEPTIONS AND STUDENT PERFORMANCE IN ACCOUNTING COURSES: THE CASE OF BUSINESS STUDENTS ON TAX ACCOUNTING COURSES OF TEI OF ATHENS

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## Abstract

*Previous researches in Greece have not investigated if there is any relation between learning conceptions and performance in accounting related courses. This paper examines the possible relation between Learning conceptions of individual students and performance in an advanced accounting related course. Research has been developed in a small homogenous group of students. Under this research students were asked to classify themselves in learning conception types. The classification was made under the learning conception types developed by Sharma (1996), Saljo (1979). The conceptions of learning of individual students were correlated with performance in the final examination of an accounting related course.*

## Περίληψη

*Παλαιότερες έρευνες στην Ελλάδα, δεν έχουν ασχοληθεί με την πιθανή σχέση μεταξύ του τρόπου που κατανοούν οι φοιτητές και της απόδοσης στα μαθήματα σχετικά με την Λογιστική. Αυτό το άρθρο εξετάζει πιθανή σχέση μεταξύ του τρόπου κατανόησης των φοιτητών και της απόδοσης σε ένα σχετικά με την λογιστική μάθημα. Η έρευνα πραγματοποιήθηκε σε μια μικρή ομογενοποιημένη ομάδα φοιτητών. Στην έρευνα αυτή, ζητήθηκε από τους φοιτητές να κατατάξουν τους εαυτούς τους σε τύπους κατανόησης/ σύλληψης της διδασκόμενης ύλης. Η ταξινόμηση έγινε με βάση το ταξινομικό μοντέλο που πρότειναν οι Sharma (1996), Saljo (1979). Ο τρόπος κατανόησης των φοιτητών συσχετίστηκε με την απόδοσή τους στις τελικές εξετάσεις για το μάθημα της λογιστικής.*

JEL No: M490

**Keywords:** Accounting, Accounting Education, Learning conceptions, Learning Types, Index of learning Styles

## Introduction

Several studies in accounting have criticized learning territory environment (Shute (1979), Ortinau et al (1989), Inman et al (1989). The point is that Business Administration students indicate poor abilities in Accounting lessons. Many of them are complaining about the complicated structure of Accounting.

*'Through an extensive review of the accounting education literature Rebele et al., (1991) urged accounting education researchers to consider the more relevant variables such as student and teacher characteristics, assessment methods and other yet-to-be-specified contextual factors. These variables are of critical importance if we are to 'find ways to improve the educational experience of our students. Nothing could be more relevant than this' (Rebele et al., 1991, p. 221', Sharma (1996). As a result Rebele (1991) and Sharma argue that the learning teaching context is the only responsible for the learning outcome.*

Evidence supporting the contention that students tend to organize their learning behavior according to their perceptions of the learning-teaching environment abound in higher education research (Entwistle and Ramsden, 1983; Marton and Saljo, 1984; Van Rossum and Schenk, 1984; Entwistle and Waterston, 1988; Ramsden, 1989; Entwistle and Tait, 1990; Trigwell and Prosser, 1991). That's why it is critical to understand the way that our students learn. The main object of this research is to

1. Identify our students conception of learning.
2. Search if there is a connection (correlation) between the learning conception of every individual student and his performance on accounting courses

## Learning Conception

According to Saljo (1979), Van Rossum et al (1985) and Sharma (1996), students learning conceptions could be classified as:

1. Learning as memorizing
2. Learning as acquiring knowledge

3. Learning as application of knowledge
4. Learning as making connections between parts of a subject and between subjects and
5. Learning as interpreting and understanding reality.

Not much literature review will be presented about the learning conception that Saljo, Van Rossum and Sharma researches are proposing. We will just use there findings in order to search if our students follows this theoretical framework. Further more we will search about performance and Learning Conception.

## Methodology

'The concept of approach to learning. . . is unquestionably a key concept in teaching and learning' (Ramsden, 1992, p.39). The importance of this concept lies in understanding deficiencies in learning and recommending appropriate solutions for improving student learning (Sharma, 1996). The 'approach to learning' concept is a qualitative description of what and how students learn (Ramsden, 1992).

In our case we select a sample of 61 business students. Those students have been selected out of a list of 423 students that follows the course of Tax Accounting. A note of great importance is that of the total of 423 students only 70 students are following the lessons and 220 students select to take part to the exams. The selected students are all following every lesson of this course. All of the students were asked about there grades of all the Accounting courses taught at the Technical University of Athens. On the same Questionnaire we place questions about their conception of learning. Important note is that we did not make any check about the truth – believes of their answers.

Before asking the student to give us their answer about their conception of learning we gave a small speech about the meaning of every factor of the Questionnaire. Following Marton and Saljo (1976; 1984), Van Rossum *et al* (1985), Speth and Brown (1988) Entwistle and Waterston (1988), Meyer and Parsons (1989), Ramsden (1992), Sharma (1996), we gave a speech about learning conceptions variables. Based on Sharma (1996) we gave information and examples about learning conceptions. Selected example that we read inside the classroom and every participant of the research were well informed about.

### For the Learning Conception 1: Memorizing/Reproduction

1. A process by which a person is able to retain information that he or she has been learning. The major way that people learn is through studying . . Learning is a process of gathering and retaining information.
2. Memorizing, knowing what formulas to apply to what situation, accepting without question what is taught.
3. Learning involves effective communication and presentation of raw material and facts so that it can be easily 'digested' and committed to memory. Therefore, it should be presented in a way that is not too strenuous and exhausting.

### For the Learning Conception 2: Acquiring Knowledge

1. Accumulate the specific knowledge in a particular area.
2. Being introduced to material not previously known.
3. Reading textbooks, reading newspapers, the ability to gain knowledge and experience to help you in life, to be able to pass your examinations and get a degree.
4. Sitting in lectures and listening to what is said. Reading a textbook and making notes. Asking questions in tutorials and having the answer explained thoughtfully.

### For the Learning Conception 3: Application (Shute, 1979).

1. Learning is gaining knowledge with respect to what will be useful to us in our future employment as accountants.
2. Gaining knowledge so that I can apply it for the purpose of succeeding in examinations. I mainly learn from reading textbooks -I get a better understanding by reading textbooks than from lectures.
3. Learning is the ability to develop skills acquired in a subject and be able to apply these skills to problems and situations in life. Learning is an ongoing process from the beginning of an individual's life to the end.
4. Learning is the accumulation of information which can be retrieved and applied.
5. Acquiring knowledge about a subject. Being able to apply that knowledge in a practical sense and in a real-world situation.

**For the Learning Conception 4: Understanding and Insight**

1. Learning is a process whereby the student not only discovers the answers relating to problems but importantly, the reasoning, or why particular answers are corrects for particular problems. Learning is a process of discovering the underlying fundamental elements of a problem, and bringing those elements together to arrive at a solution.
2. The aim of learning is to have a greater knowledge of the subject matter. In regard to accounting this would mean an understanding of how things are done practically and also why they are done in that particular way. Learning should also mean that one learns to think for oneself and thus be able to evaluate accounting theory as well as practice.
3. Learning as gaining knowledge and experience in areas of interest. The objective being to gain some insight to the subject matter to expand and develop one's own knowledge and experience.

**For the Learning Conception 5: Interpreting Reality and Construction**

1. Learning is adding knowledge to what we already know. It means acquiring new skills and understanding of why and how we do certain things. Learning can relate to many areas, i.e. not only to textbooks and lectures, but finding things out about ourselves because of the interaction with others. It's a gaining of experience. By gaining or 'learning' certain things we are more prepared to question what we hear or are being told by others. Therefore, we have a cyclical effect in the process. Learning is never ending.
2. Learning is experiencing, being exposed physically and mentally to new ideas thoughts and horizons. Learning is good for the 'soul'. Becoming aware of what I ought to know. Learning is part of growing up and becoming a better person as a whole.
3. Discovery of fresh, new and additional knowledge through experience. Knowing the subject matter which includes application, critical analysis and further expansion. Learning is exploration.
4. Learning means being able to form opinions about an issue and forming values.

All of the above mentioned examples are from the research of Sharma (1996) and have been tested by him on a quit similar research. Our research uses this methodology in order to find if there is any connection between learning conceptions and performance on Accounting courses on a Technical University level. Further more we will try to find if the type of teaching helps (on a performance base) students.

After a quick briefing of the conceptions of learning context; students kindly asked to answer the questionnaire of appendix 1. This questionnaire consists of 5 questions measuring different aspects of learning conceptions. Of each statement, a student has to indicate on a five point scale to what extent the statement is descriptive of his or her study behaviour. Depending on the formulation of the item, answers can range from 1 "I do this seldom or never" to 5 "I do this almost always".

**Descriptive Results**

From the base results we are reporting that out of 70 'sit under' students 53 answer the questionnaire. The rate of response is 75,7%. Out of 220 students that take part to the final exams of the Tax Accounting Course 61 answer the questionnaire (response rate 24%).

As for the first question 'Memorizing/Reproduction' (learning conception 1), we are counting:

**Memorizing/Reproduction (Table 1)**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	8	15,1	15,7	15,7
	2	9	17,0	17,6	33,3
	3	19	35,8	37,3	70,6
	4	14	26,4	27,5	98,0
	5	1	1,9	2,0	100,0
	Total	51	96,2	100,0	
Missing	System	2	3,8		
Total		53	100,0		

From the descriptive results can find that students are nether memorizing nor reproducing in a percentage of 35,8%. The second higher score is for the more reproducing than memorizing (26,4%) As for the second question 'Acquiring Knowledge' we count the following results

**Acquiring Knowledge (Table 2)**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	3,8	3,8	3,8
	3	12	22,6	23,1	26,9
	4	36	67,9	69,2	96,2
	5	2	3,8	3,8	100,0
	Total	52	98,1	100,0	
Missing	System	1	1,9		
Total		53	100,0		

From this question we can easily understand that 67,9% of the total sample are answering that they are learning more by Acquiring knowledge. This means that students of the Technical University of Athens are learning through knowledge acquiring in a percentage of 71,7%. This is one of the higher levels that we found in our research. This causes us an unexpected question ‘Do participant students telling us the truth on this question?’ Because of this question we are proposing further research over this.

As for the second question ‘Application’ we count the following results

**Application (Table 3)**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	3,8	3,8	3,8
	3	2	3,8	3,8	7,5
	4	24	45,3	45,3	52,8
	5	25	47,2	47,2	100,0
	Total	53	100,0	100,0	

A total of 92.4% (very much and totally) is answering that learn better using applications.

**Understanding and Insight (Table 4)**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	6	11,3	11,5	11,5
	3	27	50,9	51,9	63,5
	4	16	30,2	30,8	94,2
	5	3	5,7	5,8	100,0
	Total	52	98,1	100,0	
Missing	System	1	1,9		
Total		53	100,0		

Not many agree totally that their learning conception follows the ‘Understanding and insight’. Major finding on this question is that we found that not one learns with out understanding the insights of a subject. 50.9% and 30.2% of the total sample believes that learning is doing through insight understanding of accounting subjects

**Interpreting Reality and Construction (Table 5)**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	5,7	5,7	5,7
	3	11	20,8	20,8	26,4
	4	34	64,2	64,2	90,6
	5	5	9,4	9,4	100,0
	Total	53	100,0	100,0	

The conception of the sample about learning through interpreting and construction is quit high (64,2%). Sample believes that they learn better through interpreting reality and construction.

## Correlation

For every question we correlate the grade of its individual student with his/her answers on the Conception Learning beliefs. Correlation matrix (table 6) presents quit interesting results. All correlation results are statistical important.

**Correlation Matrix (Table 6)**

		LOGIST4	ER1
LOGIST4	Pearson Correlation	1,0000	-0,0466
	Sig. (2-tailed)	,	0,7637
	N	45,0000	44,0000
ER1	Pearson Correlation	-0,0466	1,0000
	Sig. (2-tailed)	0,7637	,
	N	44,0000	51,0000
		LOGIST4	ER2
LOGIST4	Pearson Correlation	1,0000	0,0101
	Sig. (2-tailed)	,	0,9477
	N	45,0000	45,0000
ER2	Pearson Correlation	0,0101	1,0000
	Sig. (2-tailed)	0,9477	,
	N	45,0000	52,0000
		LOGIST4	ER3
LOGIST4	Pearson Correlation	1,0000	0,0819
	Sig. (2-tailed)	,	0,5928
	N	45,0000	45,0000
ER3	Pearson Correlation	0,0819	1,0000
	Sig. (2-tailed)	0,5928	,
	N	45,0000	53,0000
		LOGIST4	ER4
LOGIST4	Pearson Correlation	1,0000	-0,2437
	Sig. (2-tailed)	,	0,1109
	N	45,0000	44,0000
ER4	Pearson Correlation	-0,2437	1,0000
	Sig. (2-tailed)	0,1109	,
	N	44,0000	52,0000
		LOGIST4	ER5
LOGIST4	Pearson Correlation	1,0000	-0,0454
	Sig. (2-tailed)	,	0,7670
	N	45,0000	45,0000
ER5	Pearson Correlation	-0,0454	1,0000
	Sig. (2-tailed)	0,7670	,
	N	45,0000	53,0000

From the correlation results we can easily understand that there is not any correlation between, learning conceptions and the performance of the students sample on tax accounting lessons.

This means that tax accounting lessons is neutral of any learning conception. Thus student of any learning conception have the same opportunities on performance on tax accounting.

Maybe the sample is so little for generalization of the findings. Thus we propose further research on this subject.

## Further research

Our first proposal for further research is to make a check for the biases of the student about their conception of learning. Researcher must search if the way that students are learning is the one that are answering on the questions that have been placed.

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# DOES OWNERSHIP, SIZE OR COMPETITION MATTER? THE EFFECTS OF TELECOMMUNICATIONS REFORM ON PRICING IN GREECE

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## Abstract

*This paper explores the effects of liberalization in the Greek telecommunication market on pricing for the period 1992-2005. In particular, we examine the implications of privatization, competition and regulation in fixed telephony, mobile telephony and the internet markets and we investigate a) whether the sector's reform influenced services pricing (descriptive analysis), b) the possible explanatory factors of these dependent variable (econometric analysis - Panel Feasible Generalised Least Squares - FGLS-). The data refers to 44 of the most prominent companies of fixed telephony, mobile telephony and internet services and was compiled by means of interviews with the help of a questionnaire. Our descriptive analysis concluded that liberalization of the telecommunication market induced price cuts. The main conclusion of econometric research is that a large market share provides in the companies the capability of cutting the prices of their services.*

*In this way, the present article offers useful information about a field that continues to be characterized by a vast researching deficit.*

## Περίληψη

*Με το παρόν άρθρο αναλύουμε τις επιπτώσεις της απελευθέρωσης της ελληνικής τηλεπικοινωνιακής αγοράς στην τιμολόγηση των παρεχομένων υπηρεσιών για την περίοδο 1992-2005. Ειδικότερα, εξετάζουμε τις επιπτώσεις αυτής της απελευθέρωσης στη σταθερή τηλεφωνία, στην κινητή τηλεφωνία και στο διαδίκτυο και διερευνούμε α) εάν η μεταρρύθμιση του τομέα επηρέασε την τιμολόγηση των υπηρεσιών (περιγραφική ανάλυση), β) τους πιθανούς προσδιοριστικούς παράγοντες αυτής της μεταβλητής (οικονομετρική ανάλυση - Panel Feasible Generalised Least Squares - FGLS-). Τα στοιχεία αφορούν 44 από τις πιο σημαντικές επιχειρήσεις της σταθερής τηλεφωνίας, της κινητής τηλεφωνίας και του διαδικτύου και συλλέχθηκαν με τη μέθοδο των συνεντεύξεων με τη βοήθεια ερωτηματολογίου. Με την περιγραφική έρευνα διαπιστώνεται ότι η απελευθέρωση της αγοράς προκαλεί μείωση τιμών. Το βασικό συμπέρασμα της οικονομετρικής έρευνας είναι ότι η κατοχή ενός μεγάλου μεριδίου αγοράς παρέχει μεγαλύτερη δυνατότητα στις επιχειρήσεις να μειώσουν τις τιμές των υπηρεσιών τους.*

*Κατ' αυτόν τον τρόπο, το άρθρο μας προσφέρει χρήσιμη πληροφόρηση σε ένα πεδίο που παρατηρείται ακόμη ένα μεγάλο ερευνητικό έλλειμμα.*

*Keywords: Telecommunication, Greece, Pricing, Privatization, Competition*

## 1. Introduction

The telecommunication sector operated in every country under the status of strict state monopoly and almost absolute protectionism (Nestor and Mahboobi, 1999, Wilson and Zhou, 2001, Spiller and Cardili, 1997, Shirley and Walsh, 2000, Sheshinski and Lopez-Calva, 1998, Smith, 1995). However, in the course of time, the rising customer demand for higher quality, new services and lower prices led to necessary structural changes (Koski, 2002, OECD, 1995, Heracleous, 1999, Nestor and Mahboobi, 1999, Gual and Waverman, 1998). This formed a deregulation tendency, which was made manifest through policies of privatization and market liberalization (Parker, 2004, Ricketts, 2004, Omran, 2004, Levi – Faur, 2003, Koski, 2002, Shirley and Walsh, 2000, Ramaswamy and Von Glinow, 2000, Li et al, 2000).<sup>1</sup>

A number of empirical studies investigated the impact of the above policies, *inter alia*, on market structure and pricing either econometrically (using panel data analysis) or descriptively. More specifically, as far as the econometric ones are concerned, Boylaud and Nicoletti (2000) showed that in 23 OECD states the newly introduced companies implemented a lower price policy. Similarly, Wallsten (2001) used a sample of 30 countries from Africa and Latin America to reach the conclusion that the competition triggered the price cut

<sup>1</sup> The reform process originated during the 1970's in the USA and from the beginning of the 1980's in Great Britain and Japan where from it consecutively spread to the other OECD member states. Within the European Union the reform commenced in 1984 and was completed in 1998.



of a 3 minute local call. Nicoletti (2001) likewise, found out that average prices of provided services fell, both in mobile as well as in fixed telephony, as a result of the competition.

Within the framework of descriptive studies (which outnumber the former ones), Min (1999) concluded that the reform of the Japanese telecommunication sector led to price cuts in all related services. Hughes and Phillips (1999) analyzed the reform policy in the USA and found out that services prices were cut, especially in long distance, international and mobile telephony services. Haggarty et al. (2003) showed that the implemented reform policy in the telecommunication sector in Ghana has prompted price cuts. Price cuts of provided services were ascertained by a series of other descriptive studies, such as the one by Ypsilantis (2002a) on Canada, Xavier (1996) on Australia, Ypsilantis and Min (2001) and Sacripanti (1999) on Italy, Ypsilantis (2002b) on the United Kingdom, Xavier and Ypsilantis (2000) on Spain, Sato and Ypsilantis (2000) on Denmark, Min and Ypsilantis (1999) on Holland, Yamada and Ypsilantis (2001) on Ireland, Vanyai (1998) on Hungary, Spiller and Cardilli (1997) on Chile, Australia, Guatemala and New Zealand, as well as Heracleous (2001) on Singapore.

The liberalization of the telecommunication market had considerable consequences in Greece too (which as an EU member country has implemented the respective European policy in the specific industry). More specifically, from the beginning of the 1990's the market is gradually liberalized, the National Telecommunications Organization (NTO) is privatized, new private companies are launched, and the Hellenic Telecommunications and Post Commission (HTPC) is established as an independent regulatory authority. The reform policy is completed in 2001. This article examines the implications of the liberalization in fixed telephony, mobile telephony and the internet markets. In particular, we investigate:

- the influence of the sector's reform on services pricing (descriptive analysis),
- the possible explanatory factors of these dependent variable (econometric analysis).

Our original sample concerns 44 of the most prominent enterprises that were active in the Greek telecommunication market during the time period 1992 – 2005. We collected the primary data concerning these companies by means of interviews (see Appendix).

## 2. Model specification, variables and data

### 2.1 Model

There are cases where a sample is composed by cross-section units  $i=1,2,\dots,n$  for a number of time periods  $t=1,2,\dots,T$ . A data set which combines cross-section data and time series is called "panel data". The use of panel data exhibits a number of advantages in relation to the use of either only cross-section data or only time series. The main advantage is that the heterogeneity of the cross-section data can be assessed. Moreover, panel data offer more complete information, more variance which can be of econometric use, a lesser degree of multicollinearity, more degrees of freedom and more effective estimates (Hsiao, 2003).

For panel data analysis we use the following basic model (Wooldridge, 2002):

$$y_{it} = \mathbf{x}'_{it} \boldsymbol{\beta} + c_i + u_{it} \quad (1)$$

where  $y_{it}$  is the dependant variable,  $\mathbf{x}_{it} = (x_{it,1}, x_{it,2}, \dots, x_{it,k})'$  is a vector of explanatory variables,  $\boldsymbol{\beta} = (b_1, b_2, \dots, b_k)'$  is a vector of the coefficients of the explanatory variables to be estimated and  $c_i$  are the time-invariant unobserved cross-sectional effects.

In the relevant literature the interest focuses on the choice of the appropriate method of estimation. The choice depends on the hypothesis that the unobserved effects  $c_i$  are correlated (or not) with the explanatory variables. Thus there are two cases:

- **$c_i$  are correlated with  $\mathbf{x}_{it}$**

In this case, the "fixed effects" method is used according to which the variables are expressed as deviations from their mean values, i.e. model (1) becomes:

$$y_{it} - \bar{y}_i = (\mathbf{x}_{it} - \bar{\mathbf{x}}_i)' \boldsymbol{\beta} + (u_{it} - \bar{u}_i) \quad (2)$$

Model (2) can be estimated by ordinary least squares (OLS) in order to produce reliable estimators.

- **$c_i$  are not correlated with  $\mathbf{x}_{it}$**

In this case, the covariance between the unobserved effects and the explanatory variables is zero for all  $t$  [ $\text{Cov}(\mathbf{x}_{it}, c_i) = 0, t = 1, 2, \dots, T$ ] and the unobserved effects are mutually independent random variables normally distributed with zero mean and constant variance. In this case, model (1) becomes:

$$y_{it} = b_0 + \mathbf{x}'_{it} \boldsymbol{\beta} + v_{it} \text{ where } v_{it} = c_i + u_{it} \quad (3)$$

The error term  $v_{it}$  exhibits positive serial correlation with  $\text{Corr}(v_{it}, v_{is}) = \sigma_c^2 / (\sigma_c^2 + \sigma_u^2)$ ,  $t \neq s$

The appropriate method for estimating model (3) is the generalized least squares (GLS) by introducing the following transformation:

$$\lambda = 1 - \left( \frac{\sigma_c^2}{T\sigma_c^2 + \sigma_u^2} \right)^{1/2}$$

Then the following model of the transformed variables can be estimated with OLS:

$$y_{it} - \lambda \bar{y}_i = b_0(1 - \lambda) + (\mathbf{x}_{it} - \lambda \bar{\mathbf{x}}_i)' \boldsymbol{\beta} + (v_{it} - \lambda \bar{v}_i) \quad (4)$$

In practice, the value of  $\lambda$  is unknown. Therefore, in order to estimate model (3) the feasible generalized least squares (FGLS) method is used, according to which the estimated  $\lambda$  is used and the new model is estimated with OLS:

$$\hat{\lambda} = 1 - \left[ \frac{1}{1 + \frac{\hat{\sigma}_c^2}{T\hat{\sigma}_u^2}} \right]^{1/2} \text{ where } \hat{\sigma}_c^2 \text{ and } \hat{\sigma}_u^2 \text{ are consistent estimates of } \sigma_c^2 \text{ and } \sigma_u^2 \text{ with:}$$

$$\hat{\sigma}_c^2 = [NT(T-1)/2 - (K+1)]^{-1} \sum_{i=1}^N \sum_{t=1}^{T-1} \sum_{s=t+1}^T \hat{v}_{it} \hat{v}_{is}$$

$$\hat{\sigma}_u^2 = \hat{\sigma}_v^2 - \hat{\sigma}_c^2$$

$\hat{v}_{it}$ ,  $\hat{v}_i$  and  $\hat{\sigma}_v^2$  are based on OLS residuals of (3).

In this paper we assume that the unobserved variables are not correlated with the other independent variables. This hypothesis prompts us to use the feasible generalized least squares (FGLS) method with random effects in order to estimate our model. Moreover, the  $F$ -test is used, in order to examine the statistical significance of the variables under consideration.

## 2.2 Variables

Variables were selected after having taken respective econometric studies into account, but were also dictated by the availability of historical information concerning the most extensive possible time period and the existence of efficient. Thus, as dependent variable, we always use the pricing (Price) of local calls (Pricelocal), long distance calls (Pricetrunk), calls to mobiles (Pricetomobil), international calls to EU countries (PriceEU) and the USA (PriceUSA), the annual standard subscription (PSTN 56k) for internet services (Priceinter) and the minimum charge per second for mobile telephony (Pricemobil). As independent variables we use the companies' size (Size), the market shares (Share), the ownership (Own), the administrative personnel's number (Man), the commercial personnel's number (Com), the technical personnel's number (Tech), the personnel's number with a university degree (Uedu) and the personnel's number with a high school and elementary degree (Bedu). This specialization is implemented for the first time in literature.

Available references for all the above variables are presented in Table 1.

## 2.3 Data

We gathered our primary data as follows. From the Companies' Register of the Hellenic Telecommunications and Post Commission (HTPC) we identified a total of 108 providers of main telecommunication services. Field research was conducted in 2005, in three phases. During the first phase, the questionnaire was edited and improved with the help of a pilot interview. During the second phase telephone contact was made with every company in the field followed by the questionnaire which was sent by e-mail. During the third phase telephone contact was resumed in order to finalize the meetings with the competent company executives. Finally, 44 companies (41%) took part in the research. The reliability degree of the sample is considered high,<sup>2</sup> likewise the information quality, which resulted from interviews with top management, marketing, public relations' and personnel's executives.

<sup>2</sup> A reliability analysis was conducted with the use of Cronbach Alpha coefficient, the value of which was 0.6456. This fact confirms the cohesion of questions asked. Consequently, the statistical analysis results (that follow) are deemed safe.

### 3. Results and discussion

#### 3.1 Descriptive statistics

The complete liberalization of the Greek market triggered the continuous revision of the companies' pricing policy. In particular, the prices of every examined subcategory of fixed telephony (local, long distance, international calls and calls to mobiles) declined (Table 2a). The monthly fixed charge, which rised, was an exception.<sup>3</sup> Moreover, mobile telephony tariffs showed a downfall during the period 1993-2005<sup>4</sup> (Table 2b). To be more exact, the lowest monthly fixed charge<sup>5</sup> and the minimum charge of a call fell markedly. Contrary to the two former indexes, the cost of sending an SMS rose.<sup>6</sup>

Furthermore, as regards internet market, significant competition dominated only regarding the fixed subscription charged by every company for the provision of internet services. As a result this subscription decreased significantly from 15,20 in 1998 to 10,34 in 2005 (Table 2c). By contrast, the monthly fixed charge paid by the subscribers almost doubled during the period 1998-2005. Moreover, the use charge remained the same for 7 consecutive years from 1999 to 2005 (0.352/ 0.176).<sup>7</sup>

#### 3.2 Econometric results

Out of the econometric model was concluded that the most important interpretative variable for the pricing (dependent variable) was market share. Other interpretative variables were the administrative, commercial and technical personnel, the company's size and the ownership (Table 3). Specifically, it seemed that company's market share regarding long distance calls and calls to mobiles and pricing of the respective provided services move in opposite direction (at significance level 5%). Probably, scale economies offered companies the chance to be more flexible in their pricing. On the other, the situation in the internet market seemed to be different (at significance level 1%), may be due to abuse of dominant position.

Second, it seemed that there is a positive relationship between the number of the administrative, commercial and technical personnel and the pricing of provided services regarding long distance calls (at significance level 1%, 5% and 5% respectively) as well as internet services (at significance level 1%). It appears that the rise of operational cost can lead to the surcharge of the final price of provided services.

Third, it seemed that there is an inverse relationship between the size of the company and the pricing in the internet subsector (at significance level 5%). We express the view that scale economies realized by bigger companies ultimately lead to the lowest average cost of provided services.

Finally, private ownership led to price reduction in the internet market (at significance level 1%). In other words, private companies offered lower prices for internet services compared to the state companies. This conclusion partially differentiates from the results of Wallsten (2001), Nicoletti (2001) and Boylaud and Nicoletti (2000), who did not find any clear relation between ownership and prices.

### 4. Conclusion

In this article we have investigated if and to what extent the liberalization of the telecommunication market in Greece influenced pricing. In order to achieve this, we conducted an empirical research in 44 of the most important companies in the sector in 2005 and we gathered data for the period 1992-2005. We elaborated these data descriptively and econometrically using the FGLS method within the framework of panel data analysis. This method is regarded appropriate for our sample which is compiled by intersectoral data for more than one time periods and there is no correlation between the unobserved effects and interpretative variables.

Our descriptive research showed that market liberalization resulted in lower prices. In this way, our results confirmed those of other research studies conducted in developed as well as in developing economies (see *inter alia* the works of Min, 1999; Haggarty and Shirley, 2003; Min and Ypsilantis, 1999; Xavier, 1996; Sato

<sup>3</sup> The main reason for this appears to be the monopolistic role of the state company in the public telecommunication network, which private companies hire in order to provide their services having the result of competition reduction.

<sup>4</sup> According to company executives, high prices during the first years of mobile telephony are justified, by the huge investment required to obtain 2<sup>nd</sup> and 3<sup>rd</sup> generation permissions, the creation of a sound telecommunications network and the high expenses in developing new services and products.

<sup>5</sup> It is useful to mention that a certain increase in the monthly fixed charge since 2003 is counterbalanced by offering new packages with free call time which were more attractive to consumers.

<sup>6</sup> This is mainly attributed to low tariffs with which this service was initially offered in order to become more easily popular.

<sup>7</sup> This was attributed to the fact that internet access was made possible via the use of a Single National Access Number or Regional Access Number, which were charged every time according to the respective rates set by the state company.

and Ypsilantis, 2000; Hughes and Phillips, 1999; Wallsten, 2001; Ypsilantis and Min, 2001; Sacripanti, 1999; Vanyai, 1998; Xavier and Ypsilantis, 2001).

Econometric analysis, on the other hand, took a step further to investigate the most important explanatory variables of prices and concerned, enterprises with large market shares had the chance to charge their services at lower rates (see also Nicoletti, 2001 and Boylaud and Nicoletti, 2000). Furthermore, we found that the excessive use of personnel can lead to higher operational costs and rising prices, a fact that companies should take seriously into consideration. In general, further significant price cuts seem to be hindered by the increase of the fixed monthly charges, which is still defined by the state company, (the only company with an integrated national telecommunication network).

We realized that during the present phase, in the corresponding literature the econometric research has some quantitative deficits comparatively to the descriptive analyses. Consequently, in the future the objective research should be the extension of the research also in other economic-political settings in order to have a better comparison and a possible generalization of our conclusions.

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## Appendix

Table 1: Econometric analysis variables

Variable	Description	Available References
<b>Pricelocal</b>	Local call charge per minute	Boylaud and Nicoletti 2000, Wallsten 2001, Nicoletti 2001, Ros 1999
<b>Pricetrunk</b>	Long distance call charge per minute	
<b>Pricetomobil</b>	Call charge to mobiles per minute	
<b>PriceEU</b>	Call charge to the EU per minute	
<b>PriceUSA</b>	Call charge to the USA per minute	
<b>Priceinter</b>	Monthly fixed charges of an annual standard subscription (PSTN 56k)	
<b>Pricemobil</b>	Minimum call charge per second	
<b>Sharelocal</b>	Market share regarding local calls owned by a company (%)	Boylaud and Nicoletti 2000, Nicoletti 2001
<b>Sharetrunk</b>	Market share regarding long distance calls owned by a company (%)	
<b>Sharetomobil</b>	Market share regarding calls to mobiles owned by a company (%)	
<b>ShareEU</b>	Market share regarding international calls to the EU owned by a company (%)	
<b>ShareUSA</b>	Market share regarding international calls to the USA owned by a company (%)	
<b>Shareinter</b>	Market share owned by a company (%)	
<b>Sharemobil</b>	Market share owned by a company (%)	
<b>Own</b>	Company ownership in the research (state=0, private=1)	Boylaud and Nicoletti 2000, Nicoletti 2001, Ros 1999, Staranczak et al. 1994, Jha and Majumbar 1999, Madden et al. 2003
<b>Size</b>	Company size in the research (small=0, big=1)	Harper 2002, Staranczak et al. 1994, Jha and Majumbar 1999
<b>Man</b>	Number of administrative-financial personnel	Not available
<b>Com</b>	Number of commercial personnel	Not available
<b>Tech</b>	Number of technical personnel	Not available
<b>Uedu</b>	Number of personnel with university degree	Not available
<b>Bedu</b>	Number of personnel with high school degree	Not available

Table 2a: Fixed telephony's price development (in €-cents, VAT is excluded)

	2002	2003	2004	2005
Fixed charge (Monthly)	9,98	10,49	11,40	11,90

	2002	2003	2004	2005
Local calls (1 minute)	0,025	0,025	0,024	0,024
Long distance calls (1 minute)	0,049	0,050	0,048	0,048
International calls (1 minute)	-	-	-	-
a) EU country	0,181	0,177	0,177	0,166
b) European country outside EU	0,216	0,217	0,214	0,193
c) USA	0,181	0,179	0,176	0,166
d) Japan	0,196	0,191	0,186	0,170
e) South Africa	0,420	0,430	0,416	0,382
Calls to mobile (1 minute)	0,214	0,219	0,207	0,181

(Source: data research)

**Table 2b: Mobile telephony's price development (in €-cents, VAT is excluded)**

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Monthly fixed charge	27,88	27,88	27,88	22,75	18,34	13,21	10,76	8,02	7,72	7,72	9,44	9,44	9,43
Minimum charge (1 second)	0,0052	0,0054	0,0056	0,0069	0,0060	0,0041	0,0054	0,0043	0,0043	0,0043	0,0040	0,0040	0,0037
1 SMS	-	-	-	0,079	0,079	0,078	0,082	0,084	0,083	0,085	0,081	0,081	0,083

(Source: data research)

**Table 2c: Internet price development (in €-cents, VAT is excluded)**

	1998	1999	2000	2001	2002	2003	2004	2005
Monthly fixed charge	6,02	6,75	6,75	8,22	9,98	10,49	11,40	11,90
Usage rental (per peak hour /non peak hour)	0,458/ 0,229	0,352/ 0,176	0,352/ 0,176	0,352/ 0,176	0,352/ 0,176	0,352/ 0,176	0,352/ 0,176	0,352/ 0,176
Annual standard subscription (PSTN 56k)	15,20	15,01	13,09	13,74	13,64	11,87	10,68	10,34

(Source: data research)

**Table 6: Pricing**

Dependent Variables	Independent Variables									F-test
	Price	Size	Share	Own	Man	Com	Tech	Uedu	Bedu	
<b>Pricelocal</b>		-0,0004 (0,0002)	≈0	-0,0003 (0,0004)	≈0	≈0	≈0	≈0	≈0	492,357*
<b>Pricetrunk</b>		0,002 (0,004)	-0,0006** (0,0002)	0,012 (0,009)	0,0006* (0,0002)	0,0004** (0,0001)	0,0005** (0,0002)	-0,0004** (0,0001)	-0,0005** (0,0001)	3,740*
<b>Pricetomobil</b>		0,006 (0,0101)	-0,006** (0,002)	-0,082 (0,049)	-0,004* (0,001)	-0,003** (0,001)	-0,003* (0,001)	0,003* (0,001)	0,003* (0,001)	9,359*
<b>PriceEU</b>		-0,001 (0,006)	-0,0007 (0,0008)	-0,015 (0,021)	≈0	-0,0002 (0,0005)	≈0	0,0001 (0,0005)	0,0001 (0,0005)	11,754*
<b>PriceUSA</b>		-0,0009 (0,007)	-0,0007 (0,0008)	-0,014 (0,022)	≈0	-0,0001 (0,0005)	≈0	0,0001 (0,0005)	≈0	10,496*
<b>Priceinter</b>		-2.681** (0,932)	0.067* (0,018)	-3.771* (1,075)	0,422* (0,060)	0,444* (0,063)	0,395* (0,063)	-0.395* (0,058)	-0.422* (0,062)	3.871**
<b>Pricemobil</b>		-0,0002 (0,001)	≈0	≈0	≈0	≈0	≈0	≈0	≈0	0,778

Note: Regressions have been estimated using Panel Feasible Generalised Least Squares (FGLS) method with random effects. Regressions include a constant as well, which does not appear on the table due to lack of space. Numbers in parentheses are the typical errors of the estimated parameters. F-test controls the joint statistical significance of the independent variables. If the absolute value of the estimated variable is <0,0001, then it is expressed with ≈0. \*\*\*, \*\*, \* indicate statistical significance at level 10%, 5% and 1%, respectively.



**ANNEX: «RESEARCH QUESTIONNAIRE»**

**Pricing**

Fixed telephony

	2002	2003	2004	2005
Fixed charge (Monthly)				
Local calls (1 minute)				
Long distance calls (1 minute)				
International calls (1 minute)				
a) EU country				
b) European country outside EU				
c) USA				
d) Japan				
e) South Africa				
Calls to mobile (1 minute)				

Mobile telephony

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Monthly fixed charge													
Minimum charge (1 second)													
1 SMS													

Internet

	1998	1999	2000	2001	2002	2003	2004	2005
Monthly fixed charge								
Usage rental (per peak hour /non peak hour)								
Annual standard subscription (PSTN 56k)								

# A NEW APPROACH ON THE PROCESSING OF QUESTIONNAIRES BASED ON THE PRINCIPLES OF SEMIOMETRY

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## Abstract

*This paper displays a new processing technique for the market research questionnaires using a method of combined analysis, which is based on the principles of Semiometry. Based upon the triple version of each word "feeling, importance and direction", a geographic dictionary is created, in which the words are not placed in alphabetical order but each one of them is positioned in relation to the other words according to the emerged feeling of the person under question.*

*A researcher who is willing to realize a market research using this new technique does not aim at obtaining opinions derived from questionnaires that are presented in a form of a sentence, which can more or less direct the asked person to specific responses, but intends to attribute values in certain words relatively to the pleasant or undesirable feeling evoked by their appeal, so as to finally emerge the basic structure of the psychograph of the social group the research is referred to.*

*With the elaboration of the aforementioned words using the Principal Component Analysis, and in combination with the social-professional variables, which are considered as supplementary variables, the researcher is given the chance to observe the emotional world of the social set that is of his interest, so as to evaluate qualitatively the subject under investigation using data analysis methods.*

**Key words :** *Semiometry, Principal Components Analysis, Market research*

## Introduction

The aim of Semiometry is to specify the special sensitivity of the persons questioned, by provoking their positive or negative reactions to certain words, which cause intense sentiments. This approach presupposes that each word contains an emotional load causing particular, yet different reactions to each one. This reactions' analysis results in the emergence of moral values connected for instance to the consumption of a product or the image of a car brand, the reading of the title of a book, the listening of a radio program. The described words' analysis above, is fulfilled through statistical methods of Data Analysis, in order to enable the researcher to express reliable results.

The standard method of Semiometry is based on a total of 210 words, representative of the western culture, the roots of which are found at 95% in the Old Testament. These words aim at describing the values and the way of living of the western civilization within the framework of psycho- sociological applications.

The Semiometric questionnaire does not intend to obtain aspects which derive from questions presented in the form of sentences, rather to attribute value to certain words according to the pleasant or unpleasant feeling of their invocation, so as to raise the basic semiometric structure of the social group it refers to.

The semiometric questionnaire is formed as follows: a scale of seven (7) ratings is associated to each word, from minus three (-3) up to plus three (+3), whereas (-) refers to possible unpleasant feelings the word evokes and (+) refers to pleasant sentiments. For the Data Processing this scale is substituted with an equivalent scale, marked from 1 to 7, where the -3 of the initial scale obviously corresponds to the quotation 1 of the new scale and the +3 of the initial scale corresponds to the 7 of the new scale.

The answers are initially modified into a "Burt table" in which the words are intersected to the quotations from 1 to 7.

This table is analyzed through "Correspondence Factor Analysis" so as to trace the way the word has been rated and at the same time to draw statistical conclusions.

Afterwards, the table of answers is analyzed through the method of "Principal Components Analysis"

On the factorial components all words are projected as well as complementary data –elements such as the variables which characterize social, financial and demographic information, as well as questions of behavior and disposition of the people questioned.

The analysis may be enriched by the creation of contingency tables, which complement the researcher’s knowledge on the topic under investigation.

**Historical retrospection**

The initial semiometric analysis of about 11.000 French citizens between 1990 and 2002 demonstrated the stability of the factor axes in relation to the time the samplings were realized and the age and sex of the questioned people.

Thus, in the pole of each axis, a “perception-moral value” was associated with, so that each factor axis was appointed by two contradictory moral values. It should be mentioned that the semiometric plan created in this research, derived from the collaboration between Jean Francois Steiner and the International Association of Communication, Taylor Nelson Sofres.

The complete application of the principles of Semiometry in the market research, presupposes the comparison of the average quotation of the 210 words which were produced by the first population (the one observed by the Sofres Association) to the average quotation of the same words produced by the second population (sample of comparison), based on the statistical test which referred to the control of difference of the two means, in order to specify not only over-rated words, but also the under-rated ones by the questioned people of the sample of comparison. Consecutively, the words of the semiometric plan are located, thus giving the researcher the opportunity to draw his own conclusions.

**The semiometric plan**

Figure 1 presents the semiometric plan 2X3 in which the perceptions “Pleasure-Duty” (Plaisir- Devoir in French) are juxtaposed, while on the vertical axis (3rd semiometric axis) the perceptions “Attachment-Detachment” (Attachement-Detachement) are contrasted.

At this point, it should be mentioned that the first factorial axis, which is under the name “axis of behavior”, has the characteristic that all the words are arranged on it on the basis of their quotations. Consequently, since the group of words used is regarded with positive grades, it is reasonable that these words are placed on the one side of the axis, whereas few ones are placed on the opposite side.

**Statistical processing**

The suggested methodology has been applied to 242 students of the 3rd grade of a senior High School. The words used for the particular survey are presented on the table below. The analysis was realized by the software MAD.

Table 1 : The 15 semiometric words of the survey

Words					
W1	Stress	W6	Knowledge	W11	Studies
W2	Absence	W7	Favour	W12	Career
W3	Evaluation	W8	Teacher	W13	Fellow student
W4	Grace	W9	National Exams	W14	T. E. I
W5	Book	W10	Universtiy	W15	Frontistirio- tutorial school

The table of data to be used for further analyses after the transformation of the initial quotations given to the 15 words is presented below:

Table 2: Part of Data Table

IND	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
I1	1	1	7	1	7	7	7	1	1	1	1	1	1	1	1
I2	4	3	5	4	3	7	3	4	6	7	7	5	6	3	2
I3	1	2	7	4	6	7	7	5	3	5	7	7	7	4	4
I4	7	4	4	6	5	6	5	6	7	6	6	6	7	7	1
I5	1	3	4	3	5	7	7	6	1	7	7	7	7	2	1

I6	2	1	3	1	5	5	6	4	1	6	7	7	6	4	2
I7	3	3	4	4	6	7	6	4	2	6	6	7	7	4	4
I8	4	4	4	4	3	5	6	5	4	4	5	4	7	4	1
.															
.															
.															
I240	I240	5	4	6	6	3	5	4	1	6	1	6	5	4	6
I241	I241	1	1	1	1	7	6	1	1	4	4	4	7	7	7
I242	I242	1	1	6	7	3	6	4	1	7	3	5	7	7	5

Table 3 is derived from Table 2. It presents the general view on how the Greek students graded the 15 words.

Table 3. The grading of the 15 words.

ind	--1--	--2--	--3--	--4--	--5--	--6--	--7--
W1	84	34	34	50	18	7	15
W2	45	30	41	83	15	12	16
W3	30	24	34	66	22	38	28
W4	37	18	29	54	25	36	43
W5	36	14	31	62	43	35	21
W6	14	4	14	27	44	60	79
W7	18	4	15	69	39	51	46
W8	37	16	22	67	32	38	30
W9	90	29	23	35	20	15	30
W10	16	8	8	32	17	47	114
W11	7	6	5	21	27	56	120
W12	10	8	4	37	24	48	111
W13	13	6	8	31	29	35	120
W14	29	9	21	74	35	24	50
W15	56	27	18	53	39	24	25

Based on table 3, the following figure arises.

Table 4

	--1--	--2--	--3--	--4--	--5--	--6--	--7--	TOTAL
SUM	522	237	307	761	429	526	848	3630
AVERAGE	34.80	15.80	20.47	50.73	28.60	35.07	56.53	242
PERCENTAGE	14.38	6.53	8.46	20.96	11.82	14.49	23.36	100

Memorandum: the quotation 522 for instance is the sum of frequency of the grading “1” for the total of 15 words. The quotation 34.80 results from the quotient 522/15. The interpretation of each average quotation is as follows: from the 242 students, 34.80 graded the total of the 15 words with “1”, 15.8 students with “2”, and so on, while 56.53 students (that is 23.36% of the 242 students) used the grade “7”.

It must be indicated that the factors of correlation among the 15 words were – in majority- low. The largest correlation was 0.63 between the words “Evaluation” and “Grade”, followed by the factor 0.59 between the words “University” and “Studies”. The factor of correlation between the words “Studies” and “Career” was 0.57, which is an indicator of the wise choice of the words for this particular survey.

### The semiometric plan

The various semiometric axes were formed after having analyzed Table 3, which shows the grading that 242 students gave to 15 words (through the method of Analysis in Main Components), as well as taking into account the students’ sex, how they imagined their University social life, how important they considered the University Degree for their professional career as complementary variables.

The semiometric plan 2X3 (Figure 2) brings on surface the main semiometric structure of the survey, which is the basic aim of the present research. Through application of the method VACOR on the data of Table 3, three classes are constructed. These classes present interesting psychological reactions of the students.

The typology of those three classes (Figure 3) is as follows:

Class 25 = {W5, W6, W7, W8, W15}

Class 26 = {W10, W11, W12, W13, W14}

Class 27 = {W1, W2, W3, W4, W6}

The psychograph of the students who form the three specific above mentioned classes is:

**With reference to Class 25: Book (W5), Knowledge (W6), Favour (W7), Teacher (W8), Tutorial School (W15). This class is characterized by the environment where the students' lives take place.**

Regardless whether the model of learning applied on the school environment of the survey or not, the "teacher" had always had a role –either central or supporting- in the educational process and the "knowledge" is closely connected to the notion "teacher".

Nevertheless, the word "book" is not possible to be isolated from the word "knowledge" since it contains the recording of "knowledge". Moreover, the "teachers" of various schools become daily objects of comparison with the teachers from the students' "frontistirio (tutorial school)". Yet, "frontistirio (tutorial school)" claim that it aids students to systemize their "knowledge".

The participation of the word "favour" is very interesting within the system of words. Students try –consciously or subconsciously- to gain the "teacher's" "favour" thinking that the "teacher" will pay special attention to his constructive collaboration with the students, so as the individual learning of each student will be promoted and maximized for the national examinations.

Also, "learning" –that is the acquisition of "knowledge" - is an activity completed within the social environment. Additionally, the pursuit of acquiring close personal relationships, as well as the effort of someone to be popular, contains structural elements of someone's social life.

**In relation to Class 26: University (W10), Studies (W11), Career (W12), Fellow student (W13), Technological Educational Institute –(T.E.I) (W14). This group is characterized by the concern and anxiety of students for their future.**

It is self-evident that in the minds of the students who answered the questionnaire of the present research, the terms "studies", "University" and "TEI (Technological Educational Institute)" are correlated.

Besides this, the students participated in the present survey just a few days before the national examinations and consequently the institutes they chose for their academic studies were the Greek "University" and the "TEI". So, they had no reason to dissociate "University" and "TEI" from their "studies".

Similarly, the correlation of "Studies" and "Career" is quite logical, since in contemporary Greece, due to over-offering of employment on one hand and decrease of working places on the other, youngsters tend to identify "Career" and successful professional life with the acquisition of loads of qualifications.

It is also of big interest, the correlation between the terms "Fellow student" and "Studies", "University", "TEI" and "Career". This can be rather explained by the insecurity of the Greek young people for the social life that lies in front of them. They want their "Fellow students" whom they already know and trust, as fellow travellers to the unknown and unfamiliar surroundings of the University and perhaps of the new city they are going to study at.

They have grown up with their "fellow students", they have acquired together self-awareness and realised how human relations function. Collaborators, friends, professional relations and generally every relation that someone has or does as an adult, is seen under the scope of personal profit and benefit by the students who seem to know a lot about the lives of the grown ups and how difficult are guileless acquaintances in the world of adults.

Thus, they correlate their "fellow student" with their studies because they want to have a stable social life which is about to be transformed very soon.

**In relation to Class 27: Stress (W1), Absence (W2), Evaluation (W3), Grades (W4), National Examinations (W9). This group is characterized by the stress which possesses the students' everyday lives.**

School life is a period of transition. At the end of this period, the students are given the opportunity to fulfil one of their main ambitions, such as professional high salaries during the rest of their lives. The fulfilment of this ambition is considered to be achieved through the "national examinations". The pressure that students face at the period of those exams either directly as an objectively difficult task, or indirectly as a demand of their family or the society in general for higher education undermines their psychological well-being and their health.

All those elements that contain part of the Greek Secondary Educational System in Senior High Schools in particular, charge the students with sentiments of "stress" and anxiety. This daily "stress" that Secondary School student experience is connected to the word "absence", because the absence from either the school or the tutorial school might be fatal in the eyes of the students, since that particular day of the student's absence the teacher might give educational clarifications of vital importance.

Since “stress” is -especially nowadays- a common human sentiment under circumstances of high pressure, it is possible to be connected to “Absence” from school, a fact which may have negative consequences for the student’s personal preparation for the national exams.

Moreover, “stress” is undoubtedly connected to “Evaluation”, because evaluation at school is for the student a general test before the national exams, something like the “dress rehearsal” in theatre.

By extension, “stress” is connected to “Grades”, as school grades include the qualitative expression of a student’s evaluation.

## **Conclusion**

It is common knowledge that words, apart from the memories that raise to people, have the power to evoke pleasant or unpleasant feelings. Taking advantage of those properties of the words we are in position to create very simple questionnaires for the market research, which are “neutral”, that is to say “questionnaires not guided by the researcher towards certain answers”.

Generally, the suggested by this paper technique of questionnaires’ processing targets at the evaluation of the asked persons’ feelings, which are evoked by the hearing of a certain and limited amount of words, which are all relevant to the subject of the research. The decision of the words’ selection and listing seems arbitrary at first sight. However, it aims at the tracing and bringing on surface of the innermost thoughts of the persons under question. Those thoughts might not have been revealed through a different form of questions.

Conclusively, this proposed approach for questionnaires’ processing offers the researcher an unprecedented experience. To be more specific, the proposed technique:

- i) Does not aim at collecting opinions via questions that are presented in the form of a sentence. For such questions the researcher not only has difficulty in proposing scaled answers, but he is also obliged to make long questions in order to be understood by the person under question.
- ii) The number of questions –using this method- is undoubtedly limited, and therefore the time needed to fill in the questionnaire is limited too. Those two are basic for the reliability of the answers parameters.

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Appendix

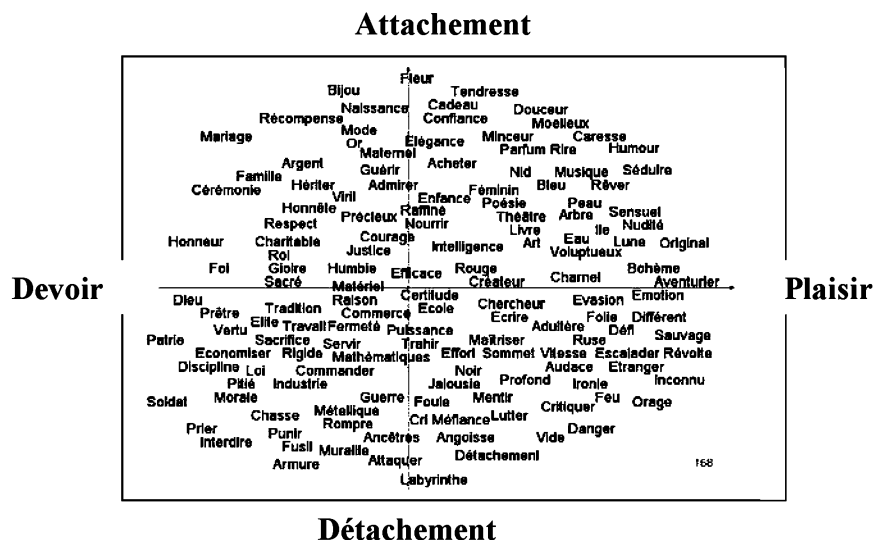


Figure 1: Classic Semimetric plan

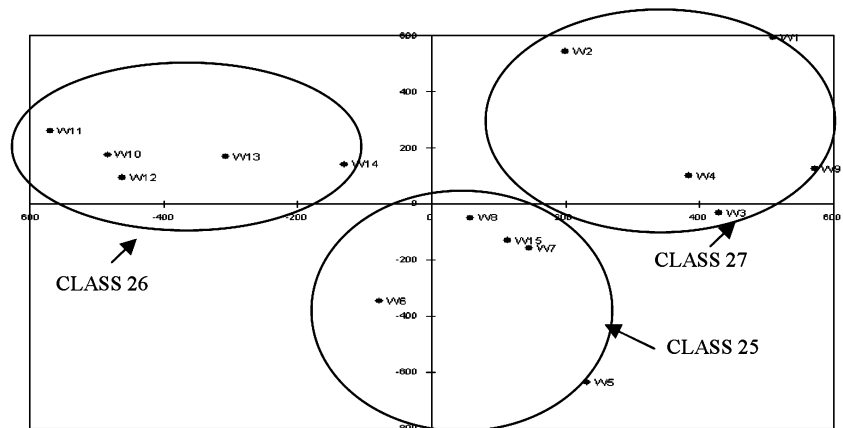


Figure 2: Semimetric plan 2x3 of the present research

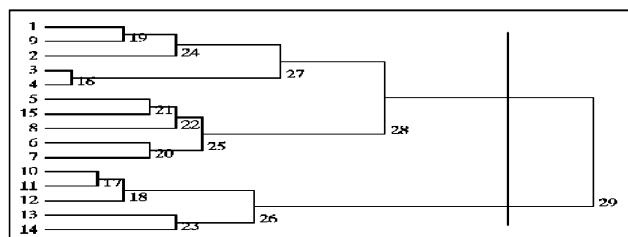


Figure 3: Dendrogramme for 15 words

# MANAGEMENT ACCOUNTING AND TOURISM ORGANIZATIONS: THE CASE OF THE KOZANI TOURIST COMPANIES

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## Abstract

*The tourist sites of Kozani are the major tourist attractions in western Macedonia, attracting over half a million visitors per year. They are unique in that they are culture sites and must be preserved as national monuments but at the same time they function as modern business enterprises. This paper explores the role of management accounting in the tourist sites in Kozani. The paper is motivated by the lack of management accounting research in the tourism sector in general. The analysis is based on a case study of four of the public tourist companies that are currently in operation in Kozani region. Data were collected from semi-structured interviews, informal discussions and document analysis. Drawing on ideas from New Institutional Sociology (NIS) we argue that the operations and decision making, including the role of management accounting information in the public tourist companies are shaped by the need for the companies to legitimize themselves as national monuments and at the same time innovate to remain competitive in a changing tourism environment. The ownership of the majority of the companies by the Municipal Councils also made the operations and decision making of these companies subject to local politics.*

## Περίληψη

*Τα τουριστικά αξιοθέατα της Κοζάνης είναι τα κυριότερα τουριστικά σημεία προσέλκυσης τουριστών στην Δυτική Μακεδονία. Είναι μοναδικά ως σημεία πολιτιστικού ενδιαφέροντος και προστατεύονται ως εθνικά ήθη και έθιμα αλλά από την άλλη πλευρά οι εταιρίες πρέπει να συμπεριφέρονται ως μοντέρνες επιχειρήσεις. Το άρθρο αυτό ανακαλύπτει τον ρόλο της διοικητικής λογιστικής στις τουριστικές εταιρείες στην Κοζάνη. Το άρθρο αυτό έρχεται να καλύψει το κενό για έρευνα στον τομέα της διοικητικής λογιστικής στον τουριστικό τομέα. Η ανάλυση βασίζεται στην μέθοδο της περιπτωσιακής μελέτης σε τέσσερις τουριστικές δημόσιες εταιρείες που λειτουργούν στην Κοζάνη. Τα δεδομένα συλλέχθηκαν από συνεντεύξεις, συζητήσεις και αρχειακή έρευνα. Βασισμένη στην νέα θεσμική κοινωνιολογική θεωρία συζητούμε ότι η λήψη αποφάσεων περιλαμβάνοντας και τον ρόλο της διοικητικής λογιστικής σχεδιάζοντας από την ανάγκη των δημοτικών επιχειρήσεων να παραμείνουν στα πλαίσια της δημοτικού κώδικα αλλά την ίδια στιγμή να παρουσιάσουν ανταγωνιστικές μεθόδους σε ένα ευμετάβλητο περιβάλλον. Η ιδιοκτησία των επιχειρήσεων αυτών ανήκουν στους δήμους και οι αποφάσεις λαμβάνονται όχι μόνο από τα δημοτικά συμβούλια αλλά επηρεάζονται και από την τοπική κοινωνία.*

*Keywords: Management Accounting; Tourism; New Institutional Theory*



## **1. Introduction**

One of the tourism areas not much research has been focused on is the decision-making process in the Tourism companies. Thus the operations and the management process of the Tourism companies are minimally understood due to a lack of empirical research. For instance, the ownership of the tourism companies varies. Ten out of the twelve tourism companies of Kozani are owned by the local municipal councils, one by the Prefecture, and one by the local chamber of commerce. The management of the municipal and prefecture controlled tourism companies is very politicized as a change in local government usually results in changes in their decision making. The municipally controlled companies are, for example, controlled by the respective mayors, who are elected in local elections. A change in mayor normally results in changes in policies and this often has significant implications for the management and operations of the companies. Different municipal governments have different emphases for the companies in their budget allocations.

The ways in which managers in the tourism companies use accounting information in performing their day-to-day decision making is an empirical question which this thesis seeks to address. As mentioned above, some researchers have argued that accounting information is minimally used in decision making in Greek organizations as their managers often tend to prefer information from informal sources (Ballas, 1994).

## **2. Literature Review**

Very little is yet known about management accounting and its use in tourism enterprises. Researchers in management accounting have traditionally been, above all, interested in the accounting systems of large manufacturing companies. In addition to that, most accounting researchers interested in service production have conducted their research in non-profit seeking, public-sector organizations (Olsen et al., 1998).

There are researchers, for example, Templeman and Wootton (1987), who argue that the relationship between small company owner-managers and their accountants is primarily an economic one. The current demand for accountants' reporting services is driven by regulatory requirements and, as many owner-managers possess limited financial skills, they do not understand or use the information produced.

One of the objectives of this article is to understand the decision-making practised in tourism enterprises in their real-life contexts. The more specific research topic is the pricing of tourism products, as pricing is one of the most central management tasks in which cost information may be of use. However, decision making is not presumed to be necessarily rational (cf. Simon, 1976; Weick, 1995). The theoretical framework applied is in accordance with the non-rational decision-making school in organisation studies, suggesting that organisational goals may be unclear or changing (Cohen et al., 1972); the search for alternative ways of action may be limited and local (Cyert & March, 1963); the process of analysis and choice may be politically motivated (Pfeffer, 1981), incremental in nature (Lindblom, 1959) and routinized by the application of procedures (Cyert & March, 1963) or more incidental than considered (March & Olsen, 1976).

## **3. Theoretical framework**

Scott (1987) argues that since the early period, institutional theory and research have developed rapidly and currently occupy a prominent place in the field of organizational analysis. Zucker (1977) and Powell and DiMaggio (1991) have written several papers in this field. Meyer and Rowan (1977) argue that one of the central problems in organizational theory is to describe the conditions that give rise to a rationalized formal structure. They argue also that as markets expand, the relational networks in a given domain become more complex and organizations in that domain must manage more internal and boundary-spanning interdependencies.

Meyer and Rowan (1977) argue that there are some myths which describe the elaboration of complex relational networks in society or some myths that describe specific structural elements. For example, laws, educational and credentialing systems and public opinion then make it necessary or advantageous for organizations to incorporate the new structures. Meyer and Rowan stated that the myths generated by particular organizational practices and diffused through relational networks have legitimacy based on the supposition that they are rationally effective.

The other foundation work of the New Institutional Theory is the article by DiMaggio and Powell (1983). New Institutional Theory is based on the premise that organizations respond to pressures from their institutional environments and adopt structures or pressures that are socially accepted as the appropriate organizational choice. DiMaggio and Powell (1991) suggest that the term "New Institutionalism" rejects the

previous model of rational-actor. Further, DiMaggio and Powell suggest the idea of an interest in institution as an independent variable and an interest in properties of the supra-individual unit of analysis that cannot be reduced to aggregations or direct concentrations of individuals' attributes or motives.

#### 4. Research Approach

Questionnaire data was collected from the four tourism companies which the in-depth case study focuses on. Limiting the case study to only four tourism companies was necessary to provide an in-depth analysis of the underlying management accounting practices. Some questions were developed based on the literature, others were developed based on the researcher's personal experience.

To explore the role of management accounting in decision making in the companies, the research was divided into three phases:

1. Phase one included gathering background information about the organizations by means of a questionnaire.
2. Phase two consisted of gathering various documents with details of decision making, data about them, and discussion of them.
3. Phase three consisted of conducting semi-structured interviews with the managers of the companies. There are four major Tourism companies in Kozani, each run by a separate organization or "company". Three of the companies are controlled by the municipalities in which they are located and one is controlled by the local prefecture. The four companies are therefore largely public rather than private enterprises (although one or two operate as if they were private enterprises), with their respective "owners" making appointments to their boards of directors. The companies have competitors, make their own decisions and are evaluated on their profitability. Most of the companies were established in the 1990s, with a few established three decades ago. Their average turnover is about €500,000 and their average net worth €50,000. The average number of employees within the companies is 20, half of whom are casual employees. None of the companies operates only seasonally.

The research was conducted by a survey of four companies, followed by intensive case studies of these. The four companies selected for the case study attract over 70% of the total number of visitors in Kozani. Three of the companies are controlled by municipal councils and the fourth by the local Prefecture.

In order to ensure confidentiality, the companies are referred to as Alpha, Beta, Gamma and Delta. Table 4.1 provides some background of the companies.

**Table 4.1 Tourism Organizations**

Organization	Ownership	Staff* No.	Annual Turnover (Euro)	Industry / Tourism	Objective
Alpha	Municipality	25	300,000	Service	Profit, socially responsible
Beta	Municipality	15	450,000	Ditto	ditto
Gamma	Prefecture	21	350,000	Ditto	ditto
Delta	Municipality	18	550,000	Ditto	ditto

\*Staff are both full-time and permanent; however, most of the companies also employ additional casual staff during the peak season.

Overall, only a small number of the employees in any of the companies are involved in the decision-making process in their respective organization. The number of employees so involved varies between 20% and 35%. In all four of the selected companies, Alpha, Beta, Gamma and Delta companies, decision making is the responsibility of managers at all levels: senior, middle and junior. The managers selected for the semi-structured interviews were all involved in the decision-making process in their respective organizations, and all were happy to participate in the research. All the participants were male and all were Greek nationals. Table 4.2 shows the number of senior, middle and junior managers interviewed.

**Table 4.2 Managers Interviewed**

Managers (by Seniority)	Companies				
	Alpha No.	Beta No.	Gamma No.	Delta No.	Total No.
Senior Managers	1	1	1	1	4

Middle Managers	2	1	2	2	7
Junior Managers	3	2	3	2	10
<b>Total</b>	<b>6</b>	<b>4</b>	<b>6</b>	<b>5</b>	<b>21</b>

The interview participants selected from each company include senior, middle and junior managers in both accounting and non-accounting positions. Table 4.3 shows the number of managers interviewed who were / were not involved in accounting.

**Table 4.3 Managers Interviewed: Involvement in Accounting**

Managers (by Seniority)	Companies							
	Alpha No.		Beta No.		Gamma No.		Delta No.	
	Accounting		Accounting		Accounting		Accounting	
	yes	no	yes	no	Yes	No	yes	no
Senior Managers	1	0	1	0	1	0	1	0
Middle Managers	2	1	2	1	1	2	1	1
Junior Managers	2	1	2	1	2	1	2	1
<b>Total</b>	<b>5</b>	<b>2</b>	<b>5</b>	<b>2</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>2</b>

## 5. Findings

The first major finding of the research is that overall there is less reliance on accounting information such as the budget in day-to-day decision making. Thus, in practice budgets are minimally used as key management planning and control tools. Moreover, budgets play minimal roles as performance evaluation and motivational devices. There is minimal participation of lower-level managers in setting budgets in all four organizations. A top-down approach is therefore used to set budgets, and budgets are imposed by top management on lower-level managers. The minimal accounting knowledge possessed by the majority of the managers also reduced the extent to which budgets are relied on as planning and control tools in the show cave companies. For example, managers rely minimally on budget variance reports because the majority believe the reports are not tailored to their needs.

Institutional change affects the decision-making process in the management and operations of the companies. When there is a change of mayor or of the board of directors, this will lead to a change of company procedures as well as of investment decisions. Many times the profession, the mayor or the chairman of the board will influence decision making, requiring more bureaucratic procedures if the mayor is a civil servant or less if the mayor or the chairman of the board is a private sector employee. The findings also shows that in Alpha, Beta and Delta companies any shift in the administration always leads to a shift to a more strictly bureaucratic procedure or to the advocacy of investments for the benefit of the municipality rather than for the companies.

There are many similarities and differences in the operation and management of the tourism companies. However, the uses of accounting information between the companies are almost identical. The main institutional forms that shaped decision making and the uses of accounting data in the companies are discussed in the reminder of this section, under the headings of the three different forms of institutional isomorphism identified by DiMaggio and Powell (1983).

**Coercive isomorphism:** Alpha, Beta, Gamma and Delta companies are all subject to “coercive isomorphism”, resulting from both official and unofficial pressure by other organizations, primarily the local municipal council in the case of Alpha, Beta and Delta companies and the local prefecture in the case of Gamma Company, which in turn are dependent on other organizations and members of society in general (and voters of course). These influences correspond to the factors identified by DiMaggio and Powell (1983) in their article about isomorphism, where they stated that legitimacy is a question of cultural theory and speaking on behalf of theory requires cultural licenses.

The findings show that Alpha Company recommends that some investments be made in the municipality, although stating that it is not obliged to make them. These findings show a correspondence with the findings of Greenings and Gray (1994) and Meyer and Scott (1983).

Gamma Company is owned by the local prefecture. While this means that Gamma Company is also under “coercive” pressure from the prefecture authority concerning employment and investment decision making since its board of directors requires assistance from the prefecture authority to acquire areas of land for development by the company.

The municipality's participation concerns the company's board of directors, who need the help of the municipality to acquire land for development activities free of charge, what is similar to the findings by Meyer and Scott (1983), Mizuchi and Fein (1999) and Carpenter and Feroz (2001), who showed that the political survival of government officials depends on their ability to negotiate exchange with the environments.

**Mimetic isomorphism:** Alpha, Beta, Gamma and Delta companies are all subject to "mimetic isomorphism", realized in similar ways and for similar reasons. Especially in the early stages of its operation, Alpha Company relied heavily on imitating the organizational details of other show cave companies, such as a company's investment program, budget development, management regulations, company reports and regulations of services. The form of mimetic isomorphism practised by all four companies was how they set the prices for their services – they imitated other companies rather than taking into account their own costs. They did this whether they had been in operation a long time (such as Gamma) or only a relatively short time (such as Alpha and Beta companies). In addition, Gamma Company sought to copy other companies' regulations concerning management and staff to achieve a more effective operation.

The reason the companies were all subject to mimetic isomorphism is more or less the same for all, namely, facing organizational problems, uncertainty about their future – one of the reasons for mimetic isomorphism identified by March and Olsen (1976) – and having failed to make their goals clear, with the latter most certainly contributing to the former. In addition, the uncertainties felt in Beta Company by the board of directors led to the employment of a general manager, who was given a number of responsibilities, including cooperation with experienced accountants and the gathering of better accounting information.

Furthermore, imitation was also followed in decision making in the planning of new services. Gamma Company previously held the view that new services were not needed to expand its activities. However, after seeing what other companies were doing, Gamma Company was motivated to imitate them in the planning of new services.

Moreover, Delta Company was heavily affected by the Greek Government's budget, being forced to copy many of the actions already being taken by other companies, such as increasing funds for the municipality and intense monitoring of its management costs. The appointment of the mayor as chairman of the board of directors contributed to increasing the flexibility of some of its practices.

**Normative isomorphism:** While some of the practices followed by the four show cave companies are essentially fixed, thus showing them to be practising "normative isomorphism", this is not as uniformly so as for the other two forms of isomorphism, nor are the reasons for them practising normative isomorphism as uniform.

Alpha Company's current board of directors and Delta Company's previous board are composed of many former members of the local Chamber of Commerce, and these boards are inclined to make decisions in favour of professionals' fixed practices.

Furthermore, the chairman of Beta Company's board of directors is a municipal councillor who is a teacher at a state school, and thus the board's decision making is inclined to favour fixed practices, for example, in the development of the budget. The decision making at Gamma Company is similarly influenced by external factors, in this case by the local union, which exerts pressure on the company to employ guides who are specialists in Tourism. The general manager of Gamma Company stated that he has often proposed that the planning of services should be conducted based on the convenience of services; however, the board of directors frequently made planning decisions that took into account the "fixed" interests of Tourism economists.

In terms of conducting accounting research, New Institutional Theory (NIT) has a significant empirical application. The research shows that New Institutional Sociology (NIS) is methodologically and empirically sound and is a suitable framework for explaining the decision-making process in the tourism companies in Kozani. Using NIS, researchers will be able to integrate both the social and technical phenomena of the decision-making process and provide explanations for the functioning of a particular management accounting control systems.

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# A THRESHOLD MODEL FOR MONETARY POLICY RULES FOR OPEN ECONOMIES

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## Abstract

*This paper estimates monetary policy reaction functions that allow for open economy. The famous Taylor rule is referred to a closed economy in which the interest rate depends on the inflation and output deviations from their target values. In an open economy the interest rate depends not only on the inflation and output deviations but also on the percentage change of the real exchange rate or the nominal interest rate of a foreign country. We consider a threshold type nonlinear monetary policy model that allows the existence of two policy regimes according to whether the output gap or the level of the unemployment rate is above or below a threshold value. We estimate the threshold parameter through the method of maximum likelihood. The results reveal asymmetries in the policy reaction functions which are associated with large output gap or high level of unemployment rate.*

*JEL Classification: E52, C13, C30*

*Keywords: Nonlinear Taylor rules, monetary policy, open economy, inflation targets, joint maximum likelihood estimation, threshold value, switching regime*

## 1. Introduction

There is a growing number of simple monetary policy rules that the central banks may follow. The pioneering work of John Taylor who implemented a simple interest rate rule for the U.S. (Taylor 1993) has challenged the policy makers' interest. According to this rule the interest rates are adjusted in response to real output and inflation deviations from their target values. The literature that stems from this fact contains simple backward and forward looking rules, rules that allow for interest rate smoothing or not and also research that compares rules responding to alternative intermediate and final targets. Many economists advocate that the inflation targeting should be implemented through a simple Taylor rule. Ball (1997) and Svensson (1997) use optimal policy rules that are versions of inflation targets and Taylor rules.

These simple policy rules refer to a closed economy. For the case of an open economy, an economy where the exchange rate channel of monetary policy plays an important role in the transmission mechanism, the simple Taylor rule has to be modified. The model proposed by Ball (1999) assumes that the optimal policy instrument is a Monetary Condition Index based on both the interest rate and the exchange rate. He also replaces inflation with "long-run inflation", a variable that filters out the transitory effects of exchange rate fluctuations. Batini et al (2001) specify and evaluate a set of simple monetary policy rules that are suitable for a small open economy like the United Kingdom. The set of these simple rules also includes the simple Taylor rule and the rule proposed by Ball (1999). They come to the conclusion that an inflation forecast base rule, a rule that reacts to deviations of expected inflation from target, is a good simple rule. Adding in this setup contemporaneous and lagged levels of the real exchange rate the improvement is marginal. But this rule, with or without exchange rate adjustment, seems to be robust to different shocks in contrast to Taylor or Ball's rule.

Svensson (2000) uses a model with forward looking agents and explicit microfoundations regarding a policy rule where the short term nominal interest rate reacts to inflation, to the deviation of the real GDP from potential and to contemporaneous and lagged values of the real exchange rate. His simulations show a deterioration of the output performance. Taylor (1999) examines an analogous monetary policy rule to that of Ball and Svensson for the European Central Bank. His simulations lead to the conclusion that there are small performance improvements from a policy rule that reacts to the exchange rate or that the performance may be worse. McCallum and Nelson (2001) propose an alternative model to that of the New Open Economy Macroeconomics models. They construct a model by treating imports not as finished consumer

goods but rather as raw material inputs to the home country productive process. The calibration of their small open economy model leads to the fact that this model performs better than the standard New Open Economy Macroeconomics models in terms of matching the dynamic behavior of nominal variables.

Clarida, Gali and Gertler (1998) estimate monetary policy reaction functions for two sets of countries: the G3 (Germany, Japan and the U.S.) and the E3 (U.K., France and Italy). They use a forward looking version of the standard Taylor rule for a closed economy where the nominal interest rate reacts to the expected future inflation deviation from target and the contemporaneous output gap. They also estimate alternative specifications allowing for additional variables such as the real exchange rate or a foreign interest rate. This is done in order to be examined whether the home country takes the foreign country's monetary policy as external constraint. They regard as a foreign country the U.S. and estimate reaction functions for the Bundesbank and the Bank of Japan. Their estimates reveal a significant but quite small reaction of the interest rate to the exchange rate or the foreign interest rate. For the case of the European countries Germany is regarded as the foreign country and the results show a significant and quite high response of the interest rate to the German interest rate.

Kazanas, Philippopoulos and Tzavalis (2007, 2008) estimate backward and forward looking threshold reaction functions for some major central banks and their results reveal certain nonlinearities that are associated with the output gap or the unemployment rate. In this paper we extend this specification trying to investigate whether or not nonlinearities arise in the monetary reaction function of a central bank when its monetary policy is constrained by a foreign country. This research considers nonlinearity in the central bank's reaction function assuming that the central bank sets first its interest rate according to a threshold value of the output gap. It also examines if the unemployment rate plays a significant role as another threshold variable. The goal of the paper is to examine if evidence of nonlinearity in the central bank's reaction function is due to certain events which are associated with the cycle of the economy. We estimate the threshold variable of the bank of Japan regarding that its monetary policy is constrained by the Fed and assuming that the bank of Japan conducts its monetary policy through choosing as instrument the nominal interest rate.

The plan of the paper is as follows. Section 2 presents the baseline features of the nonlinear monetary policy rules. Section 3 presents the estimation procedure of our threshold type models and the corresponding results. Section 4 concludes the paper.

## 2. Nonlinear Monetary Reaction Function

The linear monetary policy rules are based on the assumptions that the central bank has a quadratic loss function and the Phillips curve is linear. The monetary policy of the Fed in the U.S., as well as in many countries, has been described very well according to this type of policy rule. The framework that we develop considers a central bank that has at least some degree of autonomy over its monetary policy. For the major central banks the main operating instrument of monetary policy is a short term interest rate. Typically, the instrument is an interbank lending rate for overnight loans. The empirical reaction functions that are estimated characterize the way that the central bank chooses the level of the short term interest rate from period to period. The class of these policy rules assumes the existence of temporary nominal wage and price rigidities. With these nominal rigidities the monetary policy affects real activity in the short run. A central bank can effectively vary the real interest rate and the real exchange rate by varying the nominal interest rate. In stating the policy reaction function we assume that within operating period the central bank has a target for the nominal interest rate,  $i_t^*$ , that is based on the state of the economy. This target depends on lagged values of the inflation deviation from its target, the output gap and the percentage change of the real exchange rate. So, we have the following backward looking policy rule:

$$i_t^* = a + \beta(\pi_{t-1} - \pi^*) + \gamma \tilde{y}_{t-1} + \delta z_{t-1} \quad (2.1)$$

where  $\pi_t$  is the percentage change in the price level between periods  $t$  and  $t-1$  (expressed in annual rates),  $\pi^*$  is the inflation target and  $\tilde{y}_t$  is a measure of the output gap in period  $t$ .  $\tilde{y}_t$  is defined as the percentage change between actual GDP and the corresponding target (e.g. potential GDP). The variable  $z_t$  includes the percentage change of the real exchange rate. The parameter  $a$  is the long run equilibrium nominal interest rate when inflation and output are at their target values ( $a = r^* + \pi^*$ ) with  $r^*$  being the long run equilibrium real interest rate.



The monetary policy rule given by (2.1) is restrictive if someone wants to describe the actual changes in the nominal interest rate. One main reason for this is the fact that our form does not take into account the central bank's tendency to smooth changes in interest rates but assumes an immediate adjustment of the interest rate to its target value. This central banks' tendency for smoothing stems from various reasons such as the fear of disrupting capital markets, the loss of credibility from sudden large policy reversals, the need for consensus building to support a policy change. Moreover, the central bank may regard the interest rate smoothing as a learning device due to imperfect information. All these factors that mentioned are indeed very difficult to be captured. For this reason we assume following Clarida et al. (1998) that the actual rate adjusts partially to its target according to:

$$i_t = (1 - \rho)i_t^* + \rho i_{t-1} + \varepsilon_t \quad (2.2)$$

with the parameter  $\rho \in [0, 1]$  capturing the degree of smoothness and  $\varepsilon_t$  to be an i.i.d. exogenous shock with zero mean. Under this partial adjustment behavior the central bank wishes to adjust its instrument in order to eliminate only a fraction  $(1 - \rho)$  of the gap between its current target level and some linear combination of its past values. Substituting (2.1) into (2.2) gives the following model for the backward looking monetary rule:

$$i_t = (1 - \rho) \left[ a + \beta (\pi_{t-1} - \pi^*) + \gamma \tilde{y}_{t-1} + \delta z_{t-1} \right] + \rho i_{t-1} + \varepsilon_t \quad (2.3)$$

The above monetary policy rule assumes that the monetary authorities respond symmetrically to the variables of interest. But there is strong evidence that asymmetrical monetary policy rules may be attributed to asymmetrical central bank preferences or nonlinear structure of the economy. For that reason we adopt a monetary policy rule that will depend on whether a threshold variable is lesser or greater than a specific value. This rule takes into consideration that there are two different regimes governed by a threshold variable. For a value of the threshold variable less than or equal to the threshold parameter the central bank will follow the first regime while for a threshold variable value greater than the threshold parameter the central bank will follow the second regime. That is, the monetary policy rule is specified as

$$i_t = \begin{cases} (1 - \rho) \left[ a + \beta (\pi_{t-1} - \pi^*) + \gamma \tilde{y}_{t-1} + \delta z_{t-1} \right] + \rho i_{t-1} + \varepsilon_{1t}, & \text{if } q_{t-1} \leq \bar{q} \\ (1 - \rho) \left[ a + \beta' (\pi_{t-1} - \pi^*) + \gamma' \tilde{y}_{t-1} + \delta' z_{t-1} \right] + \rho i_{t-1} + \varepsilon_{2t}, & \text{if } q_{t-1} > \bar{q} \end{cases} \quad (2.6)$$

where  $\bar{q}$  is the threshold parameter and  $q$  denotes the threshold variable. The innovation terms are assumed to be distributed as  $\varepsilon_{1t} \sim i.i.d.(0, \sigma^2)$  and  $\varepsilon_{2t} \sim i.i.d.(0, \sigma'^2)$ . In the above specification, note that only the coefficients of inflation deviation from its target, the output gap and the real exchange rate are assumed to change their values between the two regimes. This means that the long run nominal interest rate  $a$  and the smoothing parameter  $\rho$  are constant across the two regimes. The above nonlinear model of monetary policy rule assumes that the threshold parameter is unknown. As threshold variables we will consider the first lag of the output gap and the first lag of the unemployment rate. The nonlinear model (2.5) can be employed to investigate how the central bank changes the magnitude of its reaction to the output gap and inflation deviations during recessions and expansions.

### 3. Empirical Results

In this section we estimate the policy reaction functions for the Bank of Japan assuming that its monetary policy is constrained by the Federal Reserve Bank of the U.S. The way that these central banks conduct their monetary policy has changed since the late of 70's. After nearly a decade of high inflation the inflation control became a major concern for the above central banks. We report our data set and after that we describe the estimation procedure to obtain our results.

#### 3.1. Data

We use quarterly observations from 1972:I to 2006:IV. The interest rate is the respective interbank lending rate: the "Call-Money" rate for Japan and the Federal Funds rate for the U.S. expressed at annual rates in the first month of each quarter. For both countries the inflation is measured as the annualized rate of the GDP

deflator defined as  $P_t = \frac{\text{nominal } GDP_t}{\text{real } GDP_t} \cdot 100$ . More specifically, inflation is calculated as

$\pi_t = (P_t - P_{t-4}) \cdot 100$ . As a measure of the output gap we employ the percentage change between real GDP

and potential real GDP  $\left( \tilde{y}_t = \frac{\text{real } GDP_t - \text{real potential } GDP_t}{\text{real potential } GDP_t} \cdot 100 \right)$ . The real GDP and the real potential

GDP are expressed in annual rates with the year 2000 being the base year. The unemployment rate is the seasonally adjusted civilian unemployment rate including persons 16 years of age and older at the last month of each quarter. We also use the level of the nominal yen/dollar exchange rate,  $e_t$ , to construct the annualized percentage change in the real exchange rate,  $\epsilon_t$ , as follows:

$$\% \text{ change in } e_t = \% \text{ change in } \epsilon_t + (\pi_t^{JP} - \pi_t^{US})$$

All these series were downloaded from the OECD database for the case of Japan and from the Federal Reserve Bank of St. Louis for the U.S.

### 3.2. Estimation of the baseline model

Before we estimate the baseline model, we give some descriptive statistics for our variables. These statistics are given in Table 1. The average output gap is negative for both countries, being near to zero for the case of Japan. U.S. has higher interest rates, inflation and unemployment rate than Japan.

Our baseline model is:

$$i_t = c_1 + c_2 \pi_{t-1} + c_3 \tilde{y}_{t-1} + c_4 z_{t-1} + c_5 i_{t-1} + \varepsilon_t \quad (3.1)$$

where  $c_1 = (1 - \rho)(a - \beta\pi^*)$ ,  $c_2 = (1 - \rho)\beta$ ,  $c_3 = (1 - \rho)\gamma$ ,  $c_4 = (1 - \rho)\delta$ ,  $c_5 = \rho$ . We see that our model can't identify  $a$  or  $\pi^*$  through the term  $c_1 = (1 - \rho)(a - \beta\pi^*)$ . For this reason, we have to predetermine the long run nominal interest rate  $a$  or the inflation target  $\pi^*$  in order the model (3.1) to be identified. We choose to predetermine  $a$  so as to be able to estimate the inflation target  $\pi^*$ . We take as the long run nominal interest rate the sample mean of the nominal interest rate  $i_t$ . After that we are able to estimate  $\pi^*$  jointly with the parameters  $\beta$ ,  $\gamma$ ,  $\delta$  and  $\rho$ .

Using the augmented Dickey-Fuller test for unit root we have tested for the stationarity of the nominal interest rate, inflation, output gap series and exchange rate series. Our results give evidence for stationarity for all the variables employed in our analysis.

Table 2 reports estimates for the baseline reaction function parameters for the bank of Japan. In parenthesis we report the corrected test statistics for heteroskedasticity and autocorrelation. The results indicate an accommodative policy regarding the inflation deviation, as the coefficient  $\beta$  is below the unity despite the strong smoothing process. The coefficient of the output gap  $\gamma$  is statistically significant at the significance level of 10% and is greater than zero while the coefficient of the percentage change of the exchange rate is not statistically significant at the conventional levels indicating that the monetary authorities do not consider the fluctuations in the real exchange rate as a major problem. The estimation of the inflation target is  $\pi^* = 2.698$ .

In order to check whether the coefficients are stable in the whole period, or not we first apply the CUSUM test which is based on cumulative sums of squared residuals. According to this test we reject the null hypothesis that the coefficients are stable at a significance level of 5%. This test statistic finds structural breaks for the monetary rule in the mid 80's and 90's.

As there may be more than one change in the coefficients of the baseline model we next carry out Bai's and Perron (2003) tests for multiple structural changes. These tests allow us to estimate a pure or a partial structural change model with an unknown number of breaks. We carry out these tests in both, a pure structural and a partial structural model. In the partial structural model we allow the inflation gap, the output gap and the percentage change in the exchange rate coefficients to change among regimes. Also we allow the error terms in each segment to have different variance. In order to estimate the number of breaks, we use the Bayesian Information Criterion (BIC) and the method suggested by Bai and Perron which is based on the sequential application of the  $\sup F_T(l+1/l)$  test using the sequential estimates of the breaks. The results are

presented in Table 3. These find a number of structural changes in the coefficients at the start of 80's and 90's. Note that these breaks are very close to those found by the CUSUM test.

### 3.3. Estimation of the nonlinear model

The nonlinear model (2.6) can be employed to investigate how the central bank changes the magnitude of its reaction to the output gap, to inflation deviations and the percentage change of the exchange rate during recessions and expansions. Regarding the unemployment rate as a threshold variable the central bank reactions may be different between the low and high unemployment rate regimes. Our estimate of the threshold model assumes that the threshold value  $\bar{q}$  is unknown. In order to estimate the nonlinear model we construct the following joint log likelihood function\*:

$$L(\theta) = \left( -\frac{T_1}{2} \log(2\pi\sigma^2) - \frac{1}{2\sigma^2} \varepsilon_1' \varepsilon_1 \right) + \left( -\frac{T_2}{2} \log(2\pi\sigma'^2) - \frac{1}{2\sigma'^2} \varepsilon_2' \varepsilon_2 \right) \quad (3.2)$$

where  $\theta = (\alpha, \beta, \gamma, \delta, \rho, \beta', \gamma', \delta', \sigma^2, \sigma'^2)'$ . This log likelihood has to be maximized with respect to the population parameters.

To estimate the threshold parameter we follow Hansen's (1997, 2000) approach. We first sort our threshold variable in an ascending order and then the other variables according to the threshold variable. So we have an arranged data set, a data set that is sorted according to the threshold variable. After that we choose the value of the threshold variable that corresponds to the 15<sup>th</sup> percentile of the sample. Taking this value as the threshold value we split the whole sample into two sub samples and maximize the corresponding log likelihood function. We repeat this procedure up to the 85<sup>th</sup> percentile of the sample. This means that we have an adequate number of observations in the two sub samples in each case. The threshold value and the estimation of the parameter vector  $\hat{\theta}$  will be these values that correspond to the maximum value of the maximized log likelihood functions for each possible value of the threshold parameter.

To test model linearity ( $H_0: \beta = \beta'; \gamma = \gamma'; \delta = \delta'$  vs  $H_1: \beta \neq \beta'; \gamma \neq \gamma'; \delta \neq \delta'$ ), we estimate the likelihood ratio (LR) test statistic:

$$LR = -2(l_{restricted} - l_{unrestricted})$$

where  $l_{restricted}$  and  $l_{unrestricted}$  are the maximum likelihood functions for the restricted and unrestricted model respectively. Since the threshold parameter is not identified under the null hypothesis, this statistic has a non conventional distribution tending towards the supremum of a chi-square process. This asymptotic distribution can be replicated by bootstrap according to Hansen (1996). Following this approach we perform a non-parametric bootstrap simulation procedure in order to derive the empirical significance levels of this test statistic. The non parametric bootstrap that we apply has the following steps: 1. Estimate the restricted model using the full sample of T observations and store the residuals and the fitted values of the interest rate; 2. draw with equal probability and with replacement (bootstrap) from the vector of the residuals to make another  $T \times 1$  vector of residuals; 3. add this vector to the vector of fitted values of the interest rate obtained in step 1 to obtain an artificial vector of interest rate observations; 4. estimate the restricted and the unrestricted models using the artificial interest rate vector and construct a value of the LR statistic; 5. repeat steps 2-4 one thousand times. This gives one thousand simulated values for the LR statistic. The percentage of occasions that the simulated values of the LR statistic exceed the actual value of the LR statistic then corresponds to the empirical marginal significance level of the actual statistic.

We also construct the 95% confidence intervals for the threshold parameters. These confidence intervals are derived through the above bootstrap procedure. The results are summarized in Table 4.

The estimations show an asymmetric response of the central bank depending on the actual state of the economy. The likelihood ratio tests are in favor of rejecting the null hypothesis of linearity whether the output gap or the unemployment rate is used as a threshold variable. Regarding the output gap as the threshold variable we see that the first regime corresponds to output gap values less than or equal to 0.718%. We notice that the parameter of inflation deviation is statistically significant and below unity while the parameters of the output gap and the percentage change of the real exchange rate are not statistically significant. In the second regime which corresponds to output gap values greater than 0.718% all the parameters are statistically significant. More specifically the monetary authorities respond strongly to inflation deviations (as the corresponding coefficient is 2.314 > 1) but weakly to the output gap (0.828) and

\* The derivation of the log likelihood function is demonstrated in the Appendix.

the real exchange rate (0.495). The smoothing parameter remains high (0.895). We also see that the 95% confidence interval for the threshold parameter,  $[-2.536, 2.22]$ , includes zero.

Considering the unemployment rate as a threshold variable the central bank's asymmetric response pertaining to the inflation deviation, the output gap and the percentage change in the real exchange rate still exists. The estimated threshold value is 3.182%. In the first regime that corresponds to unemployment rate values of the previous quarter less than or equal to the threshold value, the parameters of the inflation, the output gap and the exchange rate are statistically significant. The reaction of the Bank of Japan is more strongly to output gap than inflation deviations (2.69 versus 1.34) while it is weak to the real exchange rate (0.436). In the second regime all the parameters of interest are not statistically significant a fact that means that the monetary authorities abandon the monetary rule. The smoothing parameter is higher than that of the previous cases (0.963). The 95% confidence interval of the threshold parameter,  $[2.005, 4.648]$ , includes the mean value of the unemployment rate.

Figure 1 entails the graphs of the output gap and the unemployment rate including their corresponding threshold values. We notice that the break quarters that are estimated by the Bai-Perron tests are captured by this nonlinear model. More specifically, when we regard the output gap as the threshold variable we see that our model captures the breaks in 1980:3 and 1981:3 and is very close to the break of 1991:2. On the other hand, when we allow the unemployment rate to be the threshold variable our nonlinear model seems to not follow the previous path. In this case the only break is captured in 1995:3 and is not according to that estimated by the Bai-Perron tests. As we see, the patterns do not indicate a strong relationship between the output gap and the unemployment rate. Indeed, the correlation coefficient is relatively low ( $\rho_{\hat{y},u} = -0.465$ ) indicating that the responses of the monetary authorities do not weighted equally to each threshold variable.

#### 4. Conclusions

The famous Taylor rule is a good instrument rule for the case of a closed economy. In an open economy this rule has to be modified in order to include the external constraints of the home country. For this reason, the percentage change of the real exchange rate is added to the classical monetary rule. The estimating adjusted monetary rule is subject to significant nonlinearity, a nonlinearity that is associated with the real side of the economy. More specifically, when the output gap lies below or the unemployment rate exceeds its threshold value the monetary rule don't be followed by the authorities. When the opposite happens, the central banks' reactions obey the monetary rule.

There are many extensions of this study that can be followed. A forward looking version of the proposed model may be estimated allowing for endogenous variables and an exogenous threshold variable. One can examine threshold type models taking as a threshold variable the inflation deviation from its target or the volatility of inflation or output gap. Also you may allow as a threshold an endogenous variable (the expected inflation or the expected output gap) applying the method of threshold regression with endogenous threshold variable proposed by Kourtellos, Stengos and Tan (2007). Extension of our study in central banks' reaction functions that have an official inflation target zone such as the ECB may be very interesting.

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## Appendix

### A. The derivation of the Likelihood Function for the switching regime models

In this section we show the way that the likelihood function be set. We consider a process known as i.i.d. mixture distribution which is described in Hamilton (1994). Let's consider the unobserved random variable  $s_t$  which corresponds to the regime that a given process is in at date  $t$ . We assume that the variable  $s_t$  can take two values ( $s_t = 1, 2$ ) and that  $\varepsilon_{1t} \sim N(0, \sigma^2)$  and  $\varepsilon_{2t} \sim N(0, \sigma'^2)$ . The multivariate normal density for  $\varepsilon_j$

is  $f(\varepsilon_j) = \frac{1}{(2\pi\sigma_j^2)^{T_j/2}} \exp\left[-\frac{1}{2} \frac{\varepsilon_j' \varepsilon_j}{\sigma_j^2}\right]$  and the multivariate density for  $y_j$  conditional on the matrix of

regressors  $X$  is  $f(y_j / X) = f(\varepsilon_j) \cdot \left| \frac{\partial \varepsilon_j}{\partial y_j} \right|$ , where  $\left| \frac{\partial \varepsilon_j}{\partial y_j} \right| = I_{T_j}$ , for  $j = 1, 2$ . When the process is in regime 1

we assume that the observed variable  $y_t \sim N(\mu_1, \sigma_1^2)$  and when it is in regime 2 then the observed variable  $y_t \sim N(\mu_2, \sigma_2^2)$ . So, the density of  $y_t$  conditional on the random variable  $s_t$  is

$$f(y_t / s_t = j; \theta) = \frac{1}{\sqrt{2\pi\sigma_j}} \exp\left[-\frac{1}{2} \frac{(y_t - \mu_j)^2}{\sigma_j^2}\right], \text{ for } j = 1, 2.$$

The vector  $\theta$  is a vector of population parameters. More specific we have  $\theta = (\mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \pi_1, \pi_2)'$ . We denote the unconditional probability that  $s_t$  takes on the value  $j$  as  $P(s_t = j; \theta) = \pi_j$ , for  $j = 1, 2$ . The joint density-distribution function of  $y_t$  and  $s_t$  is given by the expression

$$\begin{aligned} P(y_t, s_t = j; \theta) &= f(y_t / s_t = j; \theta) \cdot P(s_t = j; \theta) = \\ &= \frac{\pi_j}{\sqrt{2\pi\sigma_j}} \exp\left[-\frac{1}{2} \frac{(y_t - \mu_j)^2}{\sigma_j^2}\right] \end{aligned}$$

The unconditional density of  $y_t$  is derived by summing the previous expression over all possible values for  $j$ :

$$f(y_t; \theta) = \sum_{j=1}^2 P(y_t, s_t = j; \theta) = \frac{\pi_1}{\sqrt{2\pi\sigma_1}} \exp\left[-\frac{1}{2} \frac{(y_t - \mu_1)^2}{\sigma_1^2}\right] + \frac{\pi_2}{\sqrt{2\pi\sigma_2}} \exp\left[-\frac{1}{2} \frac{(y_t - \mu_2)^2}{\sigma_2^2}\right]$$

If the regime variable  $s_t$  is distributed as i.i.d. across different dates  $t$ , then the log likelihood for the observed data is given by the following expression:

$$L(\theta) = \sum_{t=1}^T \log f(y_t; \theta) = \sum_{t=1}^T \log \left\{ \frac{\pi_1}{\sqrt{2\pi\sigma_1}} \exp\left[-\frac{1}{2} \frac{(y_t - \mu_1)^2}{\sigma_1^2}\right] + \frac{\pi_2}{\sqrt{2\pi\sigma_2}} \exp\left[-\frac{1}{2} \frac{(y_t - \mu_2)^2}{\sigma_2^2}\right] \right\}$$

If we are certain which observations come from regime  $j$  and which don't then the  $P(s_t = j; \theta) = 1$  for those observations that come from regime  $j$ . So, the probability will be equal to zero for the observations that come from the other regime. Under this reasoning we'll have  $T_1$  observations in the first regime with probability  $\pi_1 = 1$  and  $T_2 = T - T_1$  observations in the second regime with probability  $\pi_2 = 1$ . The log likelihood then takes the following form:

$$L(\theta) = \sum_{g=1}^{T_1} \log \left\{ \frac{1}{\sqrt{2\pi\sigma_1}} \exp\left[-\frac{1}{2} \frac{(y_g - \mu_1)^2}{\sigma_1^2}\right] + 0 \right\} + \sum_{l=1}^{T_2} \log \left\{ 0 + \frac{1}{\sqrt{2\pi\sigma_2}} \exp\left[-\frac{1}{2} \frac{(y_l - \mu_2)^2}{\sigma_2^2}\right] \right\}$$

or

$$L(\theta) = \left( -\frac{T_1}{2} \log(2\pi\sigma_1^2) - \frac{1}{2\sigma_1^2} \varepsilon_1' \varepsilon_1 \right) + \left( -\frac{T_2}{2} \log(2\pi\sigma_2^2) - \frac{1}{2\sigma_2^2} \varepsilon_2' \varepsilon_2 \right)$$

where  $\theta = (\mu_1, \mu_2, \sigma_1^2, \sigma_2^2)'$ .

## B. Tables

**Table 1 Descriptive Statistics**

Variables	U.S.A.		JAPAN	
	Mean	Std. Dev.	Mean	Std. Dev.
Nominal Interest Rate	6.668	3.6	4.216	3.558
Real Interest Rate	2.717	2.856	1.665	2.91
Inflation	4.094	2.522	2.551	4.61
Output gap	-0.608	2.064	-0.155	2.27
Unemployment Rate	6.209	1.407	2.952	1.166

**Table 2. Bank of Japan reaction function. Baseline Estimates**

$$i_t = (1 - \rho) [a + \beta (\pi_{t-1} - \pi^*) + \gamma \tilde{y}_{t-1} + \delta z_{t-1}] + \rho i_{t-1} + \varepsilon_t$$

Parameters	Estimation
$a$	4.216

<i>Parameters</i>	<i>Estimation</i>
$\rho$	0.9*** (21.24)
$\beta$	0.78*** (3.988)
$\gamma$	0.754* (1.714)
$\delta$	0.141 (1.13)
$\pi^*$	2.698*** (2.456)
$R^2$	0.967
M.S.E.	0.416
Theil	0.117

t-statistics are included in parenthesis. Newey-West covariance matrix is used for standard errors. \*\*\*, \*\*, \* denotes 1%, 5%, 10% significance.

**Table 3. Bai-Perron Tests for Bank of Japan's reaction function**

<i>MODEL</i>	<i>BIC</i>	<i>Sequential</i>
Partial Structural	1980:3 [80:1,81:2]	1981:3 [81:1,86:2]
	1991:2 [91:1,92:4]	1991:2 [90:4,93:1]
Pure Structural	1981:3 [81:2,83:4]	1981:3 [81:2,82:4]
		1991:2 [91:1,92:1]

**Table 4. Bank of Japan. Estimated Reaction Functions with unknown threshold value**

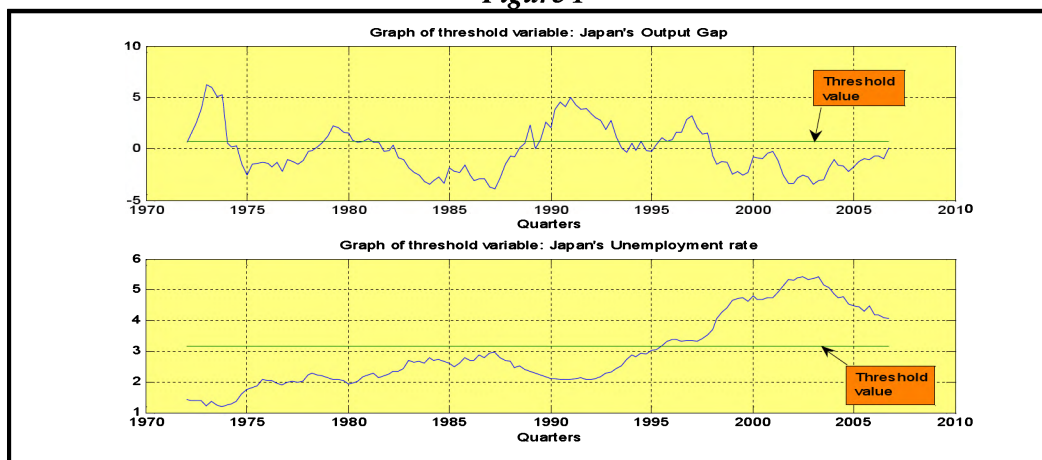
$$i_t = \begin{cases} (1 - \rho) [a + \beta (\pi_{t-1} - \pi^*) + \gamma \tilde{y}_{t-1} + \delta z_{t-1}] + \rho i_{t-1} + \varepsilon_{1t}, & \text{if } q_{t-1} \leq \bar{q} \\ (1 - \rho) [a + \beta' (\pi_{t-1} - \pi^*) + \gamma' \tilde{y}_{t-1} + \delta' z_{t-1}] + \rho i_{t-1} + \varepsilon_{2t}, & \text{if } q_{t-1} > \bar{q} \end{cases}$$

<i>Parameters</i>	Threshold variable: Output gap ( $\tilde{y}_{t-1}$ )	Threshold variable: Unemployment rate ( $u_{t-1}$ )
$\alpha$	2.948*** (4.71)	0.461 (0.35)
$\beta$	0.579*** (6.8)	1.34*** (2.92)
$\gamma$	0.034 (0.104)	2.69*** (2.828)

Parameters	Threshold variable: Output gap ( $\tilde{y}_{t-1}$ )	Threshold variable: Unemployment rate ( $u_{t-1}$ )
$\delta$	0.055 (1.53)	0.436*** (2.426)
$\beta'$	2.314*** (4.423)	-0.003 (0.008)
$\gamma'$	0.828* (1.751)	0.233 (1.12)
$\delta'$	0.495*** (3.683)	-0.026 (0.865)
$\rho$	0.895*** (47.15)	0.963*** (116.84)
$\sigma^2$	0.171*** (6.94)	0.618*** (6.4)
$\sigma'^2$	0.63*** (4.56)	0.004*** (4.15)
LR test (p-value)	68.549 (0.002)	161.89 (0.00)
Threshold value	$\bar{q}_{\tilde{y}_{t-1}} = 0.7175$ [-2.536, 2.22]	$\bar{q}_{u_{t-1}} = 3.182$ [2.005, 4.648]
Max likelihood	$\ell = -101.948$	$\ell = -55.276$
Percentile	0.698	0.684
Theil	0.101	0.118
M.S.E.	0.31	0.424

t-statistics are included in parenthesis. \*\*\*, \*\*, \* denotes 1%, 5%, 10% significance.

Figure 1





# CORPORATE GOVERNANCE IN A GLOBAL ECONOMY

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## Abstract

*In recent years, we have witnessed unprecedented changes in the conduct of business. Technological advances, political shifts and social development have combined to transform companies, industries and markets in ways unforeseeable just a few decades ago. We are challenged to take full advantage of emerging opportunities, while at the same time confronting the difficulties implicit in superimposing established practices upon divergent cultural milieus. We must also face critical questions of balance between the economic exploitation of developing regions and the economic empowerment of populations heretofore unable to participate fully in the global market. Never before has it been so critical to muster the very best and most experienced thinkers across the widest possible range of disciplines to examine these issues.*

*There have been many proposals about how to properly govern a firm. In the past decade, these proposals have increasingly tilted toward the American model as representing the appropriate pool of practices that should be applied globally. More recently, there has been renewed interest in European practices, especially financially accounting. For many countries, these practices, if adopted and implemented, would represent a radical improvement in corporate governance, especially for public companies whose shares are traded in stock markets. We fully endorse recommendations to improve corporate governance practices by identifying "best practices" regardless of their national origins.*

*However, we do not endorse recommendations that favor a single type of a corporate government system. There is frequent confusion between systems of governance and corporate governance practices. This confusion lies at the heart of much mischief; hence, we begin by making a distinction between the two.*

## **Η εταιρική διακυβέρνηση σε ένα σύγχρονο παγκοσμιοποιημένο περιβάλλον. Η προσέγγιση ενός χρήσιμου εργαλείου για την αποτελεσματική λειτουργία των σύγχρονων οικονομικών μονάδων**

### Περίληψη

Τα τελευταία χρόνια γινόμαστε μάρτυρες ριζικών μεταβολών στις επιχειρησιακές διαδικασίες και στις αγορές εξαιτίας των πολιτικών αλλαγών, της προϋπάρχουσας κοινωνικής ευημερίας και της οικονομικής ανάπτυξης. Βρισκόμαστε αντιμέτωποι με νέες ευκαιρίες (παρά τις επιπτώσεις της διεθνούς χρηματοπιστωτικής κρίσης) για την εξασφάλιση ισορροπιών μεταξύ της οικονομικής ανέλιξης συγκεκριμένων αναπτυσσόμενων περιφερειών και της ενδυνάμωσης του εργατικού δυναμικού τους που έως τώρα δεν είχε τις ευκαιρίες να συμμετάσχει στη διαμόρφωση του παγκόσμιου γίνεσθαι.

Ένας από τους τρόπους επιτυχούς κατάληξης του ανωτέρω εγχειρήματος αναφέρεται στον τρόπο διακυβέρνησης των εταιριών. Σε αντίθεση με τις πρακτικές του αμερικανικού μοντέλου που είχαν ευρεία εφαρμογή στο παρελθόν, στις μέρες μας εφαρμόζονται ευρωπαϊκές πρακτικές με εξαιρετικές επιδόσεις κυρίως στις εισηγμένες στα χρηματιστήρια δημόσιες επιχειρήσεις. Στη παρούσα μελέτη αναλύουμε άριστες πρακτικές που βελτιώνουν την εταιρική διακυβέρνηση, ανεξάρτητα από τα έως τώρα ισχύοντα.

Ταυτόχρονα προσπαθούμε να διευκρινήσουμε και να αιτιολογήσουμε τις διαφορές μεταξύ των συστημάτων διακυβέρνησης και της εταιρικής διακυβέρνησης. Ο διαχωρισμός των δύο αυτών εννοιών κρίνεται αναγκαίος για την πλήρη και επιστημονική προσέγγιση του προς εξέταση θέματος.

*Key words: Economic exploitation, Economic empowerment, Systems of governance, Corporate government system*

*Classification: Τεχνικές Επιχειρησιακών Ερευνών*

### Εισαγωγή

Τα τελευταία χρόνια γινόμαστε μάρτυρες ριζικών μεταβολών στις επιχειρησιακές διαδικασίες και στις αγορές εξαιτίας των πολιτικών αλλαγών, της προϋπάρχουσας κοινωνικής ευημερίας και της οικονομικής ανάπτυξης. Βρισκόμαστε αντιμέτωποι με νέες ευκαιρίες (παρά τις επιπτώσεις της διεθνούς χρηματοπιστωτικής κρίσης) για την εξασφάλιση ισορροπιών μεταξύ της οικονομικής ανέλιξης συγκεκριμένων αναπτυσσόμενων περιφερειών και της ενδυνάμωσης του ανθρώπινου δυναμικού τους που έως τώρα δεν είχε τις ευκαιρίες να συμμετάσχει στη διαμόρφωση του παγκόσμιου γίνεσθαι.

Ένας από τους τρόπους επιτυχούς κατάληξης του ανωτέρω εγχειρήματος αναφέρεται στον τρόπο διακυβέρνησης των επιχειρήσεων και οργανισμών και στις επιδράσεις-επιπτώσεις αυτής της νέας μορφής

στις σχέσεις κράτους-πολιτών. Σε αντίθεση με τις πρακτικές του αμερικανικού μοντέλου που είχαν ευρεία εφαρμογή στο παρελθόν, στις μέρες μας εφαρμόζονται ευρωπαϊκές πρακτικές με σημαντικές επιδόσεις κυρίως από τις εισηγμένες στα χρηματιστήρια δημόσιες επιχειρήσεις.

### Τι είναι η εταιρική διακυβέρνηση

Ένα σύστημα αποτελεσματικής εταιρικής διακυβέρνησης στηρίζεται σε συγκεκριμένους τυπικούς και άτυπους κανόνες οι οποίοι περιλαμβάνουν το θεσμικό πλαίσιο της χώρας, τη δομή της εξουσίας, τη ροή των πληροφοριών, τη κατανομή των κερδών κ.ά.

Οι πρακτικές της εταιρικής διακυβέρνησης εστιάζουν πρωτίστως στη δικαιοδοσία των Διοικητικών Συμβουλίων, στους κανόνες ψηφοφορίας, στη προστασία των μικρομετόχων, στη δημοσίευση των ισολογισμών, στη κατανομή των κερδών, στις πράξεις των στελεχών κ.ά.

Υπάρχουν αρκετοί τρόποι για την κατανόηση της εταιρικής διακυβέρνησης. Το βασικό στρατηγικό της επιχείρησης είναι η βελτίωση της αποδοτικότητας των επιχειρήσεων και οργανισμών μέσω της βέλτιστης διαχείρισης των πόρων, της άσκησης αποτελεσματικότερου management και της εκμετάλλευσης των νέων ευκαιριών.

Ως βασικά οφέλη της αναδεικνύονται η παροχή κινήτρων στους managers και στους λήπτες αποφάσεων, η μείωση των χρονικών υστερήσεων στις συναλλαγές και η ανάπτυξη του ενδιαφέροντος για τον οργανισμό ή την υπηρεσία. Κομβική επιλογή της εταιρικής διακυβέρνησης είναι η δημιουργία θετικών καταστάσεων σε μια δημόσια επιχείρηση και η βελτίωση του συνεκτικού ιστού μεταξύ όλων των συνεργαζόμενων μερών.

Ως αντικειμενικοί στόχοι αναγνωρίζονται και οριοθετούνται η υιοθέτηση καινοτόμων μεθόδων διοίκησης, η εφαρμογή της σύγχρονης τεχνολογίας, η βελτίωση της θέσης των εργαζομένων, η αгаστή συνεργασία κράτους-πολίτη, η ομαδική εργασία, η αξιοποίηση του ανθρώπινου δυναμικού και η μεγιστοποίηση της αξίας των μετοχών (στη περίπτωση όπου μια δημόσια επιχείρηση είναι εισηγμένη στο χρηματιστήριο).

*Σύμφωνα με την Ευρωπαϊκή Ένωση ως εταιρική διακυβέρνηση ορίζεται η χρήση τεχνολογιών της πληροφορικής και των τηλεπικοινωνιών στη δημόσια διοίκηση σε συνδυασμό με οργανωτικές αλλαγές και νέες δεξιότητες του προσωπικού, με σκοπό τη βελτίωση της εξυπηρέτησης του κοινού, την ενδυνάμωση της δημοκρατίας και την υποστήριξη των δημόσιων πολιτικών.*

Ο ορισμός αυτός καθορίζει δύο θεμελιώδεις αρχές:

*1. Οριοθετεί τους στόχους της εταιρικής διακυβέρνησης σε τρεις συγκεκριμένους τομείς:*

- α. την εξυπηρέτηση των πολιτών και των επιχειρήσεων,*
- β. τη βελτίωση των δημοκρατικών διαδικασιών και*
- γ. την υποστήριξη των δημόσιων πολιτικών*

*2. Συνδέει άρρηκτα την εταιρική διακυβέρνηση με ευρύτατες οργανωτικές αλλαγές στο εσωτερικό της δημόσιας διοίκησης.*

Από αυτές τις δύο θεμελιώδεις αρχές εξάγονται ορισμένα συμπεράσματα τα οποία ομαδοποιούνται κατωτέρω:

*1. Οι πολίτες και οι επιχειρήσεις καθίστανται στο επίκεντρο των προσπαθειών της δημόσιας διοίκησης.*

*2. Επιτυγχάνεται ηλεκτρονική αναγνώριση των χρηστών (για λόγους ασφαλείας) και αυθεντικοποίηση των συναλλαγών.*

*3. Βελτιώνεται η αποτελεσματικότητα και η αποδοτικότητα της δημόσιας διοίκησης.*

*4. Ενισχύονται οι διασυννοριακές υπηρεσίες.*

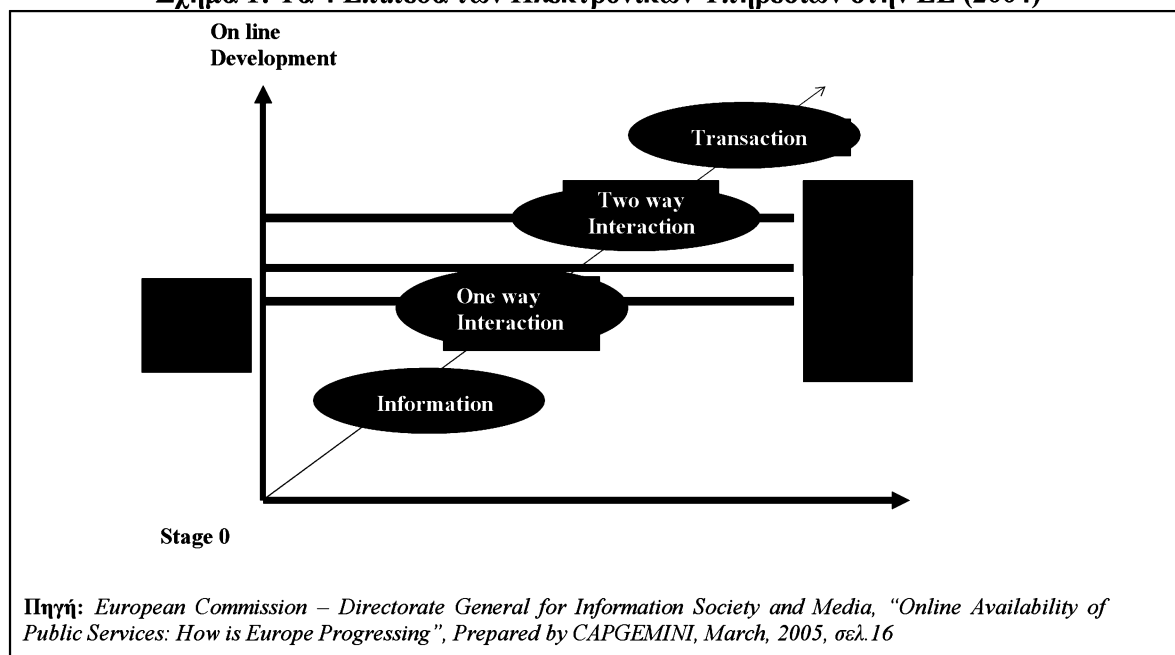
*5. Επιταχύνεται και ορθολογικοποιείται ο τρόπος των δημοσίων προμηθειών.*

Η εταιρική διακυβέρνηση βοηθά ενεργά την ανταγωνιστικότητα των εθνικών οικονομιών μέσω της αύξησης της παραγωγικότητας η οποία βασίζεται στη χρήση τεχνολογιών της πληροφορικής και των τηλεπικοινωνιών. Αυτό που απαιτείται είναι η κινητοποίηση της κρατικής μηχανής και η αναδιοργάνωση του δημόσιου τομέα της οικονομίας.

Τα επίπεδα ανάπτυξης των ηλεκτρονικών υπηρεσιών στην Ευρωπαϊκή Ένωση (Σχήμα 1) είναι:

- η πληροφόρηση (information),
- η διάδραση (one way interaction),
- η αμφίδρομη διάδραση (two way interaction) και
- η πλήρης συναλλαγή (transaction).

Σχήμα 1: Τα 4 Επίπεδα των Ηλεκτρονικών Υπηρεσιών στην ΕΕ (2004)



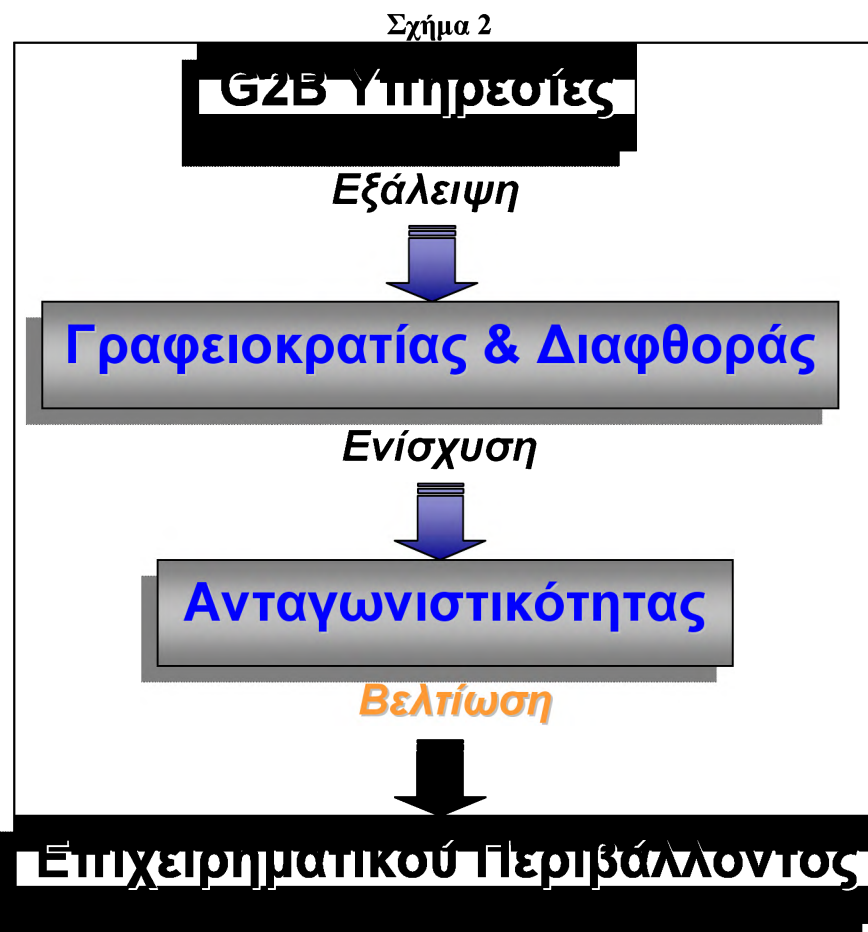
Οι υπηρεσίες που προσφέρει μια από τις σημαντικότερες μορφές εταιρικής-ηλεκτρονικής διακυβέρνησης η οποία εκφράζεται μέσα από τη σχέση κράτους-επιχειρήσεων, η γνωστή ως G2B (Government to Business), είναι οι εξής:

- εταιρικός φόρος εισοδήματος (corporate tax),
- τελωνειακές υπηρεσίες (custom declaration),
- δημόσιες προμήθειες (public procurement),
- εγγραφή νέων επιχειρήσεων (registration of a new company),
- Φόρος Προστιθέμενης Αξίας (Value Added Tax),
- κοινωνικές εισφορές εργαζομένων (social contribution),
- περιβαλλοντικές άδειες (environment-related permits),
- υποβολή στατιστικών στοιχείων (data to the statistical office).

Σύμφωνα με τον Οργανισμό Οικονομικής Συνεργασίας και Ανάπτυξης (ΟΟΣΑ), τα σημαντικότερα οφέλη των G2B υπηρεσιών είναι:

- η ποιότητα των πληροφοριών,
- η μείωση των χρονικών υστερήσεων,
- η μείωση του φόρτου εργασίας για τα στελέχη της δημόσιας διοίκησης,
- το χαμηλότερο κόστος,
- το καλύτερο επίπεδο υπηρεσιών,
- η αυξημένη αποτελεσματικότητα,
- η μεγαλύτερη ικανοποίηση των χρηστών.

Το Σχήμα 2 είναι ενδεικτικό των ωφελειών της συγκεκριμένης μορφής εταιρικής διακυβέρνησης.



Κατωτέρω αναφέρονται σε λεπτομερέστερη μορφή τα οφέλη της εταιρικής διακυβέρνησης για το δημόσιο και για τις επιχειρήσεις.

*Οφέλη για τους αγοραστές (Δημόσιο)*

- Παγκόσμια επιλογή (πρόσβαση σε προμηθευτές απ' όλο τον κόσμο)
- Βελτιωμένη ποιότητα αγαθών και υπηρεσιών
- Λήψη εξειδικευμένων υπηρεσιών από τους προμηθευτές
- Άμεση εξυπηρέτηση και κάλυψη αναγκών
- Ελαχιστοποίηση τιμών – Μείωση κόστους
- Νέα αγαθά και υπηρεσίες προς όφελος του Δημοσίου
- Ευκολία χρήσης
- Συμβατότητα και εξοικείωση των λειτουργών της δημόσιας διοίκησης με την τεχνολογία

*Οφέλη για τους προμηθευτές*

- Παγκόσμια παρουσία
- Βελτίωση της ανταγωνιστικότητας
- Παροχή εξειδικευμένων υπηρεσιών στους καταναλωτές
- Σμίκρυνση της προμηθευτικής αλυσίδας
- Ελαχιστοποίηση του κόστους παραγωγικής διαδικασίας
- Νέες επιχειρηματικές ευκαιρίες
- Προγραμματισμός για αποφυγή λαθών

## Αποτελέσματα της εφαρμογής του B2G στη προσπάθεια ποιοτικής αναβάθμισης των επιχειρήσεων και οργανισμών

Τα σημαντικότερα αποτελέσματα από την προαναφερθείσα μορφή εταιρικής διακυβέρνησης είναι τα εξής:

- Εκπόνηση στρατηγικού προγράμματος για την αντιμετώπιση του ανταγωνισμού και για την κυριαρχία στην αγορά.
- Εφαρμογή στρατηγικού προγράμματος προσαρμοσμένου στις νέες απαιτήσεις.
- Βελτίωση της ποιοτικής διαδικασίας εξαιτίας της εφαρμογής σύγχρονης τεχνολογίας.
- Εντοπισμός των κρίσιμων λειτουργιών/ διαδικασιών.
- Τυποποίηση – απλοποίηση των εναλλακτικών εργασιών και διαδικασιών.
- Προσαρμογή σε ευέλικτα οργανωτικά σχήματα.
- Μείωση του κόστους, καλύτερη εξυπηρέτηση των πολιτών, ταχύτητα επιλογών.
- Ανάπτυξη συστήματος δεικτών απόδοσης – μέτρησης – σύγκρισης των επιδόσεων.
- Αποτελεσματικότερος έλεγχος των δραστηριοτήτων του φορέα.

### Η περίπτωση της Ελλάδας

Στη χώρα μας η εταιρική διακυβέρνηση είναι σε θέση να ενισχύσει την ανταγωνιστικότητα της ελληνικής οικονομίας και τη βελτίωση του επενδυτικού κλίματος αφού στοχεύει στον εκσυγχρονισμό της δημόσιας διοίκησης με την εισαγωγή τεχνολογιών αιχμής και τη ψηφιακή σύνδεση κυβερνητικών υποδομών πληροφορικών συστημάτων για την εξοικονόμηση πόρων και τη ποιοτική αναβάθμιση των υπηρεσιών. Οι κυριότεροι τομείς εταιρικής διακυβέρνησης στην Ελλάδα είναι:

- οι νομαρχίες
- τα εκπαιδευτικά ιδρύματα της τριτοβάθμιας εκπαίδευσης
- τα ασφαλιστικά ταμεία
- ο ΟΑΕΔ
- οι ΔΟΥ
- τα Επιμελητήρια
- το Εθνικό Τυπογραφείο

### ERP: Ένα σύγχρονο εργαλείο υποβοήθησης της εταιρικής διακυβέρνησης

Ένα εργαλείο διοίκησης το οποίο μπορεί να εφαρμοστεί στις επιχειρήσεις και στους οργανισμούς του δημόσιου τομέα, κατ' αντιστοιχία του ιδιωτικού, είναι το ERP (Enterprise Resource Planning) το οποίο έχει ως βασικό αντικειμενικό στόχο την ορθολογικοποίηση του καταμερισμού των πόρων.

Το ERP είναι ένα πληροφοριακό σύστημα οργάνωσης και συντονισμού των περισσότερων δραστηριοτήτων μιας μονάδας (παραγγελιών, αποθήκευσης, επαφών με τους προμηθευτές κ.ά.).

Σύμφωνα με τον ορισμό της SAP πρόκειται για «βιομηχανική ορολογία που δίδει ερμηνεία στο λογισμικό μιας βιομηχανίας ή κάποιας άλλης επιχείρησης για να διοικήσει τα σημαντικά της μέρη, συμπεριλαμβανομένων του σχεδιασμού του προϊόντος, της προμήθειας υλικών, του ελέγχου της αποθήκης, της επικοινωνίας με τους προμηθευτές, των υπηρεσιών προς τους καταναλωτές και της παραγγελίας πρώτων υλών. Το ERP περιλαμβάνει στοιχεία που αφορούν τον λογιστικό έλεγχο και τη διοίκηση του ανθρώπινου δυναμικού. Το σύστημα ERP χρησιμοποιεί ή είναι αναπόσπαστο κομμάτι ενός συστήματος βάσης δεδομένων. Η οικοδόμηση ενός τέτοιου συστήματος επηρεάζει την ανάλυση διοικητικών διαδικασιών, την εκπαίδευση του προσωπικού και τις διαδικασίες παραγωγής νέων προϊόντων».

Εν κατακλείδι το λογισμικό ERP είναι κατασκευασμένο για να ικανοποιεί τις ανάγκες μιας επιχείρησης. Περιλαμβάνει εφαρμογές για τη λογιστική, τον έλεγχο και τη διαχείριση αποθεμάτων και αποθηκών, τη προμηθευτική αλυσίδα, τη διαχείριση παραγωγής και τη διαχείριση ανθρώπινων πόρων.

### Η ιστορία του ERP

Από τη δεκαετία του '60 αναπτύχθηκαν συστήματα ελέγχου παραγωγής. Τη δεκαετία του '70, το MRP (Material Requirement Planning) εισήγαγε ένα νέο μηχανισμό για την αντικειμενικότερη πρόβλεψη των αναγκαίων υλικών καθώς και για τον χρόνο χρήσης τους. Πολλές επιχειρήσεις, ακόμη και σήμερα, δεν

έχουν συστήματα MRP ή δεν τα χρησιμοποιούν σωστά γιατί δεν συμπεριλαμβάνουν σε αυτά σημαντικές μεταβλητές όπως τη χωρητικότητα των αποθηκών, το κεφάλαιο, τις μηχανικές αλλαγές και το κόστος. Λόγω των επιτακτικών αναγκών το MRP αναβαθμίστηκε σε MRP II (Manufacturing Resource Planning) που έδινε ιδιαίτερη σημασία στον μακροχρόνιο προγραμματισμό και στην αποτελεσματική διανομή των πόρων. Στρατηγικός στόχος ήταν η βελτίωση της παραγωγής και η αύξηση της αποδοτικότητας των εργαζομένων. Αν και το πρόγραμμα ανταποκρινόταν επαρκώς, βάσει των αναγκών που κάλυπτε, οι εταιρείες γρήγορα αντιλήφθηκαν ότι και άλλοι παράγοντες όπως η σχέση με τους πελάτες έπρεπε να ληφθούν υπόψη. Σιγά σιγά άρχισε να αναπτύσσεται το ERP, ο διάδοχος του MRP II.

Οι ρίζες του ERP βρίσκονται στη δεκαετία του '70, όταν ανεξάρτητες εταιρείες λογισμικού ανέπτυξαν λογισμικά που προορίζονταν για τους μικρο-κομπιούτερ της IBM. Το 1980 αναπτύχθηκαν παρόμοια λογισμικά για τους mainframe κομπιούτερ. Το πνεύμα στη δεκαετία του '80 ήταν η κάθε οικονομική μονάδα να αναπτύσσει το δικό της λογισμικό για τον έλεγχο κυρίως της παραγωγής. Παρόλα αυτά το κόστος ήταν δυσβάστακτο διότι έπρεπε να πληρώσει για την ανάπτυξη του λογισμικού και να προσλάβει εξειδικευμένο προσωπικό για τον χειρισμό και τη συντήρησή του. Η χρήση του ήταν πολύπλοκη, η κάθε επιχείρηση είχε διαφορετικό λογισμικό και το αποτέλεσμα ήταν να μην μπορούν να συνδεθούν μεταξύ τους ώστε να ανταλλάσουν στοιχεία και δεδομένα. Έτσι δημιουργήθηκε η ανάγκη για τη δημιουργία ενός λογισμικού, κοινού για όλες τις επιχειρήσεις και εύκολου στη χρήση του.

Η Gartner Group πρωτοχρησιμοποίησε τον όρο ERP για να ορίσει το νέο σύστημα, για το οποίο σύμφωνα με έρευνα των Heald και Kelly το 2002 το συνολικό ποσό που δαπανήθηκε για την εγκατάστασή του ξεπέρασε τα 72,6 δις δολάρια, ενώ το 2007 έφτασε τα 200 δις δολάρια. Τα βασικά κίνητρα που οδηγούν τους οργανισμούς και τις υπηρεσίες να το εγκαταστήσουν είναι ο έλεγχος των τυποποιημένων λειτουργιών, η ευελιξία χειρισμού θεμάτων που αφορούν τους πελάτες-πολίτες και τους προμηθευτές, οι ικανότητες χειραγώγησης των επιχειρηματικών μηχανισμών και η υποστήριξη όλων, εν γένει, των διαδικασιών.

## Το σύστημα ERP

Το ERP είναι μια προσπάθεια δημιουργίας ενός προγράμματος που φιλοδοξεί να ενοποιήσει και να διοικήσει όλες τις λειτουργίες μιας επιχείρησης. Παλαιότερα-σε πολλές περιπτώσεις ακόμη και σήμερα-τα συστήματα δεν ήταν ενοποιημένα. Από τη στιγμή που δεν υπήρχε ένα ενοποιημένο λογισμικό σύστημα ελέγχου έπρεπε να εισαχθεί η ίδια πληροφορία σε διαφορετικά συστήματα ανά τμήμα. Εδώ έγκειται η χρησιμότητα του ERP, όπου όλα τα τμήματα «συστεγάζονται» κάτω από το ίδιο λογισμικό ώστε όταν εισέρχεται η πληροφορία να πηγαίνει αυτομάτως σε όλα τα ενδιαφερόμενα (εμπλεκόμενα) μέρη του εσωτερικού περιβάλλοντος.

Για να γίνει κατανοητή η χρήση του ERP είναι αναγκαίο να γίνουν κατανοητά τα προβλήματα που πρέπει να επιλύσει. Κάθε μεγάλη οικονομική μονάδα συλλέγει, ταξινομεί και αποθηκεύει τις πληροφορίες που δέχεται. Σπάνια όμως υπάρχει ένα κέντρο συλλογής πληροφοριών με αποτέλεσμα αυτές να διανέμονται σε ένα μεγάλο αριθμό συστημάτων πληροφορικής, η συντήρηση των οποίων κοστίζει ακριβά αφού εκτός του άμεσου κόστους (συντήρηση, έξοδα προσωπικού, μεταφορά δεδομένων από το ένα σύστημα στο άλλο κ.ά.) είναι εμφανής και η παρουσία του έμμεσου.

Είναι πολύ σημαντικό το ERP να ταιριάζει στη πολιτική της επιχείρησης. Πολλές εταιρείες δαπανούν μυθικά ποσά για να το εγκαταστήσουν χωρίς να διαφαίνεται καμία πρόοδος στην αποδοτικότητα τους. Το ERP από μόνο του δεν βελτιώνει την εικόνα μιας επιχείρησης, ενός οργανισμού ή μιας υπηρεσίας και γι' αυτό δεν πρέπει να αντιμετωπίζεται ως ένας «από μηχανής θεός». Δεν είναι τίποτα παραπάνω από ένα εργαλείο, που με τις ανάλογες αποφάσεις από τους managers μπορεί να βοηθήσει την οικονομική μονάδα να πάει μπροστά. Πολλές οικονομικές μονάδες έχουν κάνει επενδύσεις σε συστήματα ERP δίχως ορατά αποτελέσματα. Οι πολέμοί του το κατηγορούν ότι ουσιαστικά δεν προσφέρει κάτι σημαντικό. Συνήθως κατηγορούν τους σχεδιαστές του ότι δημιουργούν συστήματα που δεν ανταποκρίνονται στις απαιτήσεις των επιχειρήσεων. Ο M. Donovan (1999) είναι ο άνθρωπος που βάλθηκε να βρει την αιτία αυτής της αντιδικίας. Αρχικά διατυπώνει τρεις λόγους που εξηγούν τα μη αναμενόμενα αποτελέσματα από τη χρήση του ERP. Εάν συμβεί κάποιος από τους κατωτέρω λόγους, το ERP καθίσταται δυσλειτουργικό:

1. Πληροφορίες που έχουν δοθεί λάθος ή πληροφορίες με ελλιπή στοιχεία.
2. Χρήστες με ελλιπή εκπαίδευση του ERP.
3. Μη προσαρμογή των επιχειρήσεων στα νέα δεδομένα.

Πρέπει να γίνει κατανοητό από τους CEO των εταιρειών ότι το ERP είναι πολύπλοκο και απαιτεί προσεκτικό σχεδιασμό. Ως αποτέλεσμα αυτού, οι επιχειρήσεις που το χρησιμοποιούν οφείλουν να

διαμορφώσουν ανάλογα τις λειτουργίες τους ώστε να προσαρμοστούν στις νεοπαγείς ανάγκες. Η εγκατάσταση ενός συστήματος ERP είναι θέμα συμβιβασμών και ισορροπίας μεταξύ του πρότερου και του νυν τρόπου λειτουργίας της επιχείρησης. Οι κατασκευαστές λογισμικών προσπαθούν να φτιάξουν τα ERP με τρόπο τέτοιο ώστε να ανταποκρίνονται πλήρως στις λειτουργίες που καλούνται να υποστηρίξουν. Από τη στιγμή όμως που πρόκειται για τυποποιημένα συστήματα είναι λογικό να μην ικανοποιούνται στον ανώτερο βαθμό οι απαιτήσεις των επιχειρηματικών λειτουργιών. Έτσι μπορεί το ERP να ανταποκρίνεται στις λειτουργίες της επιχείρησης, από την άλλη όμως η φιλοσοφία του να είναι αντίθετη με αυτήν της επιχειρηματικής μονάδας. Συμπερασματικά το ERP δεν κάνει για όλες τις επιχειρήσεις. Ένας ταχέως αναπτυσσόμενος οργανισμός που μεταβάλλεται συνεχώς είναι δύσκολο να ωφεληθεί από αυτό. Σύμφωνα με τον Merrill (1998) αν η μορφή και οι λειτουργίες είναι διαφορετικές τη στιγμή που σχεδιάζεται το ERP και διαφορετικές όταν αρχίσει να εφαρμόζεται τότε προκύπτει σοβαρό πρόβλημα.

Για έναν σύγχρονο οργανισμό που θέλει να το εγκαταστήσει απαιτείται προεργασία ώστε να γίνει ευκολότερη η εγκατάστασή του. Η προεργασία αυτή περιλαμβάνει τα ακόλουθα στάδια:

1. Σχεδιασμό των λειτουργιών.
2. Δημιουργία υποστηρικτικών δικτύων.
3. Υπολογιστές οι οποίοι ανταποκρίνονται στις απαιτήσεις που ορίζει ο οίκος παραγωγής του ERP.
4. Υποδομές εκπαίδευσης. Ύπαρξη συγκεκριμένων εκπαιδευτικών χώρων. Σε αρκετές περιπτώσεις ο κατασκευαστής του ERP κάνει την εκπαίδευση σε δικούς του χώρους.
5. Ανάγκη εξεύρεσης του κατάλληλου ανθρώπινου δυναμικού. Το ERP είναι ένα δύσκολο και αναγκαίο λογισμικό που πρέπει να το χειρίζονται οι καταλληλότεροι.

Σε έρευνα του Gupta (2000) προτείνονται συγκεκριμένοι τρόποι για τη σωστή χρήση του ERP. Οι σημαντικότεροι είναι η δέσμευση της διοίκησης, η αγαστή σχέση μεταξύ των ανωτάτων στελεχών και των στρατηγικών επιχειρηματικών μονάδων και η step-by-step είσοδος του.

Είναι σίγουρο ότι υπάρχουν ενδοιασμοί από μερίδα εργαζομένων για την εκμάθηση των νέων διαδικασιών ή για την αποδοχή καινούργιων καθηκόντων. Ο Cissna (1998) ισχυρίζεται ότι η υποστήριξη από τη διοίκηση και η ανάθεση αυτών των εργασιών στα κατάλληλα άτομα βοηθούν στην επίλυση αναφυόμενων προβλημάτων.

Ο Stymne (1999) επισημαίνει ότι υπάρχουν τρία επίπεδα που επηρεάζονται από την εγκατάσταση ενός συστήματος ERP. Αυτά είναι:

1. Η εταιρική ανάπτυξη (ανάπτυξη των επιχειρηματικών στρατηγικών).
2. Η ανάπτυξη των λειτουργιών (ανάπτυξη των επιχειρηματικών διαδικασιών και των μεταξύ τους σχέσεων όσον αφορά τη λειτουργικότητά τους).
3. Η ανάπτυξη συστημάτων (ανάπτυξη υπηρεσιών πληροφορικής, όπου το σύστημα ERP αποτελεί σημαντικό κομμάτι).

Το πρώτο επίπεδο λαμβάνει τις τελικές αποφάσεις. Το δεύτερο αναπτύσσει τις εσωτερικές λειτουργίες, ενώ το τρίτο φροντίζει τη σωστή λειτουργία του ERP. Η συνεργασία των τριών επιπέδων επιφέρει θετικά αποτελέσματα στη λειτουργία του εν λόγω συστήματος.

### Αξιολόγηση του ERP

Η εταιρεία Manoeuvre διεξήγαγε μια έρευνα βασισμένη στη μέθοδο της παρατήρησης με έμφαση στους λόγους που το ERP δεν πετυχαίνει πάντοτε. Η Manoeuvre κατηγοριοποιεί τους λόγους σε έξι κατηγορίες «αμαρτήματα», συστήνοντας τις ανάλογες λύσεις. Οι κατηγορίες αυτές παρουσιάζονται κατωτέρω:

1. Δεν έχουν καταλάβει οι ιθύνοντες τι έχουν στα χέρια τους.

- Πολλοί managers νομίζουν ότι έχουν να κάνουν με ένα σύστημα που απευθύνεται αποκλειστικά στο τμήμα πληροφορικής και μηχανογράφησης.

- Δεν γίνεται η σωστή επιλογή του λογισμικού. Πρέπει να καταγραφούν οι ανάγκες της εταιρείας ή του οργανισμού και να ακολουθήσει η σχετική έρευνα αγοράς.

2. Δεν αξιοποιείται το κατάλληλο ανθρώπινο δυναμικό.

- Δεν γίνεται προσεκτική επιλογή του ανθρώπινου δυναμικού.

- Τα άτομα που θα απασχοληθούν στο έργο πρέπει να έχουν συνειδητοποιήσει τις ευθύνες τους.

- Οι εμπλεκόμενοι με το ERP πρέπει να είναι πλήρους απασχόλησης. Είναι δύσκολο να ασχοληθεί ένας εργαζόμενος ταυτόχρονα με το ERP και με κάποιο άλλο κομμάτι της επιχείρησης.
- Τα στελέχη που θα ασχοληθούν με το ERP απαιτείται να έχουν κατανοήσει τις λειτουργίες του κάθε τμήματος (ή διεύθυνσης) που θα επηρεαστεί από το σύστημα.
- Βασική προϋπόθεση αποτελεί η θέσπιση και η παροχή κινήτρων στα μέλη της ομάδας που χειρίζονται το ERP.

### 3. Δεν γίνεται σωστή διαχείριση της αλλαγής

- Πολλές εταιρείες υποτιμούν τις αλλαγές που προκαλεί το ERP, ειδικά στο ανθρώπινο δυναμικό και στην οργανωδομή.
- Απαιτείται ιδιαίτερη σημασία στη διαχείριση των αλλαγών (change management) διότι το προσωπικό θα υποστεί αλλαγές στους ρόλους και στα καθήκοντά του.
- Αποτελεί βασική προτεραιότητα ο ορισμός ατόμων τα οποία με τις γνώσεις και την εμπειρία τους θα αποτελέσουν τον συνδετικό κρίκο μεταξύ των managers και των εργαζομένων.
- Στην εκπαίδευση εκτός από τη χρήση του ERP τα στελέχη οφείλουν να επισημάνουν και τους στόχους των αλλαγών.

### 4. Λάθος διαχείριση των ωφελειών

- Πολλά στελέχη στη προσπάθειά τους να επιλέξουν ένα σύστημα ERP δίνουν έμφαση στο κόστος χωρίς ιδιαίτερη σημασία στο προσδοκώμενο όφελος.
- Μεταβολές στο εσωτερικό περιβάλλον της επιχείρησης αλλάζουν τα οφέλη του ERP. Περιοδικά είναι αναγκαίο να εκπονούνται μελέτες βασισμένες σε εναλλακτικά σενάρια.

### 5. Θέματα ενοποίησης

- Πολλοί οργανισμοί αντιστέκονται στην ενοποίηση των λειτουργιών που επιφέρει το ERP με αποτέλεσμα να μένει ως έχει η δομή της διοίκησης.
- Για να ξεπεραστεί αυτό, πρέπει να τονιστεί στη διοίκηση ότι οι πληροφορίες πηγάζουν κατευθείαν στα εμπλεκόμενα τμήματα δίχως να μεσολαβούν γραφειοκρατικές διαδικασίες. Οι αλλαγές στις δομές κρίνονται ως απαραίτητες για την καλύτερη απόδοση του ERP.

### 6. Μεγάλος αριθμός επιχειρήσεων δεν λαμβάνει υπόψη τη μακροχρόνια δράση του συστήματος με αποτέλεσμα να μειώνονται διαχρονικά τα οφέλη

- Απαιτείται σχεδιασμός μακροχρόνιας στήριξης.
- Η σχεδίαση και η εγκατάσταση του ERP δεν επαρκούν. Χρειάζεται διαρκής παρακολούθηση και αναβάθμιση σε τακτά χρονικά διαστήματα.

## Συμπεράσματα

Στις αρχές της δεκαετίας του '80 ξεκίνησε μια ερευνητική προσπάθεια για την επιχειρηματική ολοκλήρωση (enterprise integration), η οποία χρησιμοποίησε ως τεχνολογικό υπόβαθρο τις βάσεις δεδομένων και προσπάθησε να καλύψει τις κύριες επιχειρηματικές διαδικασίες με βασική προτεραιότητα το κύκλωμα οικονομικής διαχείρισης και το κύκλωμα παραγωγής. Αποτέλεσμα αυτής της προσπάθειας είναι η εμφάνιση συστημάτων Enterprise Resources Planning (Προγραμματισμός Επιχειρηματικών Πόρων) στα τέλη της δεκαετίας του '80, τα οποία ολοκλήρωσαν πέραν του κυκλώματος οικονομικής διαχείρισης και παραγωγής και άλλες βασικές επιχειρηματικές διαδικασίες όπως τη διαχείριση ανθρωπίνων πόρων, τις πωλήσεις κ.ά. Τα συστήματα ERP είναι ολοκληρωμένα συστήματα πληροφορικής, τα οποία καλύπτουν όλες τις λειτουργικές περιοχές μιας επιχείρησης ή ενός οργανισμού, ώστε να επιτυγχάνονται οι στόχοι της μέσω μιας ορθολογικής ενοποίησης όλων των διαδικασιών.

Να τονιστεί ιδιαίτερα ότι η χρησιμότητα του συγκεκριμένου συστήματος δεν είναι προνόμιο μόνο των μεγάλων επιχειρήσεων. Κερδισμένες από τη χρήση του μπορούν να βγουν και οι μικρομεσαίες επιχειρήσεις αφού τα πλεονεκτήματα που αποκομίζουν στη συνεργασία τους με το δημόσιο είναι στρατηγικής σημασίας. Σημαντικότερα εξ αυτών είναι:

- η μεγαλύτερη παραγωγικότητα,
- η αποτελεσματικότερη ροή εργασίας,
- η μείωση του λειτουργικού κόστους,
- η μείωση του κόστους που σχετίζεται με την απογραφή και



-η βελτιωμένη εξυπηρέτηση πελατών.

Αντίστοιχα κερδισμένος από αυτήν την αμφίδρομη σχέση είναι και ο δημόσιος τομέας για όλους τους λόγους που προαναφέρθησαν στην αρχή της παρούσας μελέτης.

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# THE LIFE AND SCIENTIFIC DISCOVERIES OF GEORGE BERNARD DANTZIG “FATHER OF LINEAR PROGRAMMING AND FOUNDER OF OPERATIONAL RESEARCH”

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## Abstract

*The purpose of the present paper is to describe the life and scientific discoveries of George Bernard Dantzig (1914-2005), as well as the environment in which he lived and worked. We describe, also the main discovery of Dantzig in the newly established scientific discipline of Operations Research, namely, the Simplex Method for solving Linear Programming problems. We mention in this paper the two scientists, namely: Tjalling C. Koopmans and Leonid V. Kantorovich, who have discovered similar methods for solving Linear Programming problems and they have been awarded jointly the Nobel Prize for their contributions to the Theory of Optimum Distribution of Resources. Finally, some comments on the life and work of Professor. Dantzig are made.*

## Περίληψη

*Ο George Bernard Dantzig (1914 – 2005) υπήρξε πρωτοπόρος των καινοτόμων μαθηματικών μεθόδων (θεωρητικών και εφαρμοσμένων), που ήταν βασικές στην ανάπτυξη και την αποτελεσματικότητα του τομέα της Επιχειρησιακής Έρευνας. Σπούδασε Μαθηματικά στο University of Maryland, έκανε μεταπτυχιακό στο University of Michigan και το 1946 έλαβε το Διδακτορικό του στα Μαθηματικά από το University of California.*

*Το 1947 επινοεί τη Μέθοδο Simplex, την πλέον γνωστή και περισσότερο χρησιμοποιούμενη μέθοδο για την επίλυση ενός γενικού προβλήματος Γραμμικού Προγραμματισμού. Η μέθοδος αυτή αποτελεί μια αλγεβρική επαναληπτική διαδικασία, η οποία επιλύει ακριβώς κάθε πρόβλημα Γραμμικού Προγραμματισμού σε ένα πεπερασμένο πλήθος βημάτων. Έκτοτε έχει εφαρμοσθεί παγκοσμίως σε πληθώρα βιομηχανιών, εμπορικών επιχειρήσεων και κυβερνητικών οργάνωσεων επιτρέποντάς τους να επιτύχουν την αποτελεσματικότερη διαχείριση των πόρων τους. Η συνεισφορά του G.B. Dantzig ήταν πολύ σημαντική στα Μαθηματικά, την Οικονομική Επιστήμη, την Στατιστική, την Βιομηχανική Εφαρμοσμένη Μηχανική και την Πληροφορική*

*Κατά τη διάρκεια της ακαδημαϊκής του καριέρας διετέλεσε Καθηγητής της Μηχανικής Επιστήμης και Πρόεδρος του Ερευνητικού Κέντρου Επιχειρησιακής Έρευνας στο University of California (1960 – 1966). Επίσης υπήρξε Καθηγητής της Επιχειρησιακής Έρευνας και της Επιστήμης των Υπολογιστών στο Stanford University (1966 – 1973). Τέλος ήταν ιδρυτικό μέλος και διετέλεσε Πρόεδρος του Institute of Management Science και έλαβε πλήθος τιμών και διακρίσεων.*

**Keywords:** Simplex Method., Linear Programming, INFORMS (Institute for Operations Research and the Management Sciences), Operational Research, Nobel Prize.

## His life

*“Life is good for only two things, discovering mathematics and teaching mathematics”  
Simeon Poisson (1781 – 1840)*

George Bernard Dantzig (1914 - 2005) (Figure 1) was a pioneer of the innovative theoretic and applied mathematic methods, which were primarily focused on the development and effectiveness of Operational Research. During the last 62 years, his creative work in Linear Programming and its extensions have been applied worldwide in a massive number of industries, including commercial businesses and governmental organizations. Its application allowed them to achieve a more effective management of their resources. As a result, the development of Linear Programming and the invention of the algorithm Simplex are recognized as important scientific contributions of the 20th century.

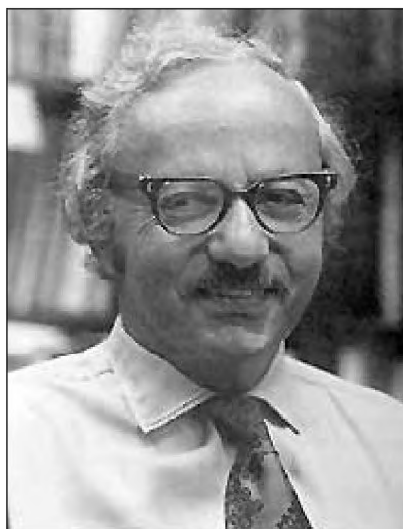


Figure 1. George Dantzig

Furthermore, Dr Dantzig made a significant contribution in Mathematics, Economics, Statistics, Industrial Applied Mechanics and Information Technology. More in particular, he was chairman of the Institute of Management Sciences, which was predecessor and co-establisher of the Institute for Operations Research and the Management Sciences (INFORMS).

G.B. Dantzig's parents were Tobias Dantzig and Anja Ourisson. Tobias Dantzig was born in Russia, but moved to France, where he studied Mathematics in Paris, having <sup>1</sup>Jules Henri Poincaré as a tutor, among others. During that time he meets Anja Ourisson who was studying Mathematics in Sorbonne. They got married and in 1910 they moved to Portland, Oregon in USA. Tobias thought that his heavy Russian accent would not allow him to find another job, besides that of a workman. Thus, he worked in road construction, as a lumberjack and as painter. At that time, on November 8, 1914, George was born, the first of two sons in the family. It has to be mentioned that this happened when the Dantzig family were experiencing financial problems.

Despite this fact, Tobias managed to get a teaching position in the Indiana University, where he got his Doctorate in Mathematics in 1916. He then taught in the John Hopkins University and in the University of Maryland, where he was also chairman of the Department of Mathematics. He had a unique ability in conceiving and explaining Classic Mathematics. His book <sup>2</sup>"*Number: The Language of Science*" published in 1930 was praised by Albert Einstein: "This is beyond doubt the most interesting book on the evolution of mathematics, which has ever fallen into my hands".

When Tobias got his two sons, he believed that the choice of names he would give them would determine to a great extent, their future course and career. For his first son, he chose the name George Bernard and later <sup>3</sup>George Bernard Shaw, naming him after the famous Irish writer, hoping he would one day become a writer, too. The second son was named Henri and later Henri Poincaré, after the already famous Mathematician Henri Poincaré, with the hope that he would be a Mathematician. Henri, indeed, became a Mathematician and Mechanic and worked as a radar mechanic. Henri Poincaré Dantzig died in 1972.

Meanwhile, Anja took her Postgraduate Diploma and then worked as a linguist in the Library of Congress in Washington DC.

George Bernard's family lived in Washington DC. He went to the Powell Junior High School. At first, his interest in Mathematics was minor as well as his records. His father was always helping and encouraging him, and as a result Mathematics became George's favorite class and the course where he achieved the highest marks. This continued at Central High School, where he was fascinated by Geometry. At that time, he was getting support from three people, an exceptional Mathematician at school, a co-student of his, later teaching Mathematics in Berkeley and of course his father. Tobias produced thousands Geometry problems, while George Bernard was still in High School and he later confessed that the mental exercise required to

<sup>1</sup> Jules Henri Poincaré (1854 - 1912). French Mathematician with great contribution to many fields of pure and applied mathematics, like celestial mechanics, fluid mechanics, optics, electricity, telegraphy, trichoid phenomena, elasticity, thermodynamic, dynamic theory, quantum theory and cosmology. He is believed to have contributed to the discovering (along with Albert Einstein and Hendrik Lorentz) of the Special Theory of Relativity.

<sup>2</sup> One of the most important books about Mathematics refers to the evolution of Mathematics and explains the concept of numbers in history. It reports on many issues, such as the function of numbers, the invention of zero and infinity. It also indicates how the evolution of numbers is connected with the history of human civilization.

<sup>3</sup> George Bernard Shaw (1856-1950) Irish playwright, honored with a Literature Nobel Prize in 1925.

solve them, was the greatest gift his father ever gave him. These problems played the most important role in the development of his analytical thought. Moreover, while Tobias was working on his famous work "Number: The Language of Science", George Bernard assisted him by preparing some of the numbers that appear in the book.

After his graduation from Central High School, G.B. Dantzig decided to study Mathematics in the University of Maryland, where his father was teaching, too. Despite the improved financial situation of the family, Tobias could not afford the study fees of his children in some acclaimed University of the States. G.B. Dantzig took his degree in Mathematics and Physics from the University of Maryland in 1936, at the age of 22. The summer of the same year, he got married to <sup>4</sup>Anne Schmuner, who had met at university. The couple moved directly to Ann Arbor, where G.B. Dantzig began his postgraduate studies at the University of Michigan. In 1937, with T.H. Hildebrand, R.L. Wilder and the G.Y. Rainer as instructors, he completed his postgraduate diploma in Mathematics. Due to the fact that during his studies he wasn't particularly pleased with abstract Mathematics and the only course he actually enjoyed was Statistics, he decided not to proceed to a Doctorate degree. Instead, he moved to Washington DC, where he worked from 1937 to 1939, as an assistant statistician, in a program for the US Bureau of Labor Statistics, called "Urban Study of Consumer Purchase". Right after the end of this program, he addresses to <sup>5</sup>Jerzy Neyman and asks for a Doctorate under his supervision, in Berkeley. J. Neyman agrees and G.B. Dantzig begins his studies, while at the same time he works as a teaching assistant of J. Neyman.

During his studies in Berkeley, an incident that would later change his life, took place. One day, he arrived late in class and saw two problems written on the blackboard. Assuming they were for homework, he simply copied them. A few days later, he apologized to Jerzy Neyman for taking him so long to finish his homework, but it seemed to him that the problems were a bit more difficult than usual. He asked him if he could still hand him in his papers, despite being late. J. Neyman told him to leave them on his desk, where there was already a huge pile of other papers. G.B. Dantzig hesitated at first, worrying his work getting lost among the rest of the papers, but couldn't do anything about it. Six weeks later, on a Sunday morning at around 8 o'clock, George and Anne got an unexpected visit at their home by J. Neyman, who was holding some papers and asked G.B. Dantzig to take a look at them, before sending them out for publication. Dantzig, still confused, couldn't realize what was really happening. After the necessary clarifications, it became clear to him that the problems he delayed' handing over were in fact two acclaimed <sup>6</sup>*unsolved problems in statistics*.

During World War II, G.B. Dantzig gave up his studies once more, even though at that point he had already completed the coursework and his Ph.D. thesis. He went to Washington DC and joined the Martial Aviation, as a civilian. From 1941 to 1946 he was in charge of the Combat Analysis Branch of Statistical Control, U.S. Army Force, Pentagon and Washington DC. In 1944, he was granted with the War Department Exceptional Civilian Service Medal. In his office he collected elements regarding sorties flown, bomb casting, air combats, factors of deterioration and loss of aircrafts. He was also an assistant in other departments of Air Staff, preparing certain plans called 'programs'. Every single thing, from supplying aircrafts with spares to any other project concerning aircrafts, was planned with great detail, even though he had to deal with different kinds of material and around fifty thousand specialized technicians. In that way, he also improved his expertise regarding organization and technical work.

In 1946, after a five-year break, G.B. Dantzig returned to Berkeley for a semester, where he got his Doctorate in Mathematics from the University of California. He was also offered an Academic position in that University, but he rejected it for being economically disadvantageous. They offered him precisely 1,400 dollars annually, but he didn't accept the offer, thinking that since his family had a new member, his son David, their expenses would increase and therefore would not be covered by that amount.

Until June of 1946, he remained in Washington DC examining various possible work positions. After a while, he was offered a position in the Pentagon, as an Advisor in the USA Ministry of Defense, which he accepted. His goal was to calculate how the Martial Aviation could mechanize its planning process, in order to accelerate the deployment of forces and equipment, as well as compute a time-staged deployment, training and logistical supply program. It was a project that suited precisely to his capabilities and interests.

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<sup>4</sup> Anne Schmuner Dantzig (1917-2006). She was born in Maryland. Her parents were immigrants from East Europe. She studied French at the University of Maryland, and Librarianship at the University of Michigan. She worked in the Library of Congress and dedicated a big part of her life in helping people that suffered from blindness.

<sup>5</sup> Jerzy Neyman (1894-1981). He was of Polish origin and studied Mathematics at the University Kharkov (Russia) and he did his PhD at the University of Warsaw. In 1938, he undertook as Chairman of the Statistics Laboratory in Berkeley, where in 1955 he founded the Department of Statistics. The six conferences that he organized there are really famous.

<sup>6</sup> The legendary story of the unsolved problems in Statistics, was the inspiration source for the similar scene in the film "Good Will Hunting", (won Oscar for best writing 1998)



**Figure 2. Dantzig was a founding member of The Institute of Management Sciences in the early 1950s.**

In 1947, G.B. Dantzig contributed to the Mathematic Science by creating the ‘Simplex Method of Optimization’, which made him famous. It was the most noted and used method for the solution of a general Linear Programming problem. This method constitutes an algebraic repetitive process, which solves precisely every Linear Programming problem, in a finite number of steps. Thanks to the use of the Simplex method, he became more efficient in his work in the Martial Aviation, which helped him also to become an expert on planning methods that could be solved by using desk calculators.

By the time G.B. Dantzig created this new method, the term ‘Linear Programming’ did not exist. He used the term ‘programming’, a military term which at the time referred to the plans and programs concerning accountancy, military supplies, education and development of individuals. G.B. Dantzig mechanized the planning procedure by introducing a “Linear Programming in Structure”, where the term ‘programming’ is the aforementioned military term. The term ‘Linear Programming’ was suggested and finally accepted by <sup>7</sup>Tjalling Koopmans during his visit at <sup>8</sup>RAND Corporation in 1948, which was aiming at view exchanging. Linear Programming was tacitly used by <sup>9</sup>Fourier in the early 1800s, but it was formally applied for the first time on economic problems, during the 1930s from <sup>10</sup>Leonid Kantorovich, whose work was neglected in the West, since it remained literally hidden behind the ‘Iron Curtain’ and as a result remained unknown to the Western Europe and America. Tjalling Koopmans applied Linear Programming in problems regarding shipping, in the early 1940s. However, the first complete algorithm for the solution of Linear Programming problems with the name ‘Simplex Method’ was published by G.B. Dantzig in 1947.

<sup>7</sup> Tjalling Charles Koopmans (1910-1985). Mathematician born in Holland. In 1975, he is granted with the Nobel Prize for the Economic Sciences, along with Leonid Kantorovich, “for their contribution in the theory of Optimum allocation of resources”. He is also known for the Koopmans Theorem, which is widespread in quantum chemistry.

<sup>8</sup> The RAND Corporation (Research and Development). Non-profit think-tank with scientific, educational and philanthropic aims, always in favor of the public welfare and security of the United States of America.

<sup>9</sup> Jean Baptiste Joseph Fourier (1768-1830). French Mathematician and Physicist, best known for initiating the research of Fourier Series and their application to problems of heat flow. Fourier is also credited with the discovery of the Greenhouse Effect.

<sup>10</sup> Leonid Vitaliyevich Kantorovich (1912-1986). Born in Russia, studied Mathematics at the University of Leningrad, where he later undertook as a teacher. In 1965, he was awarded with the Lenin Prize and in 1975 with the Nobel Prize for the Economics Sciences, joint with Tjalling Charles Koopmans.



**Figure 3. Left to right: Tjalling C. Koopmans, George B. Dantzig, Leonid V. Kantorovich. The photo was taken in Austria, in IASA - International Institute of System Analysis.**

L. Kantorovich and T. Koopmans shared the Nobel Prize in Economics in 1975 “for their contribution to the theory of optimum allocation of resources”. Dantzig wasn’t nominated, although his work would justify such a prize. T. Koopmans wrote to L. Kantorovich, announcing him that he would deny the prize, as a protest towards the exclusion of G.B. Dantzig. L. Kantorovich, however, could not follow, because he saw the prize as a vindication for the use of Mathematics in Economics, which in the countries of the Soviet Bloc was “a means for the apologists of capitalism”.

The first extended use of the Simplex Method was made in order to determine the suitable and sufficient food supply the army with the minimal cost. In the fall of 1947, Jack Laderman of the Mathematical Tables Project of the National Bureau of Standards undertook the first large-scale computation in this field, as a test of the newly proposed simplex method. It was a system with nine equations in seventy seven unknowns, using manually-operated desk calculators and nine secretaries; it took 14 days of work, for finding a solution (roughly 960 man-hours). The particular problem had already been studied by <sup>11</sup>George Stigler, who suggested a solution based on the replacement of certain foods with others, resulting in the acquisition of more food per dollar. Then, he examined a total sum consisting of five hundred and ten possible ways of combining the selected foods. He did not believe that his solution was the optimum, though he strongly believed that the cost could not be decreased more than a few dollars per year. As a matter of fact, it was proved that Stigler’s solution, expressed in 1945’s dollars, was only 24 cents higher than the actual minimum \$39.69 per year.

Linear Programming was considered a revolutionary development, which gave man the ability to set goals and reach the optimum solutions in a category of practical problems, which were characterized by a certain complexity. Thereafter, G.B. Dantzig, referring to the functions of the Simplex Method, wrote: “The huge power of the Simplex Method is a constant surprise to me”.

In the course of time, many scientists have praised its possibilities. In particular, in 1980, Eugene Lawer wrote: “Linear Programming is used for the resources allocation, the planning of production, the timetable of working people, the planning of the portfolio investments and the formulation of marketing strategies. The variability and the economic impact of the Linear Programming, in the current industrial world, are really astonishing”. Furthermore, in 1991 M. L. Balinski wrote: “Mathematic Programming seems to have been blessed by at least two exceptional creative geniuses: By George Bernard Dantzig and Leonid Kantorovich”. The Simplex Method was declared as one of the ten most important algorithms of the 20<sup>th</sup> century by the Institute of Electrical and Electronic Engineers.

A typical example of a problem that can be solved using the Simplex method is the ‘diet problem’, which is presented below, in a simple form:

<sup>11</sup> George Stigler (1911-1991). American Economist, who taught in many Universities on the USA. He was honored with the Nobel Prize for the Economical Sciences in 1982.

## Diet Problem: Dual Problem

“A dietician is preparing a meal consisting of chicken and rice. Each portion of this meal should contain at least 5 grams of proteins and 10 millionths of a gram of iron. Each chicken dish contains 5 grams of protein, 5 millionths of a gram of iron and 2 grams of fat. Each rice dish contains 1 gram of protein, 3 millionths of a gram of iron and 2 grams of fat. It is required that each portion contain the minimum fat amount. Find the number of chicken dishes and rice dishes that should be served, so that each portion contains the minimum amount of fat.”

By using the Simplex Method, we are led to the optimum solution of the problem, according to which each meal should consist of 0.5 portions of chicken and 2.5 portions of rice, so that the restrictions set in the problem to be fulfilled.

In between, in June of 1947, the Air Force established a major task force to work on the high-speed computation of its planning process, later named Project SCOOP (Scientific Computation of Optimal Programs), with George Bernard Dantzig as chief mathematician. He stayed with Project SCOOP until June 1952, when he joined the RAND Corporation as a research mathematician.

What is more, the systematic growth of the practical methods of calculating for Linear Programming basically begins in 1952 from the Rand Corporation, in Santa Monica, under G.B. Dantzig's guidance. He worked intensively in this program until the end of 1956, while in the meantime great progress had been made in the development of the first generation computers. During that time, along with the researcher Philip Wolfe, they develop the method *Dantzig-Wolfe* decomposition, which is used in order to simplify the important problems in programming and operation research, which include a vast number of data.

In 1960, he feels that the RAND Corporation is no more a source of new ideas and tries to find a way out of his uneasiness. He returns to Berkeley, as a professor of Engineering at the University of California and becomes a chairman of the Operations Research Center (1960-1966). In this way, he begins a brilliant academic career. He becomes a Professor of the Operations Research and Computer Science at the Stanford University (1966-1973). He is appointed Chairman of the CA Criley Endowed Chair in Transportation (1973-1985). He becomes a co-manager of the Systems Optimization Laboratory (1973-1998) and manager of the PILOT Energy-Economic Model Project (1975-88). He also teaches at the University until 1997, without quitting his research work.

During his academic career, he exhibited the best possible implementation of Linear Programming. He was generally involved with the formulation and resolution of management problems in most of the greatest industries, with the resolution of strategic and regular problems in defense, with the evaluation of plans and operational solutions for the better possible exploitation of energy and other resources, on a national and worldwide level, as well as with the theoretic progress of Mathematics, Statistics, Economics, Game Theory, and Computer Science. He also worked for the adopting of the model of Linear Programming, in a number of Mathematic Programming problems. G.B. Dantzig worked as an advisor in many big companies.

In 1963, his book “Linear Programming and Extensions” is published, and is commonly considered classic and impressive work of high scientific level, also pleasing to read. The readers of this book, students and researchers, get to know the basic elements of Linear Programming, a historical flashback of how this certain field began to develop, as well as the notable Mathematics applied for its extension. The book quickly became ‘the bible’ of linear programming. In a recently published two- volume edition (1997 – 2003), G.B. Dantzig and Mukund Thapa worked together on a brief review on the current functions of Linear Programming. In 1973, in his book, “Compact City: A Plan for a Liveable Urban Environment”, joint with Thomas L. Saaty, presents another view of G.B. Dantzig's wide-range of interests. The book is “a nontechnical, introductory study about the feasibility of building a city that makes more effective use of the vertical dimension and the time dimension (through around-the-clock use of facilities) than present cities do”. It includes a section on “Operations Research and the Total-System Approach”, but no linear programming!

G.B. Dantzig received many great honors and awards throughout his lifetime, some of which are the following:

- War Department Exceptional Civilian Service Medal in 1944.
- Member of the National Academy of Sciences in 1971.
- Von Neumann Theory Prize in Operational Research in 1975.
- The National Medal of Science presented by the President of the United States, Gerald R. Ford, in 1976, “for inventing linear programming and discovering methods that led to wide-scale scientific and technical applications to important problems in logistics, scheduling, and network optimization, and to the use of computers in making efficient use of the mathematical theory”.

- The National Academy of Sciences Award in Applied Mathematics and Numerical Analysis in 1977, “for the pioneering development of the theory and application of Programming, Operations Research and the Mathematic modeling of Economics”.



Figure 4. Left to right: George Dantzig, Anne Dantzig, President Gerald Ford (National Medal of Honor ceremony, 1971).

- The Harvey Prize in Science and Technology from Technion, Israel, in 1985, “in recognition of his outstanding contribution to engineering and the sciences through his pioneering work in mathematical programming and his development of the simplex method. His work permits the solution of many previously intractable problems and has turned linear programming into one of the most frequently used techniques of modern applied mathematics”.
- Member of the National Academy of Engineering in 1985.
- The Silver Medal from the Operational Research Society of Britain in 1986.
- The Adolph Coors American Ingenuity Award Certificate of Recognition by the State of Virginia in 1989.
- The Special Recognition Award from the Mathematical Programming Society in 1994.



Figure 5. George Dantzig congratulates the recipients of the Dantzig Dissertation Award 1999.

The Institute For The Operations Research and the Management Sciences (INFORMS), honored G.B. Dantzig by enacting the ‘George B. Dantzig Award’, which is awarded for the best innovative doctorate thesis in the field of Operational Research and Management Sciences.

He was a founding member of The Institute for Management Sciences and in 1966 became Chairman, too.



Throughout his career, he worked with:

- Econometric Society
- Institute of Mathematical Statistics
- Association for the Advancement of Science
- American Academy of Arts and Sciences
- Institute for Operations Research and the Management Sciences

G.B. Dantzig authored or co-authored seven books and more than 150 papers. Some examples are:

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He lived with Anne for 69 years. They had three children, David, Jessica and Paul. They also had three grandchildren and two great-grandchildren.

He died at an old age leaving behind invaluable legacy, on May 13, 2005, due to complications from diabetes and cardio vascular disease, at his home, in Palo Alto, California. He was 91 years old.

The scientific and economic impacts resulting from Dantzig's work are immeasurable. He will be warmly remembered in the years to come by those who were privileged to know him. To others, he will be known only through his work and its impact, far into the future. He also left as a legacy, his 50 students who did their doctorate under his guidance and supervision, in Berkeley and Stanford, and moreover the remembrance of being a good friend and a good teacher. Although his lifetime work has been globally recognized, he was unfairly deprived the greatest of all honors for a man of his magnitude, the Nobel Prize.

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# LOOKING FOR A FLEXIBLE FUNCTIONAL FORM: THEORY AND EVIDENCE

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## Abstract

*This paper investigates the econometric application of a flexible functional form of Generalised Leontief function. We will focus our attention on econometric techniques that are used to analyze the interrelated demands for labour, capital and other inputs in production processes. In particular, we begin with an historical overview of the literature on the demand for factors of production, beginning with the famous Cobb-Douglas model and constant elasticity of substitution (CES) and moving with the application of Generalised Leontief function using data from the Greek industry.*

## 1. INTRODUCTION

The notion of a production function has been used for a long time. In the theoretical literature, in the first edition of famous text in 1890 *Principles of Economy*, Alfred Marshall has emphasized on theoretical relationships between production function and factor demands, however, the empirical analysis lagged considerably behind theoretical developments.

Paul Douglas was very devoted considerable attention in explaining the movements of labour productivity and real wages over time.<sup>1</sup> Douglas wanted to test the marginal productivity theory. The important issue for him was if labour was in fact paid the value of its marginal product. Cobb and Douglas assumed that production was characterized by constant returns to scale.

They related empirically in a logarithmic form the value added output to the inputs of capital and labour for the U.S. manufacturing based on annual data for the period 1899-1922.

$$\ln Y = \ln A + \hat{\alpha}_K \ln K + \hat{\alpha}_L \ln L$$

where: Y are the output (value added), and K, L is capital and labour respectively .

The assumption of constant returns to scale (or otherwise the homogeneity of degree one) implied the restriction for the parameters  $\hat{\alpha}_K + \hat{\alpha}_L = 1$ .<sup>2</sup> Rearranging the above logarithmic equation of labour productivity to the capital/labour ratio:

$$\ln(Y/L) = \ln A + \hat{\alpha}_K \ln(K/L)$$

The corresponding nonlogarithmic form with constant returns to scale which using for the empirical implementation has the following form:

$$Y = A K^{\hat{\alpha}} L^{1-\hat{\alpha}}$$

Rearranging the above nonlogarithmic equation and taking the partial derivatives of Y with respect to K and L and equating the marginal products with the real input prices and solving, we can obtain:

$$\alpha_K = \frac{P_K}{PY}$$

and

<sup>1</sup> Cobb Charles and Paul H. Douglas (1928), "A Theory of Production", American Economic Review, Supplement Vol. 18, pp. 139-165.

<sup>2</sup> The nonlogarithmic form is  $Y = A K^{\hat{\alpha}} L^{\hat{\alpha}}$ , and multiplying by  $\hat{\alpha} > 1$ , we have:  $\hat{\alpha}^i Y = A(\hat{\alpha} K^{\hat{\alpha}})(\hat{\alpha} L^{\hat{\alpha}}) = A K^{\hat{\alpha}} L^{\hat{\alpha}} \hat{\alpha}^i$ . This function is homogeneous of degree  $i = \hat{\alpha} + \hat{\alpha}$  and when  $i = 1$  then  $\hat{\alpha} + \hat{\alpha} = 1$ .

$$\alpha_L = 1 - \alpha_K = \frac{P_L L}{PY}$$

Cobb-Douglas argued that if markets were competitive, if marginal products equated to the real prices and if production technology following the constant returns to scale, then the least squares estimates of the parameters  $\hat{\alpha}_K$  and  $\hat{\alpha}_L$  should be equal approximately to the value shares of capital and labour.

Other economists were more interested in measuring substitution elasticities among inputs. They defined the substitution elasticity between the capital and labour as following:

$$\sigma = \frac{\partial \ln(K/L)}{\partial \ln(F_L/F_K)} = \frac{\partial \ln(K/L)}{\partial \ln(P_L/P_K)}$$

where:  $F_K$  and  $F_L$  are the marginal products of capital and labour respectively.

For the Cobb-Douglas function the substitution of elasticity ( $\sigma$ ) always equals to unity. The first empirical paper attempted to measure the substitution elasticities between the inputs using the theory of cost and production was the Ragnar Frisch, who estimated a substitution coefficient (the ratio of marginal productivities) between the inputs.<sup>3</sup>

Later, an extension of the Cobb-Douglas function introduced by Kenneth Arrow, Hollis Chenery, Bagicha Minhas, and Robert Solow; in their model they tried to search in which functional form the substitution of elasticity ( $\sigma$ ) will be constant but not constrained to unity. They concluded in the following equation:

$$\ln(K/L) = \text{constant} + \sigma \ln(F_K/F_L)$$

where the second term ( $F_K/F_L$ ) indicates the marginal rate of substitution.

The above function indicates the well-known constant elasticity of substitution (CES) production function with constant returns to scale can be written as following:

$$Y = A[\delta K^{-\rho} + (1 - \delta)L^{-\rho}]^{-1/\rho}$$

where the substitution of elasticity  $\sigma = 1/(1+\rho)$ <sup>4</sup>

In fact, the constant elasticity of substitution (CES) production function has appeared in the literature a quarter century earlier than Cobb-Douglas production function. The constant elasticity of substitution (CES) production function has been derived on consumer demand analysis. Abraham Bergson<sup>5</sup> used the following function:

$$Y^{-\rho} = A \left( \sum_{i=1}^n \delta_i X_i^{-\rho} \right)$$

Nerlove estimated a three input Cobb-Douglas cost function (namely, capital, labour and fuels) with returns to scale to be other than constant; his empirical analysis indicated that the returns to scale were increasing rather than constant.<sup>6</sup> However, Nerlove was unsatisfied with the restricted assumptions of Cobb-Douglas function according to which the substitution of elasticities required to be equal to unity and by constant elasticity of substitution (CES) which implied some other restrictions for the substitution of elasticities that required to be constant and equal to each other.

<sup>3</sup> Frisch Ragnar (1935) "The principle of substitution: an example of its application in the chocolate industry", *Nordisk Tidsskrift for Teknisk Okonomi*, 1:1, pp: 12-27.

<sup>4</sup> There is a limiting case in which  $\rho \rightarrow 0$ ,  $\sigma \rightarrow 0$ , the Cobb-Douglas function is a limiting form of the CES function.

<sup>5</sup> Bergson (Burk) Abraham (1936) "Real Income, Expenditure proportionality, and Frisch's New Method of Measuring utility", *Review of Economic Studies*, vol. 4:1, October, pp: 33-52.

<sup>6</sup> Nerlove Marc (1963) "Returns to Scale in Elasticity Supply" in Carl Christ ed. *Measurement in Economics: Studies in Mathematical Economics and Econometrics in Memory of Yehuda Grunfeld*, Stanford, California, Stanford University Press, pp: 167-198.

Lucas et al. have attempted to reconcile the seemingly disparate cross-sectional and time-series estimates of substitution of elasticity ( $\delta$ ).<sup>7</sup>

In 1961, Earl Heady and John Dillon in their book of Agricultural Production Function<sup>8</sup> experimented with Taylor's series expansion introduced the second-degree polynomial in logarithms that added quadratic and cross-terms to the Cobb-Douglas function. They estimated the production function directly using least square methods and called this procedure production function contour fitting. They reported the least squares estimates of a square root transformation that included as a special case the generalized linear production function that introduced in 1971 by Erwin Diewert.<sup>9</sup> Diewert's Generalized Leontief Functional Form was the first in the theory of dual cost and production.

Daniel McFadden<sup>10</sup> focused on the theory and its applications of duality in production. He examined both the use of duality theory and the problem of generating more flexible functional forms with more than two or three inputs and less restrictive forms than the Cobb-Douglas and constant elasticity of substitution (CES) specifications.

Several other empirical results have been reported in the literature. In 1971, Nerlove have been surveyed empirical findings<sup>11</sup>, and in 1973 Berndt has been summarized additional empirical findings.<sup>12</sup>

A decade later, in 1970 Laurits Christensen, Dale W. Jorgenson, and Lawrence J. Lau introduced a flexible functional form the "translog production function" a form that placed no-restrictions on the substitution of elasticities.<sup>13</sup> The translog function was a second order Taylor's series in logarithms and was identical to the production function considered by Heady some decades earlier.<sup>14</sup>

Lastly, the Boskin and Lau introduced another flexible functional form "the meta-production function" that is an extension of translog production function and can be employed with the panel or pool data.<sup>15</sup> This function form places no a priori restrictions on the substitution possibilities among the inputs of production. It also allows scale economies to vary with the level of output. This feature is essential to enable the unit cost curve to attain the classical shape.

Econometric applications of cost and production functions differ in their assumptions. In the regression of the production function, output is endogenous and input quantities are exogenous. In the dual cost function, the production costs and the input quantities are endogenous. When output and input prices can be considered as exogenous, then it is better to apply a cost function that has input prices as regressors, rather than a production function in which input quantities are the right-hand variables.<sup>16</sup>

Empirical research on estimating cost and production function relationships has a long history, trying to explain the average labour productivity, the relationships between inputs and outputs, to estimate the substitution elasticities among inputs and finally to estimate the returns to scale.

The production function parameters can be uniquely recovered from estimation of the demand equations derived from the dual cost function.<sup>17</sup>

The empirical analysis of input demands and input substitution patterns provides an example of the strong links between economic theory and econometric implementation. The econometric techniques that we employ deal with estimation of parameters in systems of equations.

Furthermore, the implementation of a multiproduct cost functions can permit a richer analysis of the effects on costs and factor demands of various changes in the composition and levels of output; some recent

<sup>7</sup>Lucas Robert (1969) "Labour-Capital Substitution in U.S. Manufacturing" in Arnold C. Harberger and Martin J. Bailey eds. *The Taxation of Income from Capital*, Washington, D.C.: The Brookings Institution, pp: 223-274.

<sup>8</sup>Heady Earl and John L. Dillon (1961) *Agricultural Production Functions*, Ames, Iowa: Iowa State University Press.

<sup>9</sup>Diewert Erwin (1971) "An Application of the Shepard Duality Theorem: A Generalized Linear Production Function", *Journal of Political Economy*, vol. 79:3, May/June, pp: 482-507.

<sup>10</sup>McFadden Daniel (1978) *Production Economics: A Dual Approach to Theory and Applications*, volume 1, Amsterdam: North-Holland

<sup>11</sup>Nerlove Marc (1967) "Recent empirical studies of the CES and Related Production Functions" in Murray brown ed., *The Theory and Empirical Analysis of Production*, Studies in Income and Wealth, vol. 32, New York, Columbia University Press for the National Bureau of Economic Research, pp: 55-122.

<sup>12</sup>Berndt Ernst (1976) "Reconciling Alternative Estimates of the Elasticity of Substitution", *Review of Economics and Statistics*, vol. 58:1, February, pp: 59-68.

<sup>13</sup>Christensen Laurits, Dale W. Jorgenson and Lawrence J. Lau (1971) "Conjugate Duality and the Transcendental Logarithmic Production Function", *Econometrica*, vol.39:4, July, pp: 255-256, and Christensen Laurits, Dale W. Jorgenson and Lawrence J. Lau (1973) "Conjugate Duality and the Transcendental Logarithmic Production Function", *Review of Economics and Statistics*, vol. 55:1, February, pp: 28-45.

<sup>14</sup>Heady, however, has emphasized only on the primal production function and he did not considered the dual cost or even the specifications of the profit function.

<sup>15</sup>Boskin M.J. and Lau L.J.: (1992) "Capital, technology and Economic growth", chapter 2 in Rosenberg, Landau and Mowery (ed.) *Technology and the wealth of nations*, Stanford University press.

<sup>16</sup>Zellner Arnold, Jan Kmenta and Jaques Dreze (1966) "Specification and estimation of Cobb-Douglas Production Function Models", *Econometrica*, vol.34:3, October, pp: 784-795.

<sup>17</sup>A cost function is dual in the sense that it embodies all the parameters of the underlying production function. See Berndt Ernst (1991) *The Practice of Econometrics: Class and Contemporary*, Addison-Wesley Publishing Company.

examples of empirical implementation of multiproduct cost functions can be found among others in Douglas Caves and Lauritis Christensen.

## 2. THE THEORETICAL FRAMEWORK

There are a number of ways to approach the estimation of production function and technical progress. The aim of this section is to examine the nature of technological progress and factor substitution in the Greek industry by using the *Generalised Leontief production function* for the annual time-series data in the period 1959-1990.

The *Generalised Leontief functional form* which proposed by Diewert has been established as a useful alternative for the long-run production studies.

We can consider the following *Generalised Leontief functional form* for a cost function<sup>18</sup> with the constant returns to scale that can be written as:

$$C = Y \left[ \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij} (w_i w_j)^{1/2} \right] \quad (1)$$

where: C is the total cost, Y is the output,  $w_{ij}$  the prices of n inputs ( $i, j = 1, \dots, n$ ), and  $Q_{ij}$  the n input quantities, with  $\gamma_{ij} = \gamma_{ji}$  ( $i, j = 1, 2, \dots, n$ ). The parameters  $\tilde{\alpha}_{ij}$  are such that (1)  $\tilde{\alpha}_{ij} = \tilde{\alpha}_{ji}$  and (2)  $\tilde{\alpha}_{ij} \geq 0$  (for  $i, j = 1, 2, \dots, n$ ).

Let us assume that we have n inputs, as  $w_i$ , ( $i=1, \dots, n$ ), with the n input quantities  $Q_i$ , and the total cost indicating by C and the output by Y. We are assuming that the output and the input prices Y and  $w_{ij}$  are exogenous, while the input quantities  $Q_{ij}$  are endogenous.

The cost C which defined from equation (1) is linearly homogeneous in input-prices w and it has  $N(N+1)/2 + 2N + 3$  independent parameters, just the right number to be flexible functional form, (Diewert and Wales, 1987).<sup>19</sup> The first set of  $N(N+1)/2$  independent terms on the right hand side of equation (1) correspond to the "*Generalised Leontief cost function*" for a constant returns to scale technology with no technological progress, (Diewert).<sup>20</sup>

The  $i$ th input demand function which correspond to equation (1) can be obtained by differentiating C with respect to  $w_i$  (using the "*Shephard's lemma*").<sup>21</sup>

The function  $w_i^{1/2} w_j^{1/2}$  is concave in w and as a nonnegative sum of concave functions is concave. That function is a nondecreasing in  $w_i$  follows from the nonnegativity of the parameters  $\gamma_{ij}$ . If all  $\gamma_{ij} = 0$  (for  $i, j$ ) then the above equation reduces to a linear production function.

The production function given by equation exhibits constant returns to scale; we can generalize equation to any degree of returns to scale by:

$$c = f \left( \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij} w_i^{1/2} w_j^{1/2} \right) \quad (1')$$

where,  $\gamma_{ij} = \gamma_{ji} \geq 0$  and f is a continuous monotonically increasing function which tends to plus infinity and has  $f(0) = 0$ .

The "*Generalized Leontief cost function*" and the "*Generalized linear production function*" are very useful by providing a second-order approximations to an arbitrary twice differentiable cost function (or

<sup>18</sup>Also, we can use the following equation for the *Generalized Leontief Function*:

$$C(w_k, w_l, Y, T) = \alpha_o + \alpha_Y Y + \alpha_{YY} Y^2 + \sum_{i=1}^n \alpha_i w_i + \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij} w_i^{1/2} w_j^{1/2} + \sum_{i=1}^n \gamma_{it} w_i^{1/2} T + \gamma_t \sum_{i=1}^n w_i^{1/2} T + \gamma_{YY} \sum_{i=1}^n w_i^{1/2} Y^2 + \gamma_{iT} \sum_{i=1}^n w_i^{1/2} T^2 Y + \gamma_{TT} T^2 + \gamma_{YT} T$$

where: where: C is the total cost, Y is the output,  $w_{ij}$  the prices of n inputs ( $i, j = 1, \dots, n$ ), and  $Q_{ij}$  the n input quantities, T is the time trend.

<sup>19</sup>Diewert Erwin and Terence J. Wales (1987) "Flexible Functional Forms and Global Curvature Conditions", *Econometrica*, vol.55:1, January, pp:43-68.

<sup>20</sup>Diewert Erwin (1971) "An Application of the Shepard Duality Theorem: A Generalized Linear Production Function", *Journal of Political Economy*, vol. 79:3, May/June, pp: 482-507 and also, Diewert Erwin (1974) "Applications of Duality Theory" in Michael D. Intriligator and David A. Kendrick eds., *Frontiers of Quantitative Economics*, vol. II, Amsterdam: North-Holland, pp: 106-171.

<sup>21</sup>  $X_i(w, Y, T) = \sum_{i=1}^n \gamma_{ij} w_i^{1/2} w_j^{1/2} Y + \gamma_i + \gamma_{it} T Y + \gamma_t T + \gamma_{YY} Y^2 + \gamma_{TT} T^2 Y$  with ( $i=1, 2, \dots, n$ ).

The "*Generalised Leontief linear function*" can also be written as:  $Y = H(A_{11}K + A_{12}K^1/2L^{1/2} + A_{22}L)$ , where,  $A_{ii}$ 's are parameters and H is a single value increasing function. Also, we assume the *homotheticity hypothesis* for H, (Yasushi Toda).

production function) at a given vector of factor prices or at a given vector of inputs using minimal number of parameters.

As we discussed later, in order to obtain equations that are responsible to estimation, it is convenient to employ the shephard's lemma which states that the optimal cost-minimizing demand for input i can simply be derived by differentiating the cost function with respect to  $w_i$ .

Therefore, if we differentiate the equation (1) with respect to  $w_i$  yielding the equation (2) and dividing the equation by Y, then yielding the optimal input-output equation (3) denoted by  $\alpha_i$ :

$$\alpha_i = \frac{X_i}{Y} = \sum_{j=1}^n \gamma_{ij} (w_j / w_i)^{1/2} \quad (2)$$

$$\frac{\partial C}{\partial w_i} = X_i = Y \left[ \sum_{j=1}^n \gamma_{ij} (w_i w_j)^{1/2} \right] \quad (3)$$

when,  $i = j$  then  $(w_j/w_i)^{1/2}$  is equal to 1 and the  $\gamma_{ij}$  is a constant term in the input-output equation.

Assuming two inputs, such as K = the capital and L = the labour and also Y = the output. The "Generalised Leontief cost-minimising" equations are the followings:

$$\alpha_K = \frac{K}{Y} = \gamma_{KK} + \gamma_{KL} (w_L / w_K)^{1/2} \quad (3)$$

$$\alpha_L = \frac{L}{Y} = \gamma_{LL} + \gamma_{KL} (w_K / w_L)^{1/2} \quad (4)$$

The estimates of all parameters in the "Generalised Leontief cost-function" can be obtained by estimating only the input-output demand equations (3) and (4); this occurs because there is no intercept term in the "Generalised Leontief cost-function" owing to the assumption of the constant returns to scale. Finally, if  $\gamma_{ij}=0$  for all i and j, then the input-output demand equations are independent of the relative input prices and all the cross-price elasticities are equal to zero.

Although equation by equation OLS estimation might appear attractive since the input demand functions (3) and (4) are linear in the parameters, these demand equations have cross-equation symmetry constraints.<sup>22</sup> Constant returns to scale restrictions imply the symmetry restrictions (the cost shares sum to one). To implement the "Generalised Leontief model" empirically, a stochastic framework must be specified. An additive disturbance term is appended to each of the input-output equations and is typically assumed that the resulting disturbance vector is independently and identically normally distributed with mean vector zero and constant, nonsingular covariance matrix  $\hat{U}$ .

An attractive feature of the "Generalised Leontief cost-function" is that they place no a-priori restrictions on the substitution elasticities. The elasticity of factor substitution measures the responsiveness of the ratio of factor inputs to changes in the ratio of the marginal product of the inputs.

The Hicks-Allen partial elasticities of substitution for a "general dual cost-function" (between inputs i and j in a general functional form with n inputs) can be given as:

$$\sigma_{ij} = (C_i * C_j) / (C_i * C_j),$$

where the subscripts i and j refer to the first and the second partial derivatives of the cost function with respect to the input prices  $w_i$  and  $w_j$ .

In particular, for "Generalised Leontief cost-function" the cross-substitution elasticities are given:

<sup>22</sup>Even these constraints hold in the population, for any given sample equation-by-equation OLS estimates will not reveal such restrictions; for example,  $\hat{\alpha}_{KL}$  in the K/Y equation estimated by OLS will not necessarily equal  $\hat{\alpha}_{LK}$  estimated in the L/Y equation. For a more detailed analysis see Berbdt Ernst (1991) The Practice of Econometrics: Class and Contemporary, Addison-Wesley Publishing Company.

$$\sigma_{ij} = \frac{1}{2} \frac{C \gamma_{ij} (w_i w_j)^{-1/2}}{Y \alpha_i \alpha_j} \quad (5)$$

where  $i, j = 1, \dots, n$  (with  $i \neq j$ ).

while the own-substitution elasticities are given as following:

$$\sigma_{ii} = \frac{-\frac{1}{2} C \sum_{\substack{j=1 \\ j \neq i}}^n \gamma_{ij} (w_j^{1/2} w_i^{-3/2})}{Y \alpha_i^2} \quad (6)$$

where  $i, j = 1, \dots, n$ .

From the other hand in order to estimate the price elasticities with the output quantity and all other input prices fixed<sup>23</sup>, we can use the calculation of the following formula:

$$\varepsilon_{ij} = S_i^* \quad ij,$$

where  $S_i$  is the cost share of the  $j$ th input in the total production costs.

For the "Generalised Leontief cost-function" the cross-prices elasticities are computed as following:

$$\varepsilon_{ij} = \frac{1}{2} \frac{\gamma_{ij} (w_i / w_j)^{-1/2}}{\alpha_i} \quad (7)$$

where  $i, j = 1, \dots, n$  (with  $i \neq j$ ).

while the own-prices elasticities are computed as following:

$$\varepsilon_{ij} = \frac{-\frac{1}{2} \sum_{\substack{j=1 \\ j \neq i}}^n \gamma_{ij} (w_i / w_j)^{-1/2}}{\alpha_i} \quad (8)$$

where  $i, j = 1, \dots, n$ . In order the own-prices elasticity to be negative it is necessary the summation portion of equation (8) to be positive.<sup>24</sup>

<sup>23</sup> Also, the familiar price elasticities are given by:

$$\varepsilon_{ij} = \frac{\partial \ln X_i}{\partial \ln w_j} = \left( \frac{\partial X_i}{\partial w_j} \right) \left( \frac{w_j}{X_i} \right)$$

see Berbdt Ernst (1991) The Practice of Econometrics: Class and Contemporary, Addison-Wesley Publishing Company.

<sup>24</sup> Because from the equations (7) and (8) of elasticity computations are based on the estimated parameters, and the predicted or fitted values of  $C$  and  $\alpha_i, \alpha_j$ , it is necessary to check the elasticity calculations which always must be hold:

$$\sum_{j=1}^n \varepsilon_{ij} = 0, \quad (\text{with } i = 1, \dots, n)$$

see Berbdt Ernst (1991) The Practice of Econometrics: Class and Contemporary, Addison-Wesley Publishing Company.



Since the input prices and  $\hat{a}_i$  vary between observations, then the estimators of  $\hat{\sigma}_{ij}$  and  $\hat{a}_{ij}$  will also differ between observations. The price elasticities are not symmetric that means  $\hat{a}_{ij} \neq \hat{a}_{ji}$  unlike the Hicks-Allen elasticities and our assumption of  $\hat{\sigma}_{ij} = \hat{\sigma}_{ji}$ . According to equations (5), (6), (7), and (8) the input  $i$  and  $j$  are substitutes, independent or complement inputs depending on whether the estimated  $\hat{a}_{ij}$  is positive, zero, or negative values. To ensure as its required by theory that the estimated cost function is monotonically increasing and strictly quasi-concave in input prices, one must verify that the fitted values for all the input-output equations are positive and that the  $n \times n$  matrix of the  $\hat{\sigma}_{ij}$  substitution elasticities is negative semidefinite at each observation. Because the computed elasticities depend on the estimated parameters and therefore are stochastic, the estimated elasticities have also variances and covariances, we should calculate these variances.

### 3. THE EMPIRICAL RESULTS

The advantages of using a cost function rather than a production approach, in order to estimate the elasticities of substitution may be summarized in the in the followings:(a) the elasticity of substitution is linearly related to the estimated parameters and thus the econometric parameters are more well defined; (b) no matter what the properties of the production function are, the cost function is always linearly homogeneous in the prices and as a result the estimating procedure is more general; (c) the multicollinearity problems which are inherent to the production function approach due to the high correlation between inputs are less severe, because the prices are formed in separate factor markets.<sup>25</sup>

One of the problems in estimating the elasticity of substitution is that of accurately specifying the production function as well as the type of technical progress. Of course, to impose the cross equation constraints it is necessary to estimate the Zellner's seemingly unrelated estimator (or the so-called ZEF) and we can obtain more efficient estimates if one imposed the cross-equation symmetry constraints in the IZEF equation. We have assumed that the input prices were endogenous and that failure to account lead to a simultaneous bias. One can employ instrumental variable techniques. Equation-by equation two stage least squares (2SLS) estimation would be again inappropriate, since it could not be impose the requisite cross-equation parameter restrictions. Instead of that, one could employ three stage least squares (3SLS) estimation procedure. If one iterated the three stage least squares (3SLS) estimation, the estimated parameters would not be numerically equivalent to those of the full information maximum likelihood technique, even though their asymptotic properties are identical.<sup>26</sup>

The data used for our estimations come from the annual industrial surveys (AIS) and from the statistical yearbooks (SY) of the National Statistical Service of Greece (NSSG). The data we are use refer to the *large industries* (which correspond to the industries with 20 or more employees persons).<sup>27</sup> Output is measured as value added in the large industries, as reported by AIS and SY. The labour is measured as number of employess. The wage rate and salaries correspond to the total labour cost for the large industry. The price of labour was derived by dividing the total labour cost by the number of employess. The prices of capital stock was derived by dividing the value added minus the total labour cost by the capital stock figures. The data on value added and wage rates have been deflated to the constant prices in 1985. These data are available for twenty digit industrial sectors for 32 years (1959-1990). A function of manufacturing sector as a whole estimated using the same data, and each variable is *weighted* by its shares and calculate the averages. We are also using the three stage least square estimators with endogenous lag variables for the Generalised Leontief function.

**Table 2.1 Parameter estimations(time-series of Generalised Leontief function): Greece (1959-1990)**

	KSH	LSH	K	L	KK	LL	KL	LK
20	0.0466	0.0463	0.0421	0.0312	0.0774 (7.67)	-0.0980 (-1.03)	-0.0272 (-4.61)	0.0442 (6.591)
21	0.0459	0.0362	0.0414	0.00509	0.08857	-0.1019	-0.0663	0.1791

<sup>25</sup> The cost function approach does not dominate the production function approach; the choice depends on the parameters to be estimated. For example, the reasons much the same as the ones given above the production function approach is preferable when estimates of factor productivities are sought, (Caramanis and Ioannides).

<sup>26</sup> Hausman Jerry (1975) "An Instrumental Variable Approach to Full Information Estimates for Linear and Certain Nonlinear Econometric Models", *Journal of Economic Dynamics and Control*, vol.2:1, february, pp:7-46.

<sup>27</sup> The following analysis is conducted at the level of "double digit international standard classification of industry" (ISIC). According to this classification of industry we will use the branches (the brackets showing the categories): (20)food, (21)beverages, (22)tobacco, (23)textiles, (24)footwear & wearing apparel, (25)wood & cork,(26)furniture, (27)paper, (28)printing-publishing, (28)leather, (30)rubber and plastic products, (31)chemicals, (32)petroleum, (33)non-metallic mineral products, (34)basic metal industry, (35)metal products, (36)machinery & appliances (37)electrical supplies, (38)transport equipments (39)miscellaneous manufacturing industry.

					(8.711)	(-1.708)	(-5.842)	(9.0111)
22	0.01548	0.0141	0.01516	-0.0427	0.0299 (16.76)	0.00059 (0.044)	-0.0204 (-10.19)	0.0577 (12.62)
23	0.0360	0.0353	0.0330	0.0286	0.0738 (9.448)	-0.0183 (3.234)	-0.0431 (-6.33)	0.0318 (10.55)
24	0.0875	0.1307	0.0805	0.2331	0.1707 (7.384)	-0.0655 (-1.775)	-0.0619 (-4.842)	0.1774 (5.671)
25	0.07221	0.08801	0.0659	0.1101	0.1206 (6.292)	-0.0384 (-0.169)	-0.03431 (-3.658)	0.0820 (4.374)
26	0.06639	0.06835	0.06071	0.05432	0.1197 (9.711)	-0.0212 (-3.382)	-0.2590 (-5.535)	0.1061 (16.28)
27	0.02168	0.03716	0.0334	-0.08531	0.0896 (9.086)	-0.0137 (-2.766)	-0.0715 (-6.469)	0.01907 (7.594)
28	0.03589	0.0333	0.03321	-0.02937	0.0675 (10.46)	-0.01017 (-3.436)	-0.0259 (-6.744)	0.02937 (16.79)
29	0.04018	0.05611	0.03727	0.01360	0.0857 (10.74)	-0.0274 (-2.517)	-0.03646 (-7.096)	0.7362 (8.153)
30	0.07589	0.07356	0.0616	0.1012	0.1053 (4.29)	0.1068 (0.3613)	-0.03395 (-2.375)	0.03638 (1.800)
31	0.0266	0.0309	0.0283	0.0121	0.0442 (6.242)	0.02251 (2.999)	-0.0162 (-3.273)	-0.00576 (0.391)
32	0.0445	0.0254	0.0417	-0.184	0.0778 (8.691)	0.00536 (0.112)	-0.04932 (-5.554)	0.05442 (6.92)
33	0.04176	0.0483	0.0374	0.0259	0.0940 (10.17)	-0.0288 (-3.131)	-0.0592 (-7.376)	0.0426 (9.123)
34	0.0678	0.0648	0.06014	0.0428	0.1402 (5.710)	-0.0241 (-0.882)	-0.0943 (-3.925)	0.0464 (3.497)
35	0.0639	0.0542	0.0490	0.0869	0.0990 (8.165)	-0.0315 (-2.958)	-0.0369 (-5.436)	0.0694 (9.749)
36	0.0426	0.0457	0.0382	0.0453	0.0836 (7.21)	-0.0189 (-2.239)	-0.0189 (-2.23)	0.0447 (8.10)
37	0.0569	0.0432	0.0466	0.0561	0.0912 (5.76)	-0.0572 (-0.491)	-0.0365 (-3.649)	0.0293 (4.12)
38	0.2539	0.0121	0.2195	-0.1018	0.3305 (6.14)	0.0665 (2.10)	-0.2270 (-3.49)	0.00253 (1.796)
39	0.0535	0.0541	0.05151	0.05175	0.0989 (6.79)	-0.0214 (-0.178)	-0.0348 (-4.11)	0.0414 (5.46)
20-39	0.0916	0.0013	0.0832	-0.0066	0.1534 (7.66)	-0.00293 (-1.06)	-0.0542 (-4.61)	0.0129 (6.619)

Note: The numbers in the brackets indicating the t-statistic. KSH and LSH indicate the capital share and labour share, respectively. Note:(\*) According to the ISIC classification, we have the branches (the brackets show the categories): (20)food, (21)beverages, (22)tobacco, (23)textiles, (24)footwear and wearing apparel, (25)wood and cork,(26)furniture, (27)paper, (28) printing -publishing, (28)leather, (30)rubber and plastic products, (31)chemicals, (32)petroleum, (33)non-metallic mineral products, (34)basic metal industry, (35) metal products, (36)machinery & appliances (37)electrical supplies, (38)transport equipments (39)miscellaneous industry.

**Table 2.2 Substitution and price elasticities of Generalised Leontief function): (1959-1990)**

	LL	KK	KL	$\hat{\alpha}_{LL}$	$\hat{\alpha}_{KK}$	$\hat{\alpha}_{LK}$	$\hat{\alpha}_{KL}$	c/l
Foodstuffs(20)	-0.839	-1.101	0.957	-0.44	-0.51	0.44	0.51	c.u
Beverages(21)	-4.222	-0.184	0.875	-0.72	-0.15	0.72	0.15	c.u
Tobacco(22):	-1.699	-0.102	0.412	-0.33	-0.08	0.33	0.08	c.u
Textiles(23):	-1.077	-0.963	1.014	-0.52	-0.49	0.52	0.49	c.s
Footwear & wearing(24):	-0.267	-1.177	0.554	-0.22	-0.28	0.22	0.28	c.u
Wood & cork(25)	-0.299	-1.228	0.596	-0.17	-0.37	0.17	0.37	c.u
Furniture(26):	-0.278	-2.207	0.777	-0.20	-0.57	0.20	0.57	c.u
Paper(27):	-0.347	-0.639	0.459	-0.19	-0.26	0.19	0.26	c.u
Printing-	-0.676	-0.483	0.564	-0.30	-0.25	0.30	0.25	c.u

publishing(28)								
Leather(29):	-0.285	-1.855	0.723	-0.20	-0.51	0.20	0.51	c.u
Rubber & plastics(30):	-0.416	-0.645	0.508	-0.22	-0.28	0.22	0.28	c.u
Chemical(31)	-1.383	-0.427	0.731	-0.46	-0.26	0.46	0.26	c.u
Petroleum(32)	-2.631	-0.403	1.000	-0.17	-0.28	0.17	0.28	c.s
Non-Metallic prds(33):	-0.697	-0.904	0.789	-0.36	-0.42	0.36	0.42	c.u
Basic metal ind.(34):	-0.307	-0.129	0.189	-0.11	-0.07	0.11	0.07	c.u
Metal products (35):	-0.587	-0.738	0.653	-0.30	-0.34	0.30	0.34	c.u
Machinery & appl.(36):	-0.486	-0.952	0.672	-0.28	-0.39	0.28	0.39	c.u
Electrical supplies(37):	-1.070	-0.275	0.529	-0.34	-0.17	0.34	0.17	c.u
Transport equipments(38)	-1.214	-0.339	0.615	-0.40	-0.21	0.40	0.21	c.u
Miscellaneous manuf/ind.(39):	-0.634	-1.265	0.890	-0.36	-0.52	0.36	0.52	c.u
All manufacturing:	-0.285	-0.385	0.309	-0.14	-0.16	0.14	0.16	c.u

Note.  $\sigma_{LL}$ ,  $\sigma_{KK}$ ,  $\sigma_{KL}$  = indicate the substitution elasticities,  $\hat{\alpha}_{LL}$ ,  $\hat{\alpha}_{KK}$ ,  $\hat{\alpha}_{KL}$  = indicate the price elasticities, respectively.

Finally,  $c/l$  = indicate the capital-labour saving (where c.u. is the capital-using (or labour saving)); according to David and Van De Klundert, (1965) the technical progress is capital-saving if and only if the elasticity of substitution between capital and labour is less than unity in absolute values.

The parameters estimations  $\sigma_{KK}$ ,  $\sigma_{KL}$ ,  $\sigma_{LL}$  can be interpreted as the share elasticities of capital and labour. The negative values of the  $\sigma_{KL}$  from the parameter estimators of Generalised Leontief function indicating that the share of capital decreasing in the total cost.

The mean own substitution and price elasticities are negative as it is required. That is, the factor demands are price responsive. Furthermore, in twelve sectors 20, 24, 25, 26, 27, 29, 30, 32, 33, 35, 36 and 39 the share of capital is influenced relatively more after a change in the price of labour. In other words, the demand for capital is less inelastic for the above twelve sectors than the labour demand is. Consequently, these industrial Greek sectors are willing for instance to give up comparatively easier some capital inflows in order to substitute with the relatively cheaper labour inputs.

**Table 2.3 Parameter estimations cross-section of Generalised Leontief function in Greece (1959-1990)**

	KSH	LSH	K	L	KK	LL	KL	LK
1959	0.205	0.256	0.213	1.338	0.978 (0.863)	0.436 (3.73)	0.316 (1.045)	-0.045 (-1.54)
1960	0.185	0.216	0.191	0.982	0.764 (0.770)	0.342 (2.63)	0.327 (1.185)	-0.032 (-0.94)
1961	0.157	0.162	0.160	0.861	0.153 (2.13)	0.230 (4.70)	0.198 (0.10)	-0.159 (-1.57)
1962	0.143	0.146	0.145	0.237	0.152 (2.66)	0.220 (4.73)	-0.186 (-0.12)	-0.199 (-1.95)
1963	0.141	0.128	0.140	-0.308	0.186 (3.374)	0.192 (4.87)	-0.111 (-0.85)	-0.204 (-1.89)
1964	0.123	0.118	0.123	-0.150	0.173 (3.99)	0.185 (4.74)	-0.114 (-1.21)	-0.022 (-1.98)
1965	0.104	0.100	0.104	0.251	0.105 (3.45)	0.190 (6.92)	-0.011 (-0.02)	-0.035 (-3.92)
1966	0.087	0.084	0.087	-0.147	0.100 (2.73)	0.194 (4.067)	-0.026 (-0.35)	-0.044 (-2.47)
1967	0.078	0.077	0.078	-0.055	0.114 (3.54)	0.132 (3.97)	-0.079 (-1.15)	-0.0221 (-1.81)
1968	0.072	0.067	0.073	-0.037	0.108 (4.43)	0.146 (4.31)	-0.075 (-1.50)	-0.030 (-2.47)
1969	0.061	0.055	0.060	0.009	0.098 (4.25)	0.115 (3.31)	-0.078 (-1.68)	-0.0231 (-1.84)

1970	0.049	0.043	0.049	0.031	0.078 (3.19)	0.080 (3.62)	-0.053 (-1.21)	-0.0171 (-1.84)
1971	0.043	0.038	0.042	0.084	0.064 (4.23)	0.096 (4.71)	-0.035 (-1.45)	-0.0320 (-3.00)
1972	0.0397	0.0347	0.0398	0.0832	0.061 (2.79)	0.072 (2.82)	-0.0321 (-0.99)	-0.023 (-1.54)
1973	0.0286	0.0246	0.0284	0.0587	0.041 (3.64)	0.010 (0.373)	-0.018 (-1.16)	0.0756 (0.44)
1974	0.0220	0.0200	0.0219	0.0401	0.0276 (6.00)	0.0264 (2.075)	-0.0678 (-1.26)	-0.0481 (-0.55)
1975	0.0185	0.0198	0.0185	0.0384	0.0260 (6.68)	0.0430 (3.960)	-0.0802 (-1.99)	-0.0188 (-2.19)
1976	0.0146	0.0156	0.0147	0.0196	0.0203 (6.54)	0.0246 (4.69)	-0.0551 (-1.88)	-0.075 (-1.95)
1977	0.0199	0.0133	0.0121	0.0120	0.0229 (10.3)	0.0258 (5.96)	-0.010 (-5.09)	-0.011 (-3.15)
1978	0.0090	0.0087	0.0091	0.0102	0.0139 (5.37)	0.0186 (4.43)	-0.046 (-1.85)	-0.0855 (-2.43)
1979	0.0067	0.0063	0.0068	0.0122	0.0971 (6.50)	0.0166 (6.13)	-0.0262 (-2.01)	-0.0103 (-3.94)
1980	0.0053	0.0046	0.0053	0.0046	0.053 (12.8)	0.046 (10.0)	0.0001 (1.00)	0.0001 (1.01)
1981	0.0053	0.0060	0.0052	0.0158	0.0692 (5.24)	0.0200 (7.14)	-0.0103 (-1.27)	-0.0205 (-5.16)
1982	0.0037	0.0064	0.0035	0.0062	0.050 (10.1)	0.041 (10.0)	0.0001 (1.00)	0.0001 (1.01)
1983	0.0035	0.0047	0.0035	0.0105	0.0444 (5.14)	0.0131 (3.771)	-0.004 (-1.03)	-0.0157 (-2.48)
1984	0.0028	0.0040	0.0028	0.0081	0.0347 (3.97)	0.0712 (3.58)	-0.0034 (-0.77)	-0.052 (-1.61)
1985	0.0024	0.0032	0.0024	0.0061	0.0217 (6.88)	0.0352 (1.32)	0.1031 (0.84)	-0.003 (-0.07)
1986	0.0021	0.0025	0.0021	0.0058	0.0186 (2.49)	0.0294 (1.11)	0.0015 (0.452)	-0.007 (-0.15)
1987	0.0018	0.0021	0.0019	0.0048	0.0208 (3.91)	0.0295 (1.75)	-0.0007 (-0.34)	-0.0166 (-0.49)
1988	0.0015	0.0017	0.0015	0.0039	0.0158 (3.91)	0.0237 (1.83)	-0.0001 (-0.09)	-0.015 (-0.56)
1989	0.0013	0.0014	0.0013	0.0031	0.0142 (3.83)	0.0160 (1.32)	-0.0003 (-0.23)	-0.0044 (-0.16)
1990	0.0010	0.0013	0.0010	0.0026	0.0142 (4.30)	0.0142 (1.49)	-0.0009 (-1.01)	-0.0037 (-0.14)

Note: The numbers in the brackets indicating the t-statistic. This analysis indicate all industries by each year, (the variables are weighted shares). KSH and LSH indicate the capital share and labour share, respectively

In order to implement the "Generalised Leontief model" empirically, a stochastic framework must be specified.<sup>28</sup> We are using the "Shephard duality theorem"; according to which if we estimate econometrically the parameters of a cost function then this is equivalent to estimate the parameters which describe the underlying production possibility sets (assuming that the producers are behaving competitively in the factor markets).<sup>29</sup>

<sup>28</sup> A disturbance term must specified in each of the input-output equations (4) and (5) and also is assumed that the disturbance vector is independently and identical normally distributed with mean vector zero and constant nonsingular covariance matrix W. These disturbancy terms could simply reflect optimization errors on the part of industries, (Berndt, 1991). Since the input-demand functions are linear in the parameters and these demand equations have cross-equation symmetry constrains, then the OLS estimation equation by equation appear more attractive. However, we can use the "Zellner's seemingly unrelated estimator" (ZEF which called and "seemingly unrelated regression estimator (SUR) or the minimum ch-square estimator"). The different parameter estimates than those form equation by equation OLS result from the following reasons:(a)the disturbances across the input-output equations are contemporaneously correlated which imply that the disturbance covariance matrix is nondiagonal.(b)each of the equations (4) and (5) contains different regressors. For these reasons the ZEF estimator will provide more efficiently estimates of parameters rather than the OLS.The "Zellner's seemingly unrelated estimator" (ZEF) uses equation by equation OLS to obtain an estimate of the disturbance covariance matrix and then does generalized the least squares, (Berndt, 1991).

<sup>29</sup>The duality property between cost and production function was first introduced by Shephard (1953). Given that a cost function satisfying the certain regulatory conditions, we can use a cost function to define a production function which in turn may be used to derive our original cost function, (Diewert).

We employ data for the twenty-digit industrial sectors in Greece. Table 2.1 and Table 2.2 are showing the estimation results of Generalised Leontief function. In general, the estimates are statistically significant.

These parameters describing the implications of patterns of substitution for the relative distribution of output between capital and labour inputs. A positive share elasticity implies that the corresponding value share increases with an increase in quantity, while a negative share elasticity implies that the value share decreases with an increase in the quantity.

The parameters  $\alpha_K$  and  $\alpha_L$  can be interpreted as average value shares of capital and labour inputs; these parameters are positive and also statistically significant (except in the case of  $\alpha_L$  for the sectors of tobacco (sector 22), paper (sector 27), printing-publishing (sector 28), petroleum (sector 32), transport equipments (sector 38) and total industry equipments (sector 20-39) which are negative.

**Table 2.4 Substitution and price elasticities, technical change and scale for period 1959-1990**

	LL	KK	KL	$\hat{\alpha}_{LL}$	$\hat{\alpha}_{KK}$	$\hat{\alpha}_{LK}$	$\hat{\alpha}_{KL}$	c/l
1959	-0.285	-0.385	0.309	-0.142	-0.166	0.142	0.166	c.s
1960	-0.409	-0.411	0.368	-0.185	-0.187	0.181	0.187	c.s
1961	14.605	-0.150	0.553	-0.488	-0.064	0.488	0.064	c.s
1962	5.8562	-0.013	0.277	-0.279	0.0027	0.279	-0.0027	c.s
1963	-0.226	-0.212	0.215	-0.111	-0.103	0.111	0.1038	c.s
1964	-0.371	-0.286	0.294	-0.157	-0.137	0.157	0.137	c.s
1965	-0.461	-0.379	0.375	-0.196	-0.178	0.196	0.178	c.s
1966	-0.276	-0.273	0.256	-0.128	-0.127	0.128	0.127	c.s
1967	-0.265	-0.220	0.224	-5.039	-4.194	4.270	-0.117	c.s
1968	-0.190	-0.189	0.183	-0.092	-0.090	0.092	0.0902	c.s
1969	-0.245	-0.247	0.242	-0.123	-0.118	0.089	0.0882	c.s
1970	-0.524	-0.355	0.398	-0.212	-0.180	0.218	0.180	c.s
1971	0.0462	-0.082	0.058	-0.019	-0.038	0.019	0.038	c.s
1972	0.231	0.0714	-0.08	0.058	0.0311	-0.05	-0.03	c.s
1973	-0.38	-0.224	0.260	-0.14	-0.113	0.146	0.113	c.s
1974	-0.45	-0.276	0.308	-0.17	-0.135	0.173	0.135	c.s
1975	-0.61	-0.466	0.455	-0.24	-0.210	0.245	0.210	c.s
1976	-0.39	-0.319	0.321	-0.16	-0.153	0.168	0.153	c.s
1977	-0.02	-0.081	0.067	-0.02	-0.038	0.028	0.038	c.s
1978	-0.03	-0.136	0.124	-0.05	-0.067	0.057	0.067	c.s
1979	-0.29	-0.20	0.229	-0.12	-0.103	0.125	0.103	c.s
1981	-0.45	-0.39	0.385	-0.20	-0.183	0.201	0.183	c.s
1982	-0.51	-0.80	0.559	-0.25	-0.305	0.254	0.305	c.s
1983	-0.69	-0.80	0.639	-0.31	-0.324	0.314	0.324	c.s
1984	-0.53	-0.54	0.488	-0.24	-0.248	0.240	0.248	c.s
1985	-1.08	-1.69	1.054	-0.49	-0.558	0.496	0.558	c.s
1986	-0.41	-0.28	0.331	-0.17	-0.153	0.178	0.153	c.s
1987	-0.35	-0.25	0.283	-0.15	-0.132	0.150	0.132	c.s
1988	-0.47	-0.35	0.011	-0.19	-0.167	0.193	0.167	c.s
1989	-0.63	-0.48	0.488	-0.26	-0.227	0.260	0.227	c.s
1990	-0.84	-0.84	0.739	-0.37	-0.366	0.372	0.366	c.s

Note:  $\alpha_{LL}$ ,  $\alpha_{KK}$ ,  $\alpha_{KL}$  indicate the substitution elasticities,  $\hat{\alpha}_{LL}$ ,  $\hat{\alpha}_{KK}$ ,  $\hat{\alpha}_{KL}$  indicate the price elasticities, respectively. Finally, c/l=indicate the capital-labour saving where c.u. is the capital-using (or labour saving); according to David and Van De Klundert, 1965) the technical progress is capital-saving if and only if the elasticity of substitution between capital and labour is less than unity in absolute values.

Furthermore, Tables 2.3 and 2.4 illustrates the annually cross-section estimation of Generalised Leontief Cost Function for Greek industry. To interpret the estimates of these parameters it is useful to recall that if the production function is increasing in capital and labour inputs then the average value shares are non negative. These conditions are satisfied by our estimations. The parameters  $\alpha_{KK}$ ,  $\alpha_{KL}$ ,  $\alpha_{LL}$  can be interpreted as the constant share elasticities. A share elasticity equal to zero implies that the corresponding value share is independent of quantity; we are assuming that  $\alpha_{KK}$ ,  $\alpha_{LL}$  are zero. The parameter  $\alpha_{KL}$ , found that is negative (as in the previous estimation of the Generalised Leontief function) but however, in the most of the sectors these results are not statistically significant. In addition, from the translog function we can get some estimations for the substitution elasticities ( $\alpha_{LL}$ ,  $\alpha_{KK}$ ,  $\alpha_{KL}$ ). The  $\alpha_{KK}$ ,  $\alpha_{KL}$  have to be negative because of the

"demand-law" for the inputs. If the  $\sigma_{KL}$  which is the substitution elasticity between K and L is positive, then the K and L are compliments, or otherwise they are substitutes. If the  $\sigma_{KL}$  is less than unity, then that means the "technical change is capital-saving" (or otherwise "labour-saving").

Summarizing, we can say that the application of the translog-function is giving us more opportunities to get better and more precisely estimations for the substitution elasticities, the rate of technological change and the different parameters.

Lianos Kintis used a constant elasticity of substitution (CES) production function was used to estimate the elasticity of substitution in the manufacturing sector of the Greek economy. Lianos used two alternative formulations of the production functions derived estimates of the elasticity of substitution between capital and labour in Greek manufacturing.<sup>30</sup>

These studies of Lianos and Kintis found that the technological progress in Greece was biased. Another study using a technique proposed by Sato which postulates the existence of a production function of the factor augmenting type relating output to capital and labour measuring in efficiency units and in his study concludes that in the Greek manufacturing sector the technological progress is capital-using. In another model E. Panas (1986) following in his study the "Bergstrom-Melander-Kalt Model", presenting some further evidence on the degree of substitution between capital and labour and the estimates of capital-labour augmentation coefficients, (using an autoregressive SURE Model).

The results and estimates of Panas' SURE model is different from those of Kintis: (on the basis of SURE estimates one would reject the capital-using hypothesis in favor of labour using hypothesis in two industries 25 and 27 and this reveal that technological progress in a number of industries is completely different from that reported by Kintis). Panas was found that the bias of technological progress in Greek manufacturing is not neutral: (in fact, during the period 1958-1975 the increase in the wage rate is greater than that of the profit rate and then we can say that the entrepreneur will be included to save labour).

Finally, one can dealt with alternatives flexible functional forms such as the translog cost function<sup>31</sup> or even more general forms such as the meta-production function.<sup>32</sup>

#### 4. CONCLUSIONS

The form of technological progress has been one of the main objectives of economic policy. When a firm can achieve the same output with different combinations of factors of production, it may substitute one factor for one or more others. The substitutability in a industry is depending from the availability of capital, labour factors, from the level of adoption and diffusion of new technologies, from the level of know-how etc. The substitution of capital for labour corresponding to an increase in the importance level of capital compared with the labour in the course of production process (for instance, the use of new techniques, methods etc.). The appropriateness of technology can be measured through the substitutability of labour-capital variables.

The substitution effect is linked to the characteristics of production technology. It increases with the possibility of substitution between factors of production. Such possibilities are measured by their elasticity of substitution. A concept which most directly reflects the technical constraints inherent in production processes.

In this paper we tried to analyse a flexible functional form for Greek industry and to examine the substitutability between capital, and labour factors. Also, we should try to test the complementary/substitution effects, to measure if the constant return of scales hold for all industry. We can examine the relationship between inputs in industrial production, (as inputs we can assumed the capital, and labour).

The main obstacle facing empirical studies of R&D is the lack of information about the rate of R&D depreciation especially in two-digit industries. Most of the studies used an R&D depreciation rate 10% or even

<sup>30</sup>The first one corporate Hicks-neutral technical change:

$$Y=A(t)F(K,L) \tag{1}$$

in the equation (1) the term A(t) is the term of technical progress. The second allows for factor augmenting technical progress:

$$Y=F(A(t)K,B(t)L), \tag{2}$$

in the equation (2) A(t) and B(t) are the capital and labour augmenting factors. Also, the output is measured as a value-added, Labour is measured in manhours of works supplied by workers, employees and unpaid persons and the wage (W) was obtained by dividing the wage bill by the number of man-hours of paid workers and employees.

<sup>31</sup> Korres G. and Paraskevopoulos Y.: (1996) "The effects of technical change and foreign direct investment on the evaluation of Greek manufacturing", paper presented at the conference of *the European Firm in the Global Economy* at the Economic Society of Thessaloniki, Aristotelion University (in Greece).

<sup>32</sup> Korres G: "Technical change and Productivity Growth: an empirical evidence from European countries", A Book published by Avebury-Ashgate publishing company in London (1996).

we can take an alternative R&D depreciation rates of 5 % and 20 %. We can review some of the results which have been obtained from the regression for Greek economy for the period from 1973 to 1984. Unfortunately, was available only aggregate data for Greek economy (especially concerning the variable  $x_3$  of R&TD).

The results are showing that the capital variable is complementary with those of labour and R&TD, while the labour and R&TD variables are found to be substitutes. Positive signs imply a direct relationship, while negative signs reflect a combination of the elasticity of input demand and strong complementary with other factors. Finally, the different statistical tests shows that variables are non-CRST, (a symmetry/constant returns to scale holds).

Greece was one of those countries which having a rapid-growth in the period after the second world war when the transformation in the structure of economy from agricultural to the new-industrialized country took place. The period from 1950 until the end of 1960s has been characterized by a rapid expansion of growth rates. In this period there was a new *technological orientation* of more sophisticated products, while most of the technological inputs are transferred from abroad. The period after 1974, show a decline in economic growth. This is more obvious for the period between 1974 and 1980. The decade of the 1980s can be characterized as the start of a *new era* for technological activities, especially after the accession of Greece to the European Union.

The results indicate that most of the industrial sectors are capital using intensive (or labour saving) which can be interpreted in accordance to the previous analysis that the technological inputs (such as the imported capital goods and the transferred technologies) were not appropriate to the local necessities and did not fit the availability of market resources.

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# THE ROLE OF STATISTICAL DESIGN IN SAMPLING PLAN AND PILOTING SERVICE IMPROVEMENT INITIATIVE SURVEY - QATAR CASE

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## Abstract

*As part of Qatar's ongoing Service Improvement Initiative, a major national survey of client satisfaction is to be conducted regarding Qatar's public services.*

*The national survey is based on a representative sample of the population of Qatar's citizens and residents. This survey is intended to inform the development of client-centric approaches in Qatar's Ministries and Agencies by helping them to gain a greater understanding of the needs and expectations of their clients.*

*The research is aimed at looking into how this survey can test the survey strategy, data collection tools & field procedures for each population of interest: citizens, residents and tourists.*

*The research has showed the approaches for Assessing Customer Satisfaction and the main outcome of this experience in judging whether the survey questions flow: logic, order, relevance, easily understood, adequate to be measured.*

*Sampling plan used in this research suggested that the sample is a national probability sample drawn proportionate to population on the basis of age and gender, and separately by municipality. These groups were used as sampling parameters that have provided the number of sub-groups to be researched.*

*In this survey, there were two sources of under-coverage and over-coverage in the sample design. First, there were residents that live in labor gatherings. Second, there was the challenge of having to over-sample citizens in certain municipalities. Each of these issues were examined and dealt with accordingly.*

## 1- INTRODUCTION

One of the core functions of any branch of the state of government is to provide public services aimed at improving the quality of life of its citizens. The executive agencies provide services go directly to the public, stakeholders, and support service delivery by other parts of government or act to protect the public. Agencies operate from their departments and have considerable autonomy and freedom of action. This freedom is accompanied by obligations to meet specific financial and operational targets set by their departments. Most agencies for the sake of setting targets, they use historical performance and an assessment of what would be a realistic and achievable improvement. For that, agencies adopt a range of approaches to ensure that their targets are sufficiently focused on their users' needs.

Customer feedback was often used by agencies as a basis for negotiating with their sponsor departments the level of service which they should provide, the resources needed, and the underpinning targets against which their performance should be measured. The extent to which agencies had reliable and comprehensive information on the different characteristics of their key customers and users were, however, variable.

Most agencies have targets directed at achieving specific outcomes or financial management, or focused on speed of delivery, rather than improving access to services or measuring cost and effectiveness. While agencies generally have systems in place for identifying and monitoring costs, these are not often linked to key outputs and outcomes. As a consequence, productivity is not often measured or monitored. Unit costs were frequently hard to measure so agencies were not well informed about comparative performance or the cost of incremental improvements in service delivery.

## 2- CUSTOMER FEED-BACK INITIATIVE

In order to track and analyze customer feedback over time, organizing our efforts is important. A critical question should be asked is whether we, as the initiator of a customer service project, have the ability to act on the data ourselves, or whether others will be critical to the process. For a unit or branch Customer feedback is valuable for everyone, and everyone can easily ask his or her customers for direct feedback about their needs and how things are going. Among the most common are face to face discussions, telephone calls, meetings and other events, and written correspondence. You can find perspectives containing feedback in newsletters and other information materials, videos, web site messages or electronic mail, newspapers, radio

and television talk shows, and news. Many customer interactions provide an immediate opportunity to hear from customers about how well the government is meeting their needs.

### 3- APPROACHES FOR ASSESSING CUSTOMER SATISFACTION

There is no one "best" approach for assessing customer satisfaction. What will work best for any particular organization will depend on the kind of product or service provided, the kinds of customers served, how many customers are served, the longevity and frequency of customer/service provider interactions, and what you intend to do with the results. There are two very different approaches produce equally meaningful and useful findings:

**First method** is to obtaining customer feedback periodically, but it is very important to remember that you can adopt continuous assessment as a standard method for obtaining customer satisfaction information.

The information you obtain from continuous assessment can provide valuable and timely insight into the experiences your customers have had with your organization.

**Second method** is a Periodic survey approach that obtains feedback from groups of customers at periodic intervals after service or product delivery. They provide an occasional snapshot of customer experiences and expectations.

Understanding customers' expectations and satisfaction requires multiple inputs from customers. Both methods are helpful in obtaining customer feedback for assessing overall accomplishments, degree of success, and areas for improvement.

### 4- DATA COLLECTION METHODS

Before considering systematic methods for collecting data, we should remember that informal methods for obtaining information from customers clearly produce information that is valuable. Everyone needs to recognize and use these everyday opportunities for customer feedback.

Many formal methods can be used to collect customer feedback data. Methods frequently used to gather customer feedback include focus groups, a mail-back postcard that is included among materials sent to customers, a mail survey, electronic kiosk, a telephone survey, a publication evaluation form included at the back of every copy, and a printed or in-person survey (which might include computer-assisted personal interviews or an intercept survey where you ask every  $n$ th customer attending a function or visiting a facility to participate). Electronic mail and Web based surveys will become an increasingly important means for collecting customer feedback as more people gain access to the Internet.

### 5- PILOTING

A pilot survey (pre-testing) is required at this stage to test a small-scale trial of the survey and data collection methods. Conducting a pre-test is extremely important because the results will provide opportunities for refining the questionnaire before the comprehensive data collection activity begins.

One of the best ways to conduct a pre-test is to select individuals randomly from the target group of customers served, invite them to complete the survey according to the method planned for the overall effort, and then participate in a focus group session to review their opinions. A pre-test is helpful for cost projections, and also provides information on the amount of time required to complete the survey.

The main outcome of this experience is to judge whether the survey questions flow: logic, order, relevance, easily understood, adequate to be measured.

### 6- DETERMINING THE SAMPLE SIZE

If you choose to conduct in-person survey, you will have to decide on the number of people who will be selected to participate. To determine this number, the *sample size*, several factors should be considered, such as the total number of customers served, the intended use of the results, available resources, and time. The larger the percentage sampled, the more certain you can be that the feedback obtained will be representative of the results you would have obtained if you received feedback from every customer.

The sampling error can be estimated through a *confidence interval*. A confidence interval specifies a range of values within which the true measure is found. Typically, survey results rely on a 95 percent confidence interval, but lower levels are acceptable, depending on how you plan to use the findings. Popular media reports rarely stipulate confidence intervals, but they are implied.

## **7- SAMPLING DESIGN FOR CITIZENS AND RESIDENTS**

There are many ways in which the final sample of individuals can be defined in terms of being representative of the population in the State of Qatar. For example, one might argue that language is suitable given the range of languages used in the country. Unfortunately, the Census does not collect this data. Moreover, the survey will only be conducted in three languages, namely Arabic, English and Urdu. In studies with very large samples, the sample can be defined on many levels. Some previous studies used rural/urban splits nested within regions to determine the sample's representation of the population. Also, in some large survey, gender and age sub-groups by region can be used.

For this first study in the State of Qatar, age and gender groups are workable as sampling parameters, provided the number of sub-groups sought is manageable. If each population of interest has a total sample of 400, it should be feasible to track quotas for six to eight sub-groups defined on the basis of age and gender. In addition, representation can be sought on the basis of region or municipality to improve the confidence in the sampling coverage. This is prudent given the desire for a national probability sample for citizens and residents.

### **7-1-Sampling citizen for the Survey**

Census data allows for calculations of age and gender breakdowns for both citizens and residents in Qatar. This is used to develop individual target sample quotas as shown in **Exhibit 1**. Based on this design, the sample of residents will include a larger proportion of males since there are more of them in the population. Similarly, there are fewer persons aged 50+ in both samples because they also represent a smaller proportion of both populations.

Likewise, **Exhibit 2** shows the initial planned sample distribution by region. Much of the sample for Qataris and non-Qataris will come from Doha and Al Rayyan since they have the largest population base. This table also shows one region, Mesaieed, having no sample for Qataris. This is because there are so few Qataris residing there (0.05%) so applying this proportion to a sample of 400 citizens produces a sample count of less than 1. However, this creates a problem, or bias, related to under-coverage. Consequently, this specific sub-group is assigned a sample of 1 to overcome this problem (see **Exhibit 3**). In turn, one piece of sample is taken away from Al Rayyan to compensate. Recall, data weighting at the analysis stage can smooth out some of these imbalances. It is also likely that the five smallest municipalities will be pooled solely for the purpose of calculating proportional weights, with the goal of minimizing the impact of severe weights on the resulting statistics.

In summary, the sampling plan will be a national probability sample drawn proportionate to population on the basis of age and gender, and separately by municipality for citizens and residents. The goal, then, is to find citizens and residents to participate in the survey in the hopes of filling these sample quotas.

Like other surveys, this means having to secure a consistent rate or response across specific sub-groups of interest. In the absence of knowing those response rates a priori, it is useful to examine where specifically these citizens and residents can be found.

### **7-2-Sampling Residential Dwelling Units and Households for the Survey**

Knowledge of where citizens and residents reside provides insights into specific regions that tend to have a higher incidence of either citizens or residents. This will facilitate some targeting of specific regions in the plan to make it more efficient and productive. This is important since both groups will have equal sample sizes, despite residents outnumbering citizens by a ratio of 3:1.

The sampling strategy for this study can replicate some of the steps taken to conduct the Census. The survey of citizens and residents will rely on two-stage probability sampling methodology. First, residential units and households will be selected in a systematic manner from data that is collected as part of the enumeration process. Second, individuals aged 18 and older will be selected from sampled residential units and households. Each stage is described in greater detail below.

For the enumeration, field teams will visit specific municipalities with maps that define blocks as potential sampling units. In each block, the enumerators will identify the number of buildings, houses and camps that exist. For each one, they will record basic information, including the street address or name of the building (something to identify the building), the number of floors and apartments, and the type of dwelling it appears to be (e.g. residential, commercial, shared accommodations or mixed use).

The complete enumeration will be compiled by the fieldwork manager. Based on the sampling quotas needed for that region and some assumptions about the mix of participants there and the survey response rate, the

fieldwork manager will select sample for each block in the municipality. A systematic procedure will be used to select every  $n$ th household based on the counts from the enumeration and the desired sample in that block. While not purely random per se, this is a widely accepted approach (near random) for sampling residential units and households.

For this survey, this complexity is less relevant than it is to census-takers. This is because the sampling unit for the National Client Satisfaction Survey is not the household, but rather the individual within that household, one who uses government services. The main goal of this stage in the sampling process is to ensure that certain types of households are not excluded systematically in the design. As such, households and dwelling units are generally considered as one and the same in this study (with a small exception noted below for labor gatherings).

### **7-3- Labor Gatherings**

The 2004 Census reports that 87% of all enumerated households have inhabitants. Most of these (90.2%) are household dwellings or collective households having less than seven persons. Another 7.5% are labor gatherings with seven or more persons and 2.3% are mixed use units.

The data indicate that labor gatherings have an average of 24.0 individuals while other common types of occupancy have 5.3 individuals on average. This means that labor gatherings have 4.5 times as many individuals, on average, as other more common types of occupancy. If the sampling procedure is designed to obtain one respondent from the more common types of occupancy, then it will need to select more respondents to participate from a labor gathering to ensure they are sufficiently covered in the survey (i.e. four-five individuals per labor gathering). As a result, for every 100 sample records, 82 should come from individuals representing common types of occupancy. The other 18 should come from labor gatherings, collected over four labor gatherings (if four to five participants are selected from each gathering). If this is applied to the 800 target sample for citizens and residents combined, 656 will come from regular types of occupancy, and 144 will come from labor gatherings. If four to five persons are selected from each labor gathering, this requires sampling 32 gatherings. Stated another way, the 800 individuals will come from 688 residential units, 656 from more common types of dwellings and 32 from larger labor gatherings.

Labor gatherings generally include only residents, not citizens. If the resident sample includes 400 individuals, this means that a significant proportion of them (144 / 400 or 36%) should be selected from labor gatherings.

**Exhibit 4** shows the number of residential units that might be selected based on the type of occupancy and the municipality where they are located if they were selected proportionate to population. According to this Exhibit, most would be selected in Doha and Al Rayyan.

One issue is what to do with those labor gatherings outside Doha and Al Rayyan having a proportionate share so low (counts less than 1.0) that no labor gathering is selected for that region. This is problematic because this represents a bias against labor gatherings outside larger urban centers. To correct for this, the distribution of labor camps selected can be adjusted so that each region is represented while also adjusting the number of interviews to be completed within each gathering so that it represents that gathering's share of the population. This is shown in **Exhibit 5**.

To calculate the number of labor gatherings to be sampled, the following procedure was applied to Exhibit 5:

- Municipalities having an applied labor camp sample count of ten or less were assigned a count of one labor gathering and no more than one labor gathering;
- Municipalities having an applied labor camp sample count of 15 or more were assigned a count of three or more labor gatherings, calculated in increments of five;
- Municipalities having an applied labor camp sample count between 11 and 14 were assigned a count of two labor gatherings.

The results in **Exhibit 5** show that different regions will have slightly different sample targets for labor gatherings and completed interviews.

### **8- OVER SAMPLING**

It will be useful to know which municipalities have a lower or higher incidence of citizens. This helps the field team better plan for targeting specific municipalities of interest. The 2004 Census shows how the incidence of citizens and residents living in residential units other than labor gatherings varies by municipality (see **Exhibit 6**).

In Al Rayyan, the population in common types of occupancy is almost equally split between Qataris and non-Qataris. However, the sampling plan requires that almost two-thirds from that municipality are Qatari citizens. This is because the total sample of citizens is equal in size to the residents, yet not equal in population. For planning fieldwork, this means the field team will need to sample extra common residential units in Al Rayyan because they need to work harder to find Qatari citizens there. A similar pattern exists in Doha. Although there are fewer Qataris there, the field team has to work harder to find them because the sampling plan calls for over-sampling them in this municipality.

**Exhibit 7** includes a slight adjustment to Exhibit 6 to remove sample cells having a count of zero. In Mesaieed, the residential unit count among Qataris was increased by one to remove bias due to under-coverage. In turn, one residential unit was taken away in the largest region for Qatari citizens, Al Rayyan. A similar approach was used for residents in Al Ghuwairiya, where one was added in this municipality and one was taken away in Doha. These are shown in italics in **Exhibit 7**.

The plan needs to account for over-sampling in certain municipalities. This is done by selecting more residential units than is defined by the targeted sample. **Exhibit 8** estimates the number of sampled common households needed to reach the target sample quotas for citizens and residents in that region. It also includes different assumptions about the response rate for the survey. As the table shows, even if everyone participated (i.e. 100% response), the field team will need to contact over 1000 of these common types of households to reach the target of 656.

**Exhibit 9** summarizes the first-stage sampling plan, including target sample quotas for common types of households and for labor gatherings. This provides the blueprint for finding the types of citizens and residents needed to reach the second stage individual sampling quotas shown in Exhibits 1 and 3. The right hand column of this Exhibit is very close the sum of cells that appear in Exhibit 3. The small differences in the numbers are due to rounding.

## 9- PROCEDURES WITHIN SELECTED HOUSEHOLDS

The field team needs to implement the following procedures at each household:

- each residential unit or household selected for the sample must be rostered, collecting age and gender details on each person aged 18 and older residing there, including household employees, but excluding any visitors who normally have a residence elsewhere;
- using a random number grid, a single person will be selected from the household to secure a completed survey – the exception is for larger labor gatherings where multiple members of the roster may be selected in accordance with the sampling plan;
- once a household is selected to be sampled or an individual within it has been selected, it must be contacted on at least five occasions before it may be replaced with another household to be sampled – this will minimize the bias associated with having a low completion rate, especially among qualified contacts;
- surveys may be completed in either Arabic, Urdu or English;
- surveys may be self-completed or administered by a trained interviewer;
- only the person selected to complete the survey may do so - they should have no help or interference from anyone else in the household – if they require assistance, they may ask the interviewer; and
- upon completing the survey, it must be returned to the interviewer who will review it for accuracy before leaving – if errors are found, the interviewer will ask the respondent to correct the errors.

## 10- DETAILED FINDINGS AND IMPLICATIONS OF PILOT SURVEY

After conducting the pilot survey, there are few important issues and findings. These are listed below:

### Survey Strategy

- In a word, this is ‘sound’
- Prospects for collecting high quality data with minimal refusals are high
- Field tools work
- Sample plan is feasible
- People will respond, despite the length of the interview
- Trained interviewers make a difference
- Supervision & observation must occur early in field

### Interview Length

- The interview is long by most standards

- Between 45 and 60 minutes to complete questionnaires, plus a few minutes for rostering & respondent selection
- Some participants take longer if they take time to weigh their opinion, if their education level is lower or if their language skills are limited
- Once interviewers are comfortable with tools & process steps, an interview can be completed in 40 minutes
- Interviewer fatigue does set in after two completed interviews
  - The interview length is of no material consequence
- No one asks about length in advance of the interview
- No one asks how much longer an interview will take
- No evidence of data quality suffering closer to end of interview
- No terminations part-way

#### **Understanding Questions**

- Large majority of questions understood
- Interviewers reported that training helped in providing guidelines on what could and could not be said to support respondents' understanding of question
- Frequently, problem areas were overcome by patiently re-reading a question or statement
- All languages worked well
- Urdu was not particularly problematic, just a little too 'wordy' in spots
- Note, the pilot testing did not test comparisons of meaning & interpretation across languages

#### **Ability to Respond**

- Response categories are generally functional, complete
- The greatest barrier to an accurate response was memory, but this occurred only rarely
- People follow instructions & interviewers reinforce them when recognizing signs that they are not being followed
- Residents move through services lists faster than citizens because they use a more narrow range of services
- Need to examine research questions separately for residents & citizens

#### **Scales**

- Scales are easy to understand & use by respondents
- They also make people think before responding
- With proper training, interviewers can help respondents use them properly & effectively, encouraging people to respond using numbers
- No need to label each point
- Respondents use all points without each one being labeled
- They interpret 4 and 2 to be less strong than 1 and 5
- It is faster when interviewers do not have to read itemized labels

#### **Training**

- Mission critical to success of study – needs time & attention
- With compressed pilot schedule, too few hours were devoted to training (15)
- Strong need for guidelines on how to help respondents understand questions & common strategies for promoting accurate (not leading) response
  - varies section to section
- Interviewers learn best during field trials, role-playing
  - Survey questions are ambitious, takes time to cover each topic
  - Too much time in class is boring for interviewers
  - Interviewers do not prepare in advance of training (by reading), even when asked
  - Testing warranted for full field study to ensure interviewers are ready
- Once in field, observation & supervision must be done early & often to prevent bad habits from taking root
  - If time permits, re-testing part-way through field may be necessary to ensure interviewers administer survey properly

#### **Citizen & Resident Sample Lists**

- Lists very accurate, useful in field
- Finding homes a challenge for field team, even in new areas
  - Street names rarely shown
  - House numbers rarely shown, difficult to follow



- Prospects for interviewer error are high
- Nationality collected during enumeration process, but languages spoken in home more useful for planning interviewer assignments
- Frame to complete ratio workable only if number of contacts allowed is increased from current maximum of three contacts

#### **Citizen & Resident Sample Lists: Labor Gatherings**

- Not quite as expected – better not worse
- Statistics Department treats these differently for enumeration, however for this study they seem just like large apartment buildings
- Initially planned to allow for respondent replacement within a gathering
- Suggest these be treated like other apartments, using same rostering & respondent selection without respondent replacement

#### **Securing Interest**

- Interviewers very skilled at securing interest
- As instructed, got across key messages without reading script
- Personable, engaging
- Ability to read person who greets them at door, adjust messaging accordingly
- Resourceful in connecting with someone who knows something about home or respondent (e.g. building manager, neighbor) if no person is home

#### **Respondent Selection**

- Interviewers took rostering seriously, few errors found
- When found, they were corrected
- Initially, rosters were incomplete, but corrected with coaching
- Kish table easy to use, makes process of selection objective, legitimate to respondent

#### **Confidentiality**

- This is not a barrier to participation
- Few respondents mention it or ask questions about it
- Interviewers sometimes forget to communicate confidential nature of data collected
- Corrected with coaching
- Some interviewers note this can be sensitive in Qatar, asked if they may be allowed to volunteer this only if necessary
- Perhaps language can be adjusted to communicate meaning & intent without using the word ‘confidential’

#### **Call Attempts & Call-backs**

- Critical to study success
- Ensure fieldwork gets completed on time
- Help reach target response rates (> 60%)
- Average number of contacts in pilot > 4
- Guideline was three contact attempts due to concerns about burden
- If pilot field followed this guideline, available sample would have resulted in low response rate (much less than 50%) & only half of target interviews completed
- Frequent call-backs more important for residents where households are smaller in size
- With Qataris, someone was almost always in the home, which facilitated scheduling of specific call-backs

#### **Field Times, Dates**

- Most productive times
- Evenings
- Saturdays
- However, different types of respondents identified on different days, different times in pilot
- Flexible times, dates needed, subject to interviewer availability, or non-response bias may result

#### **Refusal & Response Rates**

- Refusal rate low, 3%
- Response rate on target, 66%, but excludes eligible homes screened out at enumeration stage by Statistics Department
- Only possible to achieve response rate by increasing number of call-attempts from 3 to 6 – 8
- Response rate slightly lower among residents

- Not home often, some work long hours
- Higher incidence of language barriers

### **Supervision & Observation**

- Higher level of supervision & observation used
- Tied to nature of testing objectives
- Both important to success of study
- Promote high data quality
- Improve interviewer consistency
- Even new interviewers develop bad habits early (e.g. biased body language), which needs to be identified & corrected

### **Support Tools**

- ID badges effective when worn in a visible location
- Must be shown to people on first contact – makes study more legitimate, helps open doors
- Bags are functional, make interviewers look like they belong to field team
- Helps when call-backs are made by other interviewers
- Show cards & survey packages useful & effective
- Both need to be more user-friendly
- Show cards should all be same size, collated on a single ring for ease of reference (e.g. like paint or material swatches)
- Survey must be in package for interviewer, but allow for introductory script, Kish table, sample information to be removed from questionnaire post interview (to protect confidentiality)

### **Approach for Tourists**

- Fieldwork not conducted at airports
- Encountered hurdles in securing suitable interview location
- Smaller sample size further marginalizes this group relative to other populations of interest
- Raises questions about utility of addressing research questions with this segment & level of effort expended to do so.

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### **Appendices**

Exhibit 1 Desired Sample Distribution by Age, Gender and Citizenship								
Age (18+)	Census				Sample Quotas			
	Qataris		Non-Qataris		Qataris (n=400)		Non-Qataris (n=400)	
	males	females	males	females	males	females	males	Females
18 – 24	12.55%	12.82%	8.05%	3.33%	50	51	32	13
25 – 34	13.73%	14.14%	24.95%	8.50%	55	57	100	34
35 – 49	14.38%	15.65%	33.26%	8.90%	58	63	133	36

50 +	8.44%	8.28%	10.97%	2.05%	34	33	44	8
Total	49.11%	50.89%	77.22%	22.78%	196	204	309	91

Source: Population Census, State of Qatar, March 2004.

Municipality	Qataris		Non-Qataris	
	Population% from Census	Sample Size	Population% from Census	Sample Size
Doha	32.10%	128	50.19%	201
Al Rayyan	47.43%	190	33.10%	132
Al Wakra	5.63%	23	3.76%	15
Umm Salal	9.02%	36	2.66%	11
Al Khor	2.69%	11	4.75%	19
Al Shamal	0.98%	4	0.56%	2
Al Ghuwairiya	0.18%	1	0.33%	1
Al Jemailya	1.07%	4	1.49%	6
Jeryan Al Betna	0.85%	3	0.91%	4
Mesaieed	0.05%	0	2.25%	9
Total	100%	400	100%	400

Source: Population Census, State of Qatar, March 2004.

Municipality	Qataris		Non-Qataris	
	Population% from Census	Sample Size	Population% from Census	Sample Size
Doha	32.10%	128	50.19%	201
Al Rayyan	47.43%	189	33.10%	132
Al Wakra	5.63%	23	3.76%	15
Umm Salal	9.02%	36	2.66%	11
Al Khor	2.69%	11	4.75%	19
Al Shamal	0.98%	4	0.56%	2
Al Ghuwairiya	0.18%	1	0.33%	1
Al Jemailya	1.07%	4	1.49%	6
Jeryan Al Betna	0.85%	3	0.91%	4
Mesaieed	0.05%	1	2.25%	9
Total	100%	400	100%	400

Source: Population Census, State of Qatar, March 2004.

Municipality	Residential Units with Inhabitants			Counts Applied to Sample	
	Total Number	Labor Gathering (Column %)	More Common Types of Occupancy (Column %)	Labour Gathering	More Common Types of Occupancy
Doha	63371	52.23%	57.59%	16.71	377.82
Al Rayyan	30325	35.12%	26.74%	11.24	175.41
Al Wakra	4409	2.76%	4.08%	0.88	26.75
Umm Salal	3895	1.55%	3.67%	0.50	24.10
Al Khor	3566	3.85%	3.17%	1.23	20.77
Al Shamal	935	0.65%	0.86%	0.21	5.64
Al Ghuwairiya	240	0.57%	0.19%	0.18	1.24
Al Jemailya	2597	2.42%	2.34%	0.77	15.33
Jeryan Al Betna	695	0.55%	0.63%	0.18	4.15
Mesaieed	771	0.30%	0.73%	0.10	4.77

Total	110804		32	656
Residential Units				688

Source: Population Census, State of Qatar, March 2004

Municipality	Counts from Census		Counts Applied to Sample		
	Number of Gatherings	Population Counts in Gatherings	Sample Counts Applied from Population Counts	Gathering Counts	Target Completes Per Labor Gathering
Doha	52.23%	33.46%	48	10	4-5
Al Rayyan	35.12%	44.90%	65	13	5
Al Wakra	2.76%	2.28%	3	1	3
Umm Salal	1.55%	1.90%	3	1	3
Al Khor	3.85%	8.48%	12	2	6
Al Shamal	0.65%	0.47%	1	1	1
Al Ghuwairiya	0.57%	0.61%	1	1	1
Al Jemailya	2.42%	1.12%	2	1	2
Jeryan Al Betna	0.55%	1.97%	3	1	3
Mesaieed	0.30%	4.79%	7	1	7
Total	100%	100%	144	32	

Source: Population Census, State of Qatar, March 2004.

Municipality	Percent from Census			Counts Applied to Sample			
	% of Population in Municipality	Incidence of Qataris %	Incidence of Non-Qataris %	Qataris		Non-Qatari	
				Sample	Row %	Sample	Row %
Doha	50.14	21.80	78.20	128	45.76	152	54.24
Al Rayyan	33.67	47.98	52.02	190	73.62	68	26.38
Al Wakra	4.93	38.87	61.13	23	65.79	12	34.21
Umm Salal	5.10	60.18	39.82	36	82.05	8	17.95
Al Khor	2.69	34.11	65.89	11	61.03	7	38.97
Al Shamal	0.73	45.59	54.41	4	71.71	2	28.29
Al Ghuwairiya	0.17	35.51	64.49	1	62.49	0	37.51
Al Jemailya	1.48	24.60	75.40	4	49.67	4	50.33
Jeryan Al Betna	0.51	57.17	42.83	3	80.15	1	19.85
Mesaieed	0.58	2.87	97.13	0	8.21	2	91.79
Total	100%			400		256	

Source: Population Census, State of Qatar, March 2004.

Municipality	Percent from Census			Counts Applied to Sample			
	% of Population in Municipality	Incidence of Qataris %	Incidence of Non-Qataris %	Qataris		Non-Qatari	
				Sample	Row %	Sample	Row %
Doha	50.14	21.80	78.20	128	45.76	151	54.24
Al Rayyan	33.67	47.98	52.02	189	73.62	68	26.38
Al Wakra	4.93	38.87	61.13	23	65.79	12	34.21
Umm Salal	5.10	60.18	39.82	36	82.05	8	17.95
Al Khor	2.69	34.11	65.89	11	61.03	7	38.97
Al Shamal	0.73	45.59	54.41	4	71.71	2	28.29

Al Ghuwairiya	0.17	35.51	64.49	1	62.49	1	37.51
Al Jemailya	1.48	24.60	75.40	4	49.67	4	50.33
Jeryan Al Betna	0.51	57.17	42.83	3	80.15	1	19.85
Mesaieed	0.58	2.87	97.13	1	8.21	2	91.79
Total				400		256	

Source: Population Census, State of Qatar, March 2004.

Municipality	Residential Units			Households Needed			
	Qataris	Non-Qataris	Total	100%	75%	50%	25%
Doha	128	151	279	610	814	1220	2441
Al Rayyan	189	68	257	273	364	546	1092
Al Wakra	23	12	35	48	64	96	193
Umm Salal	36	8	44	48	64	96	192
Al Khor	11	7	18	28	38	56	113
Al Shamal	4	2	6	7	9	14	27
Al Ghuwairiya	1	1	2	3	4	6	11
Al Jemailya	4	4	8	16	22	33	65
Jeryan Al Betna	3	1	4	4	6	9	17
Mesaieed	1	2	3	36	48	72	143
Total	400	256	656	1074	1431	2147	4294

Municipality	Types of Residential Units			Target Samples of Individuals		
	Common	Labor Gatherings	Total	Common	Labor Gatherings	Total
Doha	279	10	289	279	48	327
Al Rayyan	257	13	270	257	65	322
Al Wakra	35	1	36	35	3	38
Umm Salal	44	1	45	44	3	47
Al Khor	18	2	20	18	12	30
Al Shamal	6	1	7	6	1	7
Al Ghuwairiya	2	1	3	2	1	3
Al Jemailya	8	1	9	8	2	10
Jeryan Al Betna	4	1	5	4	3	7
Mesaieed	3	1	4	3	7	10
Total	656	32	688	656	144	800

# MULTIPLIER ANALYSIS AND TOURISM DEVELOPMENT

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## **Abstract**

*Tourism multipliers allow researchers to analyze the effect or consequences caused in tourism development of an area or country by a unit of added tourism expenditure.*

*The development and implementation of tourism multiplier models is proportional to the progress of the aggregate economic theory which in many cases has defined the sense and contents of tourism development.*

*Researchers and investigators of tourism activity have been dealing with the issue of the capacities and constraints of these tourism multipliers for the evaluation of the developmental impact of tourism.*

*The analysis of the topic in question generates various conclusions on the suitability of the major tourism multiplier models, the limits of their capacities and their constraints and also the comparability of the values of the various categories of multipliers arising from different models and concerning economically heterogeneous tourism locations/countries.*

*Key-Words: tourism multipliers, tourism expenditure, tourism effect, multiplier categories, tourism multiplier models.*

## **1. INTRODUCTION**

The concept of multipliers is based on the neoclassical Keynesian economics. Multipliers are based on the principle that a change of public expenditure alters the product and the equilibrium income of the economy by an amount which is a multiple of the initial variation of these sizes.

The effects of the tourism expenditure on the macro-economic sizes of an economy can be assessed by means of creating detailed models including the major categories of tourism expenditure. These models provide a quantitative assessment of the multiplying effects of tourism expenditure on national income, employment, income from taxation, Foreign Transactions Equilibrium, etc.

The concept of multipliers was studied in the first place by Bagehot (1882), who examined the negative effects of the co-operating industries in an economy. In the '30s, Pigou (1929) and Mund (1930) investigated many of the essential information of the multiplier analysis, however, most essential are the essays of R.F Kahn (1931) and J.M Keynes (1933), who introduced the theoretical framework upon which are based all modern multiplier models until today. The first studies, which date back to the 1960s, aimed at the evaluation of the economic effects of tourism utilizing the technique of multiplier analysis in order to assess the primary and secondary flows of tourism expenditure within the economic network on a national and regional level (Archer 1973, 1977, Diamond 1976, Liu and Var 1982, Milne 1987).

The objective of this paper is to pinpoint the capacities and constraints of tourism multiplier analysis as well as of the main methodological approaches used to evaluate the impact of expenditure on tourism development of an area or country.

## **2. CATEGORIES OF TOURISM MULTIPLIERS**

The major tourism multipliers are the following (Ryan 1991:76, Witts-Brooke-Buckley 1991:15, Lickorish-Jenkins 2004:107):

The *output tourism multiplier* measuring the additional production (both primary and secondary) which is created in tourism economics by a unit of added tourism expenditure.

The *income tourism multiplier* indicating the size of the added tourism income created in an economy as a result of an increase in the initial tourism expenditure related to the changes in the real levels of tourism production. The income tourism multiplier is given by the ratio of the changes in production, employment and public income to the initial increase of tourism expenditure.

The *employment tourism multiplier* indicating the relation between the added tourism expenditure and the number of new jobs (both direct and indirect employment) created in a tourism economy.

The *sales or transaction tourism multiplier* measuring the additional commercial turnover (primary and secondary) created by a unit of added tourism expenditure.

The *government revenue tourism multiplier* measuring the additional net public revenues (primary and secondary) created by a unit of added tourism expenditure. This multiplier is defined in terms of net or gross revenues.

The *import tourism multiplier* measuring the value of imported goods and services (both primary and secondary) which are created by a unit of added tourism expenditure.

The aforementioned multipliers assess the results of tourism development in the major macro-economic sizes of tourism economics and consequently the impact caused on tourism development.

### 3. TOURISM MULTIPLIER ASSESSMENT METHODS

There are four main methodological approaches used to assess the impact of tourism expenditure. These are Keynes' models, the Leontief's input-output models, the base-theory models and the ad-hoc models. More particularly:

#### 3.1. KEYNESIAN MODELS

The Keynesian models are based on the concept that a change in an economy's expenditure results to multiplied effects on the national product and national income since the initial increase or decrease of the expenditure is followed by other stages of increases or decreases, which however become gradually smaller. The above applies in the case of tourism economics.

The value of the tourism multiplier is derived from the ratio of exogenous coefficients (e.g. tourism investments, public tourism expenditure) to the proportion of leakages (e.g. tourism savings, tourism imports). Therefore it is given by the ratio:

$$k = \frac{1}{\text{leakages}}$$

In detail, the mathematical formula of the tourism multiplier is as follows:

$$k = \frac{1}{1 - c + m}$$

Where:

k = tourism multiplier

1 = unit change of tourism expenditure

c = the marginal propensity for tourism consumption (e.g. the ratio of change in tourism consumption to the change of tourism income).

m = the marginal propensity of tourism imports (e.g. the proportion of income increase spent on imported goods and services).

The above basic Keynesian model is in fact a static model and can become more dynamic if it incorporates the results of the marginal propensity for tourism investments. Consequently the formula shows as follows:

$$k = \frac{1}{1 - c + m - i}$$

Where i = marginal propensity for investments

It is noted here that the model is limited as regards its practical application since the Keynesian tourism multiplier in its current form ignores the interdependence and leakages taking place during the successive rounds of tourism activity. The reason for this lies in the fact that there are various disadvantages related to the multiplier of this formula (Fletcher 1999:10). The biggest disadvantage is that the formula in its current form is not detailed enough. Another disadvantage is that Keynes' general equilibrium system adopts the aggregate approach, which presupposes in a simplified way that all sectors of an economy experience the same marginal propensity for consumption, regardless of the expenditure of the final demand.

### 3.2. INPUT – OUTPUT MODELS

The input-output models are a means of analyzing the role of inter-sectoral or inter-industry relations in the economy of an area. The input – output analysis is based on the belief that an economy’s productive sector can be divided into a number of homogenous productive sectors and that the gross production value of a sector is equal to the total demand of a sector’s product. The structure of a characteristic input – output table starts with the construction of the *inter-industry or intermediary transaction flows*.

The inter-industry or intermediary matrix can be described in terms of algebra as follows:

$$X_i = \sum_{j=1}^n X_{ij} + Y_i$$

Where  $X_i$  = total output (production) of the  $i$ th industry  
 $X_{ij}$  = sales of industry  $i$  to industry  $j$   
 $Y_i$  = final demand for industry  $i$

From the matrix of inter-industry transactions derives the *matrix of primary inputs*. In this matrix each column represents the input that the first industry listed requires from the rest of the industries. Applying algebra to the primary input matrix we calculate the matrix of final demand which represents the indirect output multipliers and ultimately the estimated secondary impact.

The matrix of final demand illustrates the output required both directly and indirectly by each industry as well as the main input of each column to the industry on top of the column, so that this can produce an output of one monetary unit to the final demand. It summarizes all the required intermediate outputs to the final production. From the sum of the coefficients in the columns derives a multiplier of indirect output, which can be applied to an industry’s sales to calculate the required final output.

The Leontief inverse or inverted technology matrix is a table representing both the direct and indirect effect of a change in any category of final demand. Using simple algebra we have:

Let  $I$  = the identity matrix (which is equal to 1)  
 $A$  = the inter-industry transaction flow matrix of the economy or  
the matrix of technological coefficients  $n \times n$   
 $X$  = the vector of the total output of each industry  
or the vector of gross output  $n \times 1$   
 $Y$  = the vector of final demand  $n \times 1$

Then:  
 $(I - A) X = Y$

which can be written as:

$$X = (I - A)^{-1} Y$$

Where  $(I - A)^{-1}$  is the inverted technology matrix.

Consequently, a change on the level of the final demand ( $\Delta Y$ ) leads to an increase of the financial activity within an economy, which then causes changes in the production and the sales in every sector of the financial activity. Furthermore, several of the models used, allow us to calculate the impact on business revenues, state revenues as well as on employment and income.

According to Fletcher (1999) and Gartner (2001:114-115), there is a series of advantages concerning the use of the input – output models for the calculation of the total economic impact on tourism rather than other alternative approaches. The most important advantages include the following: offering the authorities responsible for making decisions in the tourism industry a comprehensive view of tourism economics; paying attention to inter-industry tourism relations; allowing researchers to configure the model in such a way that it can provide more detailed information on individual industries; assessing each industry in the



same way and allowing the examination of the individual direct, indirect and derivative effects throughout the whole network of tourism economics.

### 3.3. BASE THEORY MODELS

The approach of the base theory models divides the total economy into two sectors (Lagos 2006:60-630). On one side, into the main sector including establishments serving markets outside a particular territory and on the other side into the side sector including establishments serving markets within a territory. Any goods and services sold outside this territory are considered exports and are supposed to be the lever of the local economy.

The calculation of the economic base multiplier takes place using the available income data. However, when no such data is available, data on employment might be used instead. In this case we distinguish the total employment of a region into two parts: one involved in the production of export goods (main employment) and the other involved in the production of goods for local consumption (side employment). This way we calculate the total employment (T) in the territory, which is equal to the sum of the employment in the main sector (B) and the employment in the side sector (N). In this approach we presume that the product of the main sector is defined by the performance of a local economy in its total, whereas the performance of this main sector depends on coefficients exogenous to the local economy (McCann 2002:222-223). Consequently, we have  $N = nT$ , where n is a variable between zero and 1, representing the sensitivity of employment generation in the side sector compared to the total level of employment created in an area.

Thus, we have:  $N=B + nT$ , transformed into:

$$\frac{T}{B} = \frac{1}{1-n}$$

The ratio  $\frac{T}{B}$  is called multiplier of the main sector and gives us the relation between employment in the main sector and employment throughout the whole economy. The greater the  $\frac{T}{B}$  ratio, the greater the main sector multiplier. Furthermore, the higher the value of n is, the lower is the (1- n) value and the higher the multiplier of the main sector, for there is a dependence relation among the total regional employment and the employment in the main sector.

Therefore, in case of change of data we have the following:

$$\Delta T = \frac{1}{1-n} \Delta B$$

In this case, the variation of  $\Delta B$  of the employment level in the main sector results in an increase of the total employment by  $\Delta T$ .

The use of the pattern in the main sector tends to refer mainly to urban regions having urban concentration of population and activities. In terms of the above, tourism is an activity developing mainly in some urban locations and expressing the new phenomenon of tourism urbanization, which is a new form of spatial development (Lagos 2001).

The advantage of this method lies in its simplicity and ability to utilize data which is easily available, even on a small scale. Among its disadvantages we find an often subjective distinction between main and side sectors, the presumption that all kinds of exports possess the same multiplying effect and the presumption that an area's development depends primarily on its exports.

### 3.4. AD HOC MODELS

Archer and Owen (1971) were the first to adopt the methodological approach of the Keynesian multiplier for the calculation of the total impact of tourism expenditure on an area. They developed a model which they called the *Ad Hoc model* because it was developed individually for every area studied.

The Ad Hoc model focuses on the income created in an area due to the initial variation in tourism expenditure. This model has the following formula:

$$AHM = \frac{A}{1 - BC}$$

Where:

- $AHM$  = the tourism multiplier value;
- A = the proportion of tourism expenditure remaining in the economy after the first round leakages in tourism expenditure;
- B = the propensity of local people to consume in the local economy;
- C = the proportion of expenditure by local people that accrues as income in the local economy;

During a study of the Cook Islands in the South-West Pacific, Milne (1987) used this technique to determine the value of the tourism income multiplier at both the industry and firm level. Milne's model is shown below:

$$Y_a = \frac{W(1 - h - t_w) + P(1 - t_p) + F(1 - t_w) \sum_{j=1}^I S_{ai} Y_i}{D_a}$$

Where:

- $Y_a$  = local income generation coefficient for an enterprise;
- W = gross wages and salaries paid to local residents;
- h = national insurance and other deductions from W for individuals working in the region;
- $t_w$  = direct taxes on wages and salaries;
- P = local profits;
- $t_p$  = tax rates on local profits;
- F = rent paid to local residents;
- $S_{ai}$  = purchase by a business from the  $i$  th type of business;
- $Y_i$  = regional income generation coefficient for the  $i$  th type of business;
- $D_a$  = total turnover of a business.

Using this model at the establishment level, Milne found that smaller establishments in the accommodation, tour operation and handicraft sectors invariably exhibited greater income, employment and government revenues. This is not a surprising result given that the smaller establishments are traditionally less capital-intensive than the larger firms. Besides, larger firms –particularly in small island economies- tend to be partly or wholly foreign-owned and, therefore, repatriate profits and have higher propensities to import than their local counterparts.

## 4. APPLICATIONS OF THE TOURISM MULTIPLIER ANALYSIS

Tourism research has developed several patterns, which –based on the theoretical background of the Keynesian multiplier approach- assess the effects of tourism expenditure on the most vital sizes of tourism economics (Clement 1961, Archer and Owen 1971, Richards 1972, Bryden 1973).

The patterns indicate that the smaller –and, consequently, the less developed- an area is, the smaller tends to be the tourism expenditure multiplier. The national tourism income multipliers seldom exceed 2, whereas the relevant regional multipliers are always smaller (around 0.5). Tourism income multipliers depend directly on the area and thus they cannot be used in any other region, even if the regions have similar economic characteristics. However, these values constitute a good standard for those researchers assessing the new tourism multipliers.

On the contrary, tourism production and employment multipliers have higher values. For example, the tourism production multiplier is 1.16 in the regional economy of Great Britain and 3.198 for the whole Turkish economy.

More particularly, two researches have been conducted in Greece (Papadopoulos 1964 and Suits 1965) on the entire economic impact of tourism; another research was conducted in the region of Crete evaluating how the implementation of an island's development plan affects tourism. Suits applied an econometric pattern for tourism multiplier assessment, whereas Papadopoulos and Basil were based on the results of the Checchi & Company experts, from where they adopted the income multipliers: Papadopoulos for the entire country and Basil for the area of Crete respectively. More particularly, Papadopoulos (1964:232) assessed the tourism income multiplier to 1.35 and Basil (1965:110) to 4.0.

Suits's assessment (1965) of the tourism expenditure multiplier, which was based on an econometric pattern of the Greek economy, resulted in a value around 1.2, which is considered rather low. According to a different pattern of the Centre for Planning and Economic Research (KEPE) based on the macroeconomic pattern KEPE – LINK (MYKL) and the financial data of 1990, the tourism income multiplier was assessed at 1.9. According to the same pattern, Kouzelis calculated the tourism income multiplier at 2.184, which constitutes its upper threshold.

## 5. CONCLUSIONS

Tourism multipliers can be assessed for an entire country, for a region within a country or even for a local society. Normally, the size of an economy can affect the size of the multiplier. It is noted here that we should be especially careful when comparing the multipliers of various states between them, since such comparisons can be misleading.

Taking into consideration that most tourist destinations promote tourism activity in an attempt to improve their economy's income and tourism employment levels, is not surprising that many people regard tourism income multiplier as the most important index. It measures the change in tourism income (wages, salaries, profits, etc.) and the impact this involves for the entire economy and presents it as a result of the various changes either at the level of tourism economics or at the level of tourism expenditure distribution. The changes in tourism income can be measured in terms of either gross national income or available national income and reflect the amount of the extra acquired income that is available either for reconsumption or for saving. Particular emphasis should be given to the assessment of tourism income multipliers, especially in developing areas with a high proportion of foreign-owned establishments. This can take the form of an income reduction destined for repatriated salaries and profits. The non-repatriated income should remain in the analysis so that the multiple results generated from its reconsumption can be reflected in the end value of the multiplier. The income multiplier is particularly useful for authorities responsible for tourism policies. It can also be used to indicate the benefits related to various types of tourism activity in order to target the right economies and maximize the financial benefits of tourism.

The tourism employment multiplier indicates the change in the number of opportunities for new jobs related to a change either at the level or at the distribution of tourism expenditure. It can be expressed in terms of number of new jobs or as the ratio of the sum of opportunities to the direct opportunities caused by an additional unit of tourism expenditure. Thus, it is obvious that tourism policy organizers and developers face a substantial need to be aware of the consequences for tourism employment involved in any potential change of the end demand. This is even more important in developing countries, which could probably face complex problems rendering the results in tourism employment equally vital with the results in tourism income. The employment multipliers offer invaluable information on the planning of human resources. Nevertheless, attention should be paid whenever employment multipliers measured either by ad hoc or by input-output models are used.

The tourism production multiplier is the result of an additional increase of tourism expenditure. Given that not the entire current tourism production is sold within a particular period of time during which the multiplier in question is assessed, the relevant effects (either positive or negative) account for the everlasting difference in its values. The tourism production multiplier enables the planning of tourism policies and provides the authorities responsible for them with useful information on production requirements in the industrial sector as well as on any potential changes taking place either in the level or in the distribution of tourism expenditure. This way it enables making forecasts regarding the stocks and any obstacles existing in the production process. Furthermore, such information allows taking policy-related measures to reverse any changes noted in the propensity to import goods and services, which, however, lead to a decrease in tourism income and tourism employment.

Given the errors of the base theory model, researchers tend to choose between the ad hoc and the Leontief's input-output models, according to the budget of their research and their personal experience. The input-output models are considered to offer more advantages as regards their analytical aspect and provide more accurate results. Their main disadvantage lies in their requirement for a great amount of statistical information.

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# GRANGER CAUSALITY IN PHILLIPS CURVES: DOES INFLATION RUN FROM OUTPUT TO PRICES OR PRICES TO OUTPUT IN GREECE? A PRELIMINARY ECONOMETRIC MODEL

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## Abstract

*The aim of this paper is to examine the existence and direction of the relation between output and prices in Greece, in a short-run Granger causal sense, over the period 1986Q1-2005Q4. More specifically, the Granger causality test is employed in order to specify the direction of causality between the output gap and the surprise inflation. The expected inflation was estimated using a dummy variable in order to capture the shift of the regime after the adoption of the common currency. Next, we employed a number of recently developed time series econometric techniques such as unit root testing and multivariate cointegration. A first indication of a causal relationship between prices and output appeared after the estimation of two specifications of the Phillips, namely a New Keynesian Phillips Curve and a Lucas Aggregate Supply Function, including an exchange rate term as a second driving variable in both the formulations which, however, was found not to be statistically significant. The indication of a unidirectional causal relationship running from prices to output was further strengthened after computing the Granger test for causality.*

## Method

The existence of a tradeoff relationship between unemployment and inflation remains at the heart of the controversy between economists and policy-makers for several decades. Since it involves two macroeconomic variables of enormous political significance, the temptation of governments and monetary authorities to exploit it in order to deliver their desirable outcomes seems justified, even if not rational in some cases.

Although I. Fischer (1926) was the first one to perform a statistical investigation between inflation and unemployment using US data, the relation between these two macroeconomic variables gained great attention due to the influential study of A.W Phillips (1958) who discovered the negative relation between unemployment and the rate of change of money wage rates in the UK for the period 1948-1957. That statistical evidence gained some theoretical justification over the next years, i.e. in Lipsey (1960) and Samuelson and Solow (1960).

However, after experiencing the phenomenon of stagflation in the 1970s, some serious monetarist objections about the effectiveness of such a tradeoff as a policy rule were raised, mostly by the Monetarist School. Proposing the *expectations – augmented Phillips Curve*, Friedman (1968, 1977) and Phelps (1967a, b) argued that little reliance should be put on the original Phillips Curve since workers were concerned about their real wages and not the nominal ones.

But the Phillips Curve theory was about to receive much more criticism after the “rational expectations evolution” and the neoclassical economists who adopted the hypothesis that agents form their expectations rationally, using all the available information and knowing the structure of the economy. In a series of influential publications, Lucas (1972, 1973, 1976), Sargent (1971, 1973), Sargent and Wallace (1975, 1976), McCallum (1976) and Barro (1977) left a little room for effective policy intervention; assuming rational behaviour only unanticipated money growth could affect real economic variables, the tradeoff seemed to disappear in the long-run.

In the years followed, in order to justify some room for active monetary policy, new models that combined price stickiness together with rational behaviour started to gain attention. The most famous formulations of the so called *New Keynesian Phillip Curve*, were those of Taylor (1979) and Calvo (1983) and laid the foundations of later research based in models incorporating the New Keynesian Phillips Curve, with its later

modification to be just about limitless. With no exception, these models presented canonical Phillips Curves which were driven either by current real marginal cost or today's output gap and were forward-looking in the current expectation of tomorrow's inflation.

After the 1990s the Phillips Curve went through further formulation in order to fit the data, since there have been cases of economic environments of low inflation and low unemployment, so a lot of researchers presented some hybrid models, as those of Gali and Gertler (1999), Fuhrer and Moore (1995) and Roberts (1997). Generally, since the 1990s the research on the New Keynesian Phillips Curve has been huge and numerous studies have been published. This indicates that the Phillips Curve remains a popular topic and it is justified to argue that as long as there are signals of potential exploitability of such a tradeoff relation, the authorities will be always tempted to explore it, keeping the Phillips Curve in the game. Thus, in this paper we try to investigate the existence of such a relationship in a short-run causal sense.

### Data

This paper will focus in the case of Greece, estimating a tradeoff relation of the kind analyzed in previous sections using quarterly Greek data covering the period between 1986Q1 and 2005Q4. The variables of the Consumer Price Index (CPI), the Gross Domestic Product (GDP), the unemployment rate, the public expenditure and the domestic demand as a percentage of the GDP were obtained from the Bank of Greece. The public deficit as a percentage of the GDP was obtained from the IMF's database. The money supply, using the definition of M1 which includes the currency in circulation and sight deposits in commercial banks, and the exchange rate of the euro against the US dollar were provided by various issues of the OECD Main Economic Indicators over the period 1987-2006. The quarterly values of the European CPI were obtained from Eurostat. The conversion from drachmae to euros before 2001 was made by own calculations using the exchange rate of euros against drachmae, 1 Euro = 340.75 Drachmae. It should be mentioned that, wherever needed, the above variables are expressed in constant prices.

### Empirical Analysis

The first thing was to test our variables for a unit root process. Using an ADF test we found all our variables to be I(1) except the output gap which was I(0). After that, a necessary task before estimating a version of the Phillips Curve or testing for causality was to estimate the level of the expected inflation. Following the relevant literature, we employed the Engle-Granger two-step procedure in order to test for a cointegrating relationship among the variables that were chosen as determinants of the inflation rate (namely, the money supply growth, the public deficit as a percentage of the GDP and the change of the European CPI). Again, after performing an ADF test, these variables were found to be cointegrating, so we could use them to estimate the level of the expected inflation, using a dummy variable to capture both the regimes in the pre and the post Euro adoption era.

$$p_t = D(a_1 + a_2 m_t + a_3 pd_t) + (1 - D)(a_4 + a_5 peu_t)$$

The fitted residuals obtained from this regression provided us the level of the expected inflation.

Next we estimated two specifications of the Phillips Curve in order to get some early indications about the direction of a causal relationship. First, we estimated a NKPC formulation, but this was not quite fruitful until we took out of the sample the period 1986Q1-1990Q4 where there were some wide fluctuations of the output gap. So, for the remaining period 1991Q1-2005Q4 the estimated regression was:

$$p_t = \underset{(0.049)}{0.878} p_t^e + \underset{(0.058)}{0.124} (y_{t-1} - y_{t-1}^*)$$

It seems that the expected inflation and the lagged output gap have a good explanatory power over the inflation rate. In order to be in greater accordance with the theory, we assumed that the coefficient of the expected inflation equals to one. Under this assumption, the estimated model became:

$$p_t = p_t^e + \underset{(0.06)}{0.111} (y_{t-1} - y_{t-1}^*)$$

The coefficient of the lagged output gap was found not to be statistically significant, leading to a first evidence of a unidirectional causal relationship running from the inflation surprise to the output gap. This evidence was further strengthened when we estimated another formulation of the Phillips Curve which actually resembles to Lucas supply function. The estimated regression was the following:

$$y_t = y_t^* + \underset{(0.250)}{0.738}(p_{t-1} - p_{t-1}^e)$$

The rationale under this specification is that the output is highly related to the potential one when the actual inflation level is higher than the expected level. The coefficient of the lagged inflation surprise was statistically significant, so further evidence that the Phillips Curve runs from inflation to output was provided.

The next step was to employ the Granger test to see whether there is any causal relation between the output gap,  $y_t - y_t^*$ , and the inflation surprise,  $p_t - p_t^e$ . A simple ADF unit root test showed that these two variables were found to be stationary I(0) as shown in the table:

**Table 1**

Unit root ADF tests		
Variable	ADF test statistic	Probability value
$p_t - p_t^e$	-4.581	0.0022
$y_t - y_t^*$	-7.371	0.0000

The essence of the Granger's test for causality seems to be predictability. A variable, name  $X$ , is said to Granger – cause another variable  $Y$  if past values of  $X$  can offer more accurate predictions for the present value of  $Y$ . Such a relationship can be investigated in both directions, from  $X$  to  $Y$  and vice versa. We choose first to test if there is any causal relationship running from inflation surprise to the output gap. The estimated model was:

$$y_t - y_t^* = \underset{(0.001)}{0.001} + \underset{(0.129)}{0.051}(y_{t-1} - y_{t-1}^*) + \underset{(0.273)}{0.709}(p_{t-1} - p_{t-1}^e)$$

According to the above, the coefficient of the lagged inflation surprise term is statistically significant so the null hypothesis of non causality is rejected at the 5% level of significance so the inflation surprise Granger – causes the output gap. In other words, the lagged inflation surprise has a good explanatory power over the current value of the output gap so it can be argued that there is a causal relationship running from inflation to output. This finding confirms the implications provided when we estimated the two specifications of the Phillips Curve earlier in this section. Furthermore, this finding is consistent with those of Papapetrou (2001) and Tsionas (2003) which also worked using Greek data. However, the causal relationship between inflation and output seems to be a unidirectional one, but bearing in mind the estimated Phillips Curves this should not come as a surprise. Hence, as expected, when we tested the hypothesis of causality running from the output gap to the inflation surprise, the estimated coefficient of the lagged output term appeared not to be significant, implicating that there is not a causal relationship running from output to inflation

## Results

The empirical analysis showed that there is a relationship between prices and output in the Greek economy. This was confirmed not only by the two estimated Phillips Curves but also from the Granger causality test between surprise inflation and output gap. Specifying the models estimated with one lag, the estimation results were in favor of a unidirectional causal relationship running from the surprise inflation to the output gap. When the deviation of the actual inflation rate from its expected level is increasing this seems to have a positive impact on the widening of the output gap which normally leads to a decrease in the rate of unemployment. Hence, unanticipated changes in the price level can affect real economic variables in the short –run.

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# DECISION MAKING UNDER RELATIVE UNCERTAIN CONDITIONS IN HOTEL SECTOR: DECISION TREES

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## Abstract

*The position of an enterprise in given time is consequence of decisions taken in the past. Decision-making is influenced by many factors, and mostly by conditions and people who make the decision. A method that facilitates decision-making is called decision trees, where possible alternatives are examined extensively; so that the best is selected. However, this does not mean that the appropriate conditions for making the most suitable decision always exist.*

## Special Features of Hotel Enterprises

The hotel product is polymorph and complex, compiled of separate different products. These products are delivered at different moments in different places by different people.

Many of the services composing the hotel product are consumed when produced and cannot be in a client's possession because of its non-material nature. Due to this, there is often no ability to make corrections in case of defective products, except for the ability to reduce the cost of damage.

Hotels demand highly-rated investments in fixed cost. The numeral supremacy of fixed assets in relation to floating assets is obviously shown on balance sheets. This is why hotels belong to intense-fixed cost enterprises.

The business risk increases as the investment budget rises and the time between the production and the income of sold products expands. Hotels combine both of these negative assets, and are ranked as among those functioning in conditions of high danger.

The productivity in hotel enterprises is absolutely inelastic (cannot get higher in case of price reduction), as long as it is related to the existing premises; because the productivity of the agreed services is limited by the capacity of the hotel.

In the hotel sector, the constant expenses are ostensibly higher, compared to the variable ones. The constant expenses which stem from the premises (amortizations or rents, taxes and maintenance) are high due to the impact of fixed costs to the property total.

Hotels are characterized by continuous production even when no demand exists. While the demand fluctuation is frequent and intense; the hotel cannot increase and decrease its staff, correspondingly, particularly the specialised ones. For this reason, during its functioning period it maintains a minimum number of staff that could be called Safety Staff. So, in spring, the vast majority of Greek season hotels has many empty although ready for use rooms, and can serve the 100% of its capacity in departments. Therefore, the salary payment is not very elastic as compared with the production level, while it is a big part of the cost percentage, no matter what happens with the hotel occupancy rate.

From an economical point of view, these factors lead hotel enterprises into a difficult position of binding the production inelasticity together with the cost inelasticity.

In combination with the low percentage profit of hotel activities, the facts above force the sector to use the maximum space of installations. Basically, this means that hotels have to achieve the highest possible occupancy percentage.

A necessary requirement for the achievement of this goal is the conception of most profitable decisions, often in very limited time space.

## Making Business Decisions

Decision is the choice made after thinking. Consequently, decision making essentially requires having more than one choice in order to make a comparison. **For this reason, the decision defines as much of what someone chooses as well as what choice is discarded.**

Business decisions deal with the need of changing a situation, then controlling the possibility of a change. This change has to do with the transformation of an in-effective situation to another one, most desired. The hotel management has to make the decision whether or not to carry out this change, and also find out the most appropriate action to make it happen.

Decisions often lead to changes disordering the normal enterprise function. The significance of each time decisions is major for determining the course of the hotel enterprise, because **its present position is a consequence of past decisions**. This is why managers must have no doubts to make these important changes.

**It is not always easy to make the correct decision**, because most times important information is missing and enterprise executives lack the necessary skills and know-how for information processing; or even more, information processing does not lead to secure results but to possible ones. Making the correct decision requires the appropriate people, supported by suitable information, to use the right methods. Nowadays, personal computers can contribute significantly to issues of decision taking, since the problem we deal with is specific and its variables can be countable.

### Decision Makers and Conditions of Conceiving

Decisions can be made in conditions of:

◇ **Certainty**, in which the results of the decision are certain. For example, a seasonal hotel can easily decide against a proposal of an agency of little importance, to book over allotment in high season.

◇ **Partial uncertainty**, in which alternatives' odds can be measured. For example, a known tourist agency proposes a low demand hotel a three-year exclusive collaboration, promising high fullness percentage.

◇ **Uncertainty**, in which alternatives cannot be measured. For example, an unknown tourist agency proposes exclusive collaboration, but with exorbitant rates.

The level of uncertainty depends on the conditions and the sector's environmental altered rates, and also on the complexity and the sensitivity of the enterprises<sup>1</sup>. Hotel enterprises are complex and sensitive, often facing a slowly changing environment, however showing high sensitivity in economical and political changes, as well as in social changes.

The very same conditions can be received by one enterprise as the cause of high uncertainty, while not by another. This happens because what defines the level of uncertainty are not the environmental conditions themselves, but the environmental information received by the enterprise along with its processing level. Thus, during the Gulf War, some hoteliers were concerned and took measures to overcome the forthcoming situation, while others ignored the possible problems that could appear.

Uncertainty pushes the enterprises for structures guaranteeing the ability to adapt in their environment. Enterprises not facing the problem of high uncertainty tend to build cumbersome and bureaucratic structures; while enterprises facing certainty conditions prefer more flexible structures.

The significant decisions determining the fate of a hotel enterprise are taken by people whose relation with the hotel varies, just as under different circumstances. Based on this concept we can distinguish two cases<sup>2</sup>:

#### **Decisions Made by the Businessman – Creator of the Enterprise**

The creator of the enterprise bears the palm of administration, feels totally connected with it and seeks its development more than its problem solving. The businessman knows the weaknesses and the advantages of the enterprise and trusts his business instinct, often making risky decisions.

**Decision-Making in Situation of Adaptation** The businessman – manager coincidentally took the lead of the enterprise and is in situation of adaptation. In this case, he manages without knowing the corporal operations in depth, giving more significance to dealing everyday problems rather than configuring strategic growth. The received decisions, consequently, are usually of small importance.

**Avoidance Decision Making.** Avoidance decisions are those which aim at avoiding damage, without aiming the best possible choice. For this reason there are solutions to be chosen that:

- o ignore problems (by hoping they stop existing)
- o are connected with another usual way of reaction with no consideration whether it is the appropriate
- o reduce conflicts between people or teams.

Of course, these solutions do not look forward to growing the enterprise.

<sup>1</sup> Mpourantas D. «Management» Mpenos Athens 2001

<sup>2</sup> Papadakis B. «Business strategy, Greek and International Experience» Mpenos, Athens 1999

**Making Decisions of Sensible Amendments.** This concerns decisions of small importance, after systematical processing of information focused on the changes of the environment, targeting the continuous adaptation of the enterprise.

**Making Decisions Under Multiple-Guided Centres.** These entail decisions taken under situations of conflict between members of the management. It is a quite often phenomenon at hotels managed by families, where the conflicts take place not only between family members, but moreover between the family and the manager or the enterprise executives. The prevailed decisions come from compromising and retreating.

**Making Culturally Influenced Decisions.** These decisions can be made by different decision centers over an enterprise, but the enterprise culture provides these decisions with a common direction resulting in the creation of a uniform dynamic enterprise development. Of course, the necessary requirement is the prevalence of a remarkable enterprise culture in all enterprise levels.

**Decision Making Under Confusing Conditions.** These are decisions taken by imposing groups upon the administration. Having not a specific direction, not only do these decisions not serve a strategy but also they do not serve the enterprise itself.

**Decision Making Under Pressure.** The hotel sector is characterized by the constant fluctuations in its service demand. It is a frequent phenomenon to observe pressure created for productivity without being given the necessary means or time space. In this case, the executives are required to take decisions under pressure.

**Decision Trees.** The decision trees are diagrams of consecutive choices and their possible consequences in conditions of relative uncertainty. The diagram depicts the branches of different possibilities and leads to problem analysis in order to reveal the most profitable solution.

In the tree diagram, the nodes are points of decision or incidental events while the lines depict each choice. The initial problem is analysed in possible solutions and afterwards the possible results of each solution are traced. These results may constitute issues for analysis in order to create a tree with branches constantly increasing until the possible solutions to be found.

On a decision tree two kinds of nodes, the **decision nodes** (symbolized with a small square) and the **nodes of incidental events** (symbolized with a circle) <sup>3</sup>

To proceed on making decisions with this method, we necessarily have to describe factors influencing the problem. These factors are:

- ◇ Mission statement
- ◇ Purpose
- ◇ Time available
- ◇ Resources available - space
- ◇ Problem solving manager – administrative skills
- ◇ Funds available

Solutions opposing to the specifications above must be rejected or considered after much attention.

For example (watch scheme 1), we make the hypothesis that the marketing department of a 500 bed hotel functioning 365 days per year, estimates that if it operates an advertising campaign, the maximization of its fullness is possible. Consequently the hotel income can be counted by the product:

$$500 \times 100 \times 365 \times (\text{ADF}) = 18,25 \text{ million} \times (\text{ADF})$$

ADF is average daily fullness.

It is also considered that there is a 60% chance of high demand and a 40% chance of low demand. More precisely it is appreciated that:

- If operating a 100,000 € advertising campaign, in case of high demand the occupancy will reach 90%, while in case of low demand the occupancy will drop to 80%.
- If operating a 80,000 € advertising campaign, in case of high demand the occupancy will reach 80%, while in case of low demand the occupancy will drop to 70%.
- If not operating an advertising campaign, in case of high demand the occupancy will reach 60%, while in case of low demand the occupancy will bottom-out at 50%.

<sup>3</sup> Decisions taken under Bayes' criteria. In program, the nodes are created by the interrelation  $\text{MAX}(x_1, x_2, \dots, x_n)$ , and the nodes of incidental facts by the interrelation  $\text{EMV}(p_1\%; \text{event } 1; p_2\%; \text{event } 2; \dots; p_n\%; \text{event } n)$ . «pn» equals the odd of facing the n-th fact.

With the facts above there is the creation of a tree same as that of scheme 1. The first solution appears to be the most preferable; because the expected income excluding campaign expenses is  $7,855+3,84=€11.695$  million, while the second solution brings  $7,56+3,91=€11,47$  million and the third one  $6,75+3,65=€10,4$  million. The calculations are now done by computers. Widespread softwares are:

**Decision Tools Suite** which is a complete sum of five products designed to cooperate in the area of combining analysis targeting the best analysis of decisions in a complete set. Decision Tools Suite includes the programs: *RISK*, *PrecisionTree*, *TopRank*, *BestFit*, and *Riskview*. These programs are designed to cooperate in a complete interface as they function through a common Microsoft Excel toolbar.

- **DecisionPro** which can solve problems of decision making in a simple way, as shown in scheme 2. TRUE shows the branch of the decision tree which offers the most advantageous solution, while FALSE shows the branches with disadvantageous solution(s).

### Obstacles in Decision Making

Many obstacles can affect the make of the orthologic decision.

Managers and the rest of the staff do not have the demanded time to make an orthologic decision. Knowledge, information and know-how which can serve the procedure of making decisions, may not be available.

Sometimes the people responsible to make decisions do not have an analytic and composed way of thinking which are necessary for decision making, or they lack necessary creativity to detect satisfying solutions.

Other times, they decide by choosing a learned habit of theirs, meaning that they bring back a solution from similar past problems, often not having observed the diversity of the current situation.

The biases and the stereotypes which possess people, that is to say the shaped perceptions with regard to various subjects, frequently prevent the rational analysis of problems. Thus, it is possible that a director considering the young people as flippant, impedes the advancement of appreciable young people to executive level, when facing important problems of discovering capable executives.

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Figures

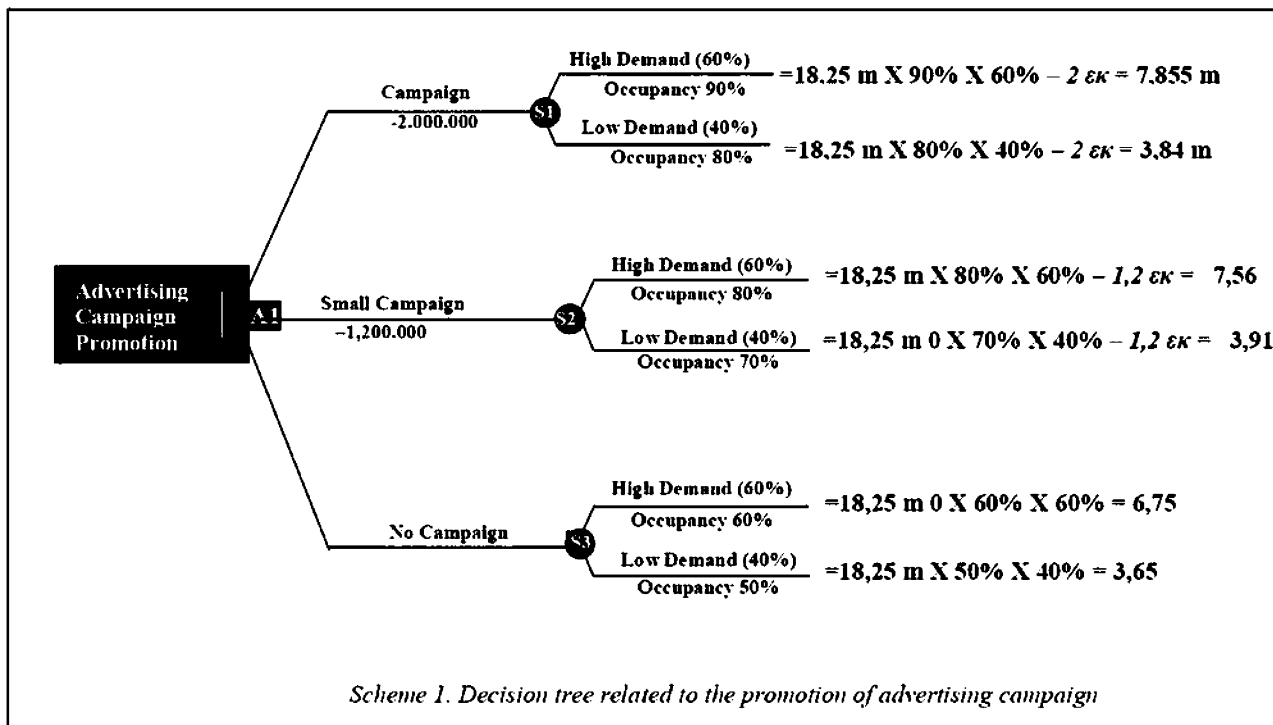


Figure 1. Decision tree related to the promotion of advertising campaign

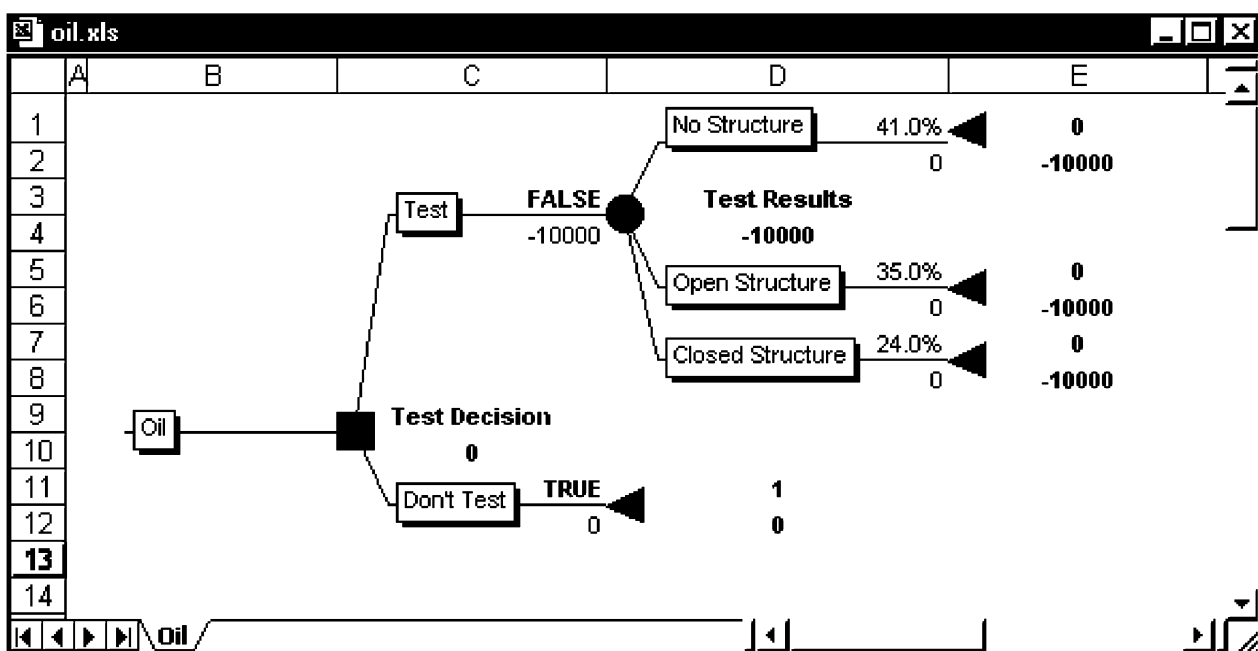


Figure 2. DecisionPro Program

# THIRD PARTY LOGISTICS (3PL) MODELS: PERSPECTIVES AND PRACTICES. THE CASE OF THE GREEK PHARMACEUTICAL INDUSTRY

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## Abstract

*The purpose of the present study is to investigate the probability that Pharmaceutical Companies located in Greece entrust their products' storage and distribution services with Third Party Logistics (3PL) Companies, as well as the criteria on which this entrusting is based. Questionnaires including open and close type questions filled out by 25 of the largest pharmaceutical companies in Greece, starting from September 2007 to April 2008, were used to collect data. Furthermore, the survey uses the model of Logistic Regression so as to examine the usage of Third Party Logistics' services.*

*The analysis of the results concluded that the possibility of the pharmaceutical companies to have assigned the distribution and storage of their products to an independent 3PL company depends on the following:*

- *whether the pharmaceutical companies consider that the entrusting of their storage and distribution services to a 3PL company appears no default*
- *whether they believe that great funds are released due to the entrusting of the products' storage and distribution to 3PL companies, making it difficult - at the same time - to control them in a directly way*
- *whether they use the internet facilities in order to find potential suppliers to cooperate with*

*Key Words: outsourcing, inventory management, supply chain, Third Party Logistics (3PL)*  
*Classification, JEL: M10-General*

## 1. Importance of Supply Chain

Logistics have immense importance particularly in chemical and pharmaceutical supply chains. Companies in this industry, have gradually begun focusing on their supply chains, and research on pharmaceutical supply chain management and logistics has gained importance, although it has received little attention in the literature. Pressures are leading many pharmaceutical companies to leverage all elements of their business, including increasingly complex supply chains, for making logistics a competitive advantage. Attention focuses in how to improve service quality while reducing operational costs and optimizing efficiency in inventory management and distribution. Moreover, integrated systems at network supply chain level of temperature-controlled shared warehouses and transportation management services, can increase capabilities and ensure the right product where and when needed, so that to reduce inventory and improve delivery status. Besides, the drugs bill of the national health system, funded by taxpayers, is under increasing pressure in recent years adding the need to afford some of the new and expensive drugs which are now being developed to tackle 'modern diseases' such as cancer. As with any organizations, this area is looking for costs savings through better supply chain management.

## 2. Special Characteristics of the Pharmaceutical Sector

There is a number of special characteristics of the pharmaceutical sector that affect directly or indirectly the physical flow of drugs throughout the supply chains (Logistics Europe,2006):

- Combination of state intervention and social policy with the pharmaceutical market
- Role of innovation in developing new products and building-up distribution networks to store and move promptly and efficiently to final users (expensive R&D programs)
- Economic imperatives for lower costs without impairing quality: since drugs are for protection of social health and customership is in package form
- Continuing adjustment process: in view of changing business and technology environment and rising demand, living standards, life expectancy, modern illnesses, etc.
- Particular importance of the RL since the health of patients may be put at risk if drugs are not withdrawn expeditiously, with a timely and cost-effective manner
- Global marketplace changes: need for global SCS, strategic alliances, joint ventures, etc.
- Inter-European trend to integration: more complex 'strategy-structure-performance' circuit for value adding and creation of sustainable competitive advantage
- Prediction of rising role of logistics with harmonisation and a gradual shift towards pan-European distribution networks
- Need for excess stock, increased role of 3PL, wholesalers role, etc.
- Efficient technology use: rising role, available technology solutions, NIT, EDI, ERP, etc.
- Outdated Manufacturing: increasing competition, updated equipment in pharmacies, etc.
- Counterfeit products are coped with logistics through promoting innovation
- Parallel trading and black market: faced by RFID technology, product origin, etc.
- Law adequacy: helped by improving capabilities of control system, etc.

### **3. Outsourcing Logistics in the Pharmaceutical Sector**

The historical 'question to make or buy' is frequently asked, in the main scope of promoting firms' adjustment to the new corporation and technology environment (Laios and Moschuris, 1999). The relations among the outsourcing firm, the 3PL service providers and customers are complex to integrate, and NIT are helpful to reduce the risks of outsourcing (Xu et al., 2008). However, the 3PL providers may affirm declining efficiency, insofar as they focus on traditional service offerings such as transportation, and warehousing rather than playing the role as integrator or lead service provider (Zhou et al., 2008).

There is a growing international logistics industry trend for expansion of capabilities for handling temperature-sensitive pharmaceuticals, by 3PL developers. Moreover, pharmaceutical wholesalers are widening their service offerings and becoming health providers, supplying the pharmacy not merely with medicines, but with total solutions. Many wholesalers are also developing closer relationships with manufacturers, and offering them logistics services that have traditionally been the domain of 3PLs. With a trend towards greater harmonisation and unity in the EU, there is a gradual shift of European pharmaceutical logistics towards pan-European distribution networks (Addison C. et.al, 2005).

The 3PL providers who remain stick to traditional service offerings may become victims of short-sightedness falling in declining efficiency, insofar as they focus on traditional service such as transportation, and warehousing rather than playing the role as integrator or lead service provider (Malindretos G., 2008).

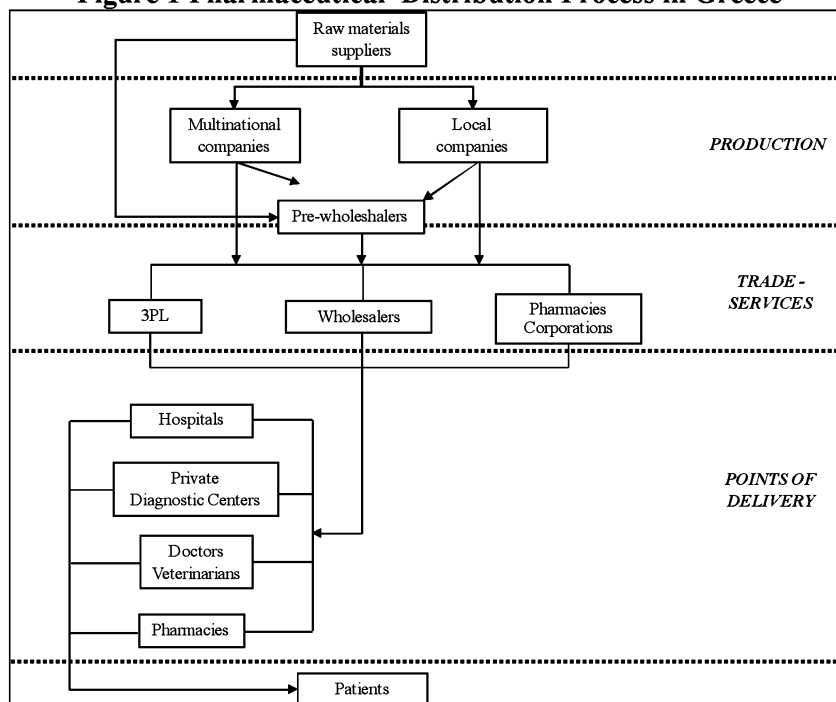
While outsourcing is a powerful tool to cut costs, improve performance, and refocus on the core business, outsourcing initiatives often fall short of management's expectations. There are three principles for effective implementation of outsourcing: requirements, coordination and communication (Lynch, 2004). More specifically, it has been constructively criticised that outsourcing has to overcome a list of 'seven deadly sins' that underlie most of the failed outsourcing efforts: (1) outsourcing activities that should not be outsourced; (2) selecting the wrong vendor by overblown expectations; (3) writing a poor contract, by blindly banishing projects; (4) overlooking personnel issues; (5) losing control over the outsourced activity; (6) overlooking the hidden costs of outsourcing; and (7) failing to plan an exit strategy, by negligence and end-game myopia (Baitheimy, 2003; Artunian, 2006).

### **4. The Pharmaceutical Sector in Greece**

The 55% of the market share belongs to private companies and the 45% to pharmacies cooperatives (IOBE,2008). In addition, there are companies called as 'pre-wholesalers', which are local producers that provide logistics services as well for other pharmaceutical companies (figure 1).

The list of the first 25 pharmaceutical companies in Greece, according to their turnover is shown in Table 1. Globally, first is JOHNSON & JOHNSON which doesn't sell drugs in Greece, second is PFIZER (1<sup>st</sup> in Greece), followed by BAYER, GLAXOSMITHKLINE and NOVARTIS (correspondingly 11<sup>th</sup>, 3<sup>rd</sup> and 4<sup>th</sup> in Greece). In the sixth place is SANOFI-AVENTIS (9<sup>th</sup> and 10<sup>th</sup> in Greece – before their merger) and finally HOFFMANN-LA ROCHE and ASTRAZENECA (6<sup>th</sup> and 8<sup>th</sup> correspondingly in Greece). In other words, the biggest global players in the pharmaceutical sector are the main players in the Greek market place as well.

**Figure 1 Pharmaceutical Distribution Process in Greece**



**Table 1 List of the first 25 pharmaceutical companies in Greece**

a/a	Company	Turnover (€)	Market share
1	PFIZER	400.186	8,5%
2	BOEHRINGER INGELHEIM	329.486	7,0%
3	GLAXOSMITHKLINE (GSK)	267.681	5,7%
4	NOVARTIS	254.869	5,4%
5	VIANEX	249.707	5,3%
6	ROCHE	227.485	4,8%
7	JANSSEN - CILAG	206.073	4,4%
8	ASTRA ZENECA	203.500	4,3%
9	SANOFI-SYNTHELABO	168.202	3,6%
10	AVENTIS	151.892	3,2%
11	BAYER	147.924	3,1%
12	PHARMASERVE LILLY	144.812	3,1%
13	ABBOTT	130.749	2,8%
14	GENESIS	130.486	2,8%
15	BRISTOL MYERS SQUIBB	123.137	2,6%
16	WYETH	100.137	2,1%
17	ΓΕΡΟΛΥΜΑΤΟΣ	100.080	2,1%
18	SCHERING-PLOUGH	92.705	2,0%



a/a	Company	Turnover (€)	Market share
19	ELPEN	74.401	1,6%
20	DEMO	70.373	1,5%
21	FAMAR	67.056	1,4%
22	ΙΦΕΤ	46.217	1,0%
23	CANA	44.314	0,9%
24	BAXTER	43.405	0,9%
25	SERVIER	37.709	0,8%

Source: IOBE

## 5. Survey Study of the Greek pharmaceutical sector

Based on the discussed research methodology framework, it is conducted here a survey study for the purpose of identifying the extent of logistics penetration in the pharmaceutical companies suppliers of drugs in Greece.

This study has certain advantages and limitations. The sample size is relatively high, as the sample includes twenty five (25) pharmaceutical companies of a total of 102 pharmaceutical companies, representing over 90% of total sector revenues (IOBE, 2008). Ten (10) of the companies included in this study are in the first sixteen (16) places in the global market and fourteen (14) are in the first twenty places in the Greek market.

The study was conducted through a questionnaire of 18 questions regarding the following issues: infrastructure and use of outsourcing logistics in relation to strategy and performance, automation and procurement. The information was collected in mid 2006-mid 2007 from the following pharmaceutical companies.

**Table 2 List of the pharmaceutical companies included in the survey**

a/a	Company
1	ABBOTT LABORATORIES HELLAS ABEE
2	ASTRA ZENECA S.A. HELLAS
3	BAYER ΕΛΛΑΣ ABEE
4	BOEHRINGER INGELHEIM ELLAS
5	BRISTOL-MYERS SQUIBB
6	CANA S.A.
7	CSL BEHRING ΕΛΛΑΣ Μ.Ε.Π.Ε.
8	GALENICA AE
9	GLAXOSMITHKLINE AEBE
10	JANSSEN-CILAG ΦΑΡΜΑΚΕΥΤΙΚΗ AEBE
11	LAVIPHARM ACTIVE SERVICES
12	NOVARTIS (HELLAS) AEBE
13	OMEGA PHARMA HELLAS AE
14	PHARMATHEN S.A. INDUSTRIAL & COMMERCIAL COMPANY
15	ROCHE (HELLAS) AE
16	SANOFI-AVENTIS AEBE
17	SCHERING PLOUGH
18	SERONO HELLAS AE
19	UCB AE
20	BIOSER A.E.
21	GENESIS PHARMA S.A.
22	KORES S.A.
23	MINERVA S.A.
24	GEROLYMATOS
25	PHAMAR

The analysis of the collected data in terms of descriptive statistics is summarized in the following results:

- **The Logistics organization:** 94% of the staff members have expressed in principle the view that an organized Logistics department has to be included in strategic priorities and only 6% of them perceive Logistics solely as a routine function.
- **Logistics Outsourcing (3PL):** Larger proportion (56%) of the interviewed companies have declared that they conduct the warehousing and distribution 'in house', in own (31%) or rented installations (25%). The 44% has subcontracted outsourcing servicing (3PL). However, a number of smaller size companies have adopted 'in house' logistics, while one company of the sample operates as a 'pre-wholesaler', providing logistics services beyond production. It is anyhow noted that most companies that have installed own or rent installations preclude proceeding to 3PL in the foreseeable future.
- **Main advantage of 3PL Warehousing:** The benefits from assignment of the warehousing in third parties are similarly distributed, mainly cheaper warehousing services (38%), capital saving and possibilities of investing in other outlets (31%), focus in 'core processes', etc.
- **Cost of assigning 3PL warehousing services:** The cost of 3PL warehousing is perceived to include the lack of control of the warehousing conditions (38%), which is important in view of the sensitivity of pharmaceutical products, the lack of specialized in pharmaceuticals 3PL companies (25%), the delays in customer service (25%) and the insufficient store management, while 6% had not declared any reservation in outsourcing choice. In effect, none pharmaceutical company considers the 3PL services as high cost (answer to alternative question), but almost all companies perceived defective the quality of services supplied, e.g. delays, bad management, lack of experienced staff, impossibility of any control, etc.
- **Use of 3PL in Distribution:** A noteworthy observation is that the pharmaceutical companies put under consideration the issue of distribution assignment to outsourcing following their decision of warehousing management, assessing it as secondary strategic importance. Any how, the big majority of Greek pharmaceutical companies do not use own fleet in the distribution of their products (71% in the greater Attica area), while all companies make use of agents for the distribution in the provincial country.
- **Assessment of the distribution outsourcing:** The assessed main advantages of outsourcing were the release of capital in transportation means (62%), the possibilities of focusing in 'core processes' (25%) and the cheaper cost of transport services (13%). These advantages overbalance the 'cost' of distribution outsourcing, which is assessed to include the impairment of quality and the impersonal service (57%), the lack of modern transport means for pharmaceutical products (19%), the impossibility of immediate control of the process and the channels of distribution (6%) the damages and returns (6%) and the information leakages (6%), while only the 6% of pharmaceutical companies consider defective the distribution process.
- **Cost and computerization of Logistics:** The cost of orders and of warehousing is significant in the pharmaceutical sector (Pantazis, 2005). The big majority of interviewed companies use ERP program (68%), a small proportion of them uses WMS (13%) and some use combined ERP + WMS (19%). It is inferred that no extensive use has been yet of specialized computer programs for the warehousing management, such as the WMS. Mostly, ERP systems support the movements to and from the store, but do not offer detailed design and following-up as WMSs concerning internal handling process and positions and systems. The computerized support of warehouses, according to staff of the interviewed pharmaceutical companies, contributes chiefly for reduction of faults and for the speed of the warehousing processes (88%).
- **Procurement and orders' processing:** Almost all pharmaceutical companies of the sample (94%) evaluate their suppliers from the time of response to orders and the conformance in quantity and quality. However, just the 6% has developed close and trusting connection with their suppliers, considering unnecessary the evaluation in this area. The communication of the sector's companies and the putting of orders is conducted through Fax (53,8%), via e-mail the 11,8%, via ERP the 11,7% and by telephone the 10,3%, while the 12,4% had not revealed this information. It is shown therefore that the new technologies have not yet reached the Greek pharmaceutical companies, in part possibly as considering past practices as more personal and friendly. Thus, the majority of these companies (62%) make rare use of the internet tools and facilities for searching new suppliers, while 19% do not use it at all and the rest 19% makes exclusive use of internet for this purpose.

A model of the following form of using 3PL services was build-up and tested:

$$3PL = a_0 + a_1 WSD + a_2 DSD + a_3 DSP + a_4 IPS + e_i$$

where:

3PL, for use of 3PL services

WSD, for main feature of use of warehousing 3PL services

DSD, for main negative feature of use of distribution 3PL services  
 DSP, for main positive feature of use of distribution 3PL services  
 IPS, for using internet facilities in search of suppliers

For the estimation of the depended variable 3PL for a pharmaceutical company the Logistic Regression method was applied with the above independent variables concerning the use of 3PL services. The Lickert scale was used with '1' for the main characteristic of each variable and '0' for its refusal or not answering. The dependent variable also takes the value '1' for use of 3PL services and '0' for not use of 3PL services by a pharmaceutical company. The main regression results are outlined in the following table:

**Table 3 Estimated regression results**

Variables' Parameters	Estimated Parameter
$a_1$ for WSD	3,5* (2,759)
$a_2$ for DSD	-7,254** (4,333)
$a_3$ for DSP	2,288*** (1,303)
$a_4$ for IPS	-3,109** (4,055)

symbols \*\*\*, \*\*, \* for statistical significance at 1%, 5% και 10% respectively

The main quantitative results of this survey research are summarized as follows:

The parameter of the WSD is positive and statistically significant at 10% level, which means that warehousing 3PL services have positive influence in using such services. Moreover, the coefficient of DSD, for main negative feature of use of distribution 3PL services, is negative and statistically significant at 5% level, implying that the pharmaceutical company which considers negative the 3PL services because of impossible exercising of direct control, avoids using them. The positive coefficient of DSP, of use of distribution 3PL services, at 10% level considers positive the 3PL services chiefly because of 'freeing capital'. In addition, the use internet services for procurement by a pharmaceutical company, reduces the probability of using 3PL services.

In brief, these results indicate that the Greek pharmaceutical companies have as main criteria of using 3PL services the warehousing services and the freeing capital, which however reduces exercising direct control and the alternative use of internet services for the procurement. It means dominance of lack of understanding and awareness of the role of 3PL and more broadly the perception of the supply chain strategy, for achieving sustainable competitive advantage. The research of the logistics infrastructure and the education in logistics have substantiated such a situation. Although the supply chain of the pharmaceutical products is critical for the social health, in the majority of the pharmaceutical companies the responsibility of the warehousing and distribution processes remain in the responsibility of the general management. Of course, in consideration of the 'economies of scale' in production and distribution, have pushed a number of pharmaceutical companies and a number of services companies in mergers and collaborations, with main aims the cost reduction and the capital saving.

Comparison of advantages and disadvantages of the 3PL in warehousing and distribution, in the framework of the results of this study, main disadvantage has been considered the loss of direct control (44%) and main advantage the freeing of capital (40% on average) in combination with the basic production functions (average 24%).

## 6. Main concluding remarks

In this paper has been attempted to erase a series of misconceptions concerning the quality of outsourcing (3PL) through ascending qualitative technical support to induce initiatives for strategy forming at network supply chain level, and mobilization of all available resources. Participative action research based on the triangular integration approach for strategy formulation (at technocratic, corporation and state policy level) can be useful in the case of the Greek pharmaceutical sector. It may help to reveal a series of hindering factors to strategy formulation for acquiring sustainable competitive advantage, such as the relatively high returns and rising drugs demand due to rise in income and aged population. Helpful to this goal is the

identification of a series of special characteristics of the pharmaceutical sector to facilitate the supply chain analysis of this sector. Moreover, useful are assessed the presentation of the distribution network structure and a survey study of the logistics outsourcing conducted in the Greek pharmaceutical sector. Actually, the results of this research have shown a number of developments in the correct direction, but self-complacency deprives the sector from the potential benefits of SCS for attaining sustainable competitive advantage, due to lack of knowledge, understanding and mistrust. Thus, although the pharmaceutical companies which use 3PL in warehousing and distribution have higher market shares, the main criterion has been the capital saving. This, along with the restricted action in the area of pharmacies' cooperatives, is indicative of big possibilities of use of integrated logistics strategy to succeed sustainability of the Greek pharmaceutical sector.

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# THE FARM SIZE, THE USE OF THE RESOURCES FOR AGRICULTURAL PRODUCTION AND THE IMPORTANCE OF THEM TO THE REGIONAL DEVELOPMENT IN GREECE IN 1981

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## Abstract

*The agriculture in Greece was and continues to be an important economic and social sector. This paper examines the basic role of agriculture in the regional economic development in Greece through the use of principal component analysis (PCA) and the SPSS package. Determinants of the differential development rates of the regions and provinces (nomos in Greece) are identified. The basic variables such as per capita output, output per hectare, farm labour size, rented land, farm size inequality etc. and the components such as productivity of the farm, inequality degree of trading that influences the RED in the regions and provinces (nomos in Greek) are analysed. The results indicate that where the agricultural farms are operated in the traditional family way without dynamic cultivations or cattle-breeding, they are in a disadvantageous position with respect to those regions and nomos where the agricultural farms are operated in an enterprising way, high degree of trading, modern technology, dynamic cultivations and good organization. In the regions and nomos with traditional agriculture, the structure in general is low and the rate of development is low also, where the more modern regions have a better structure, the rate of development is good, the per capita regional income is high and other economic and social indexes are also high.*

## 1. Introduction

Greece is a regional country of the European Economic Community (EEC) with special problems (Manolopoulos 1983,1992, 1990 Report). Greece has the lowest per capita income and the highest percentage of occupation in the original sector (Agriculture, forestry, fishery) than the other countries. The labour force in the original sector is 1.037.000 or 28,9% of the total labour force (1) (EEC, Report 1986). In 1983 according to the same report Greece had farms with the smallest average physical size, equal to 4.1 hectares.

Agricultural participation in the Gross National product (GNP) was 16,8% in 1984, which was the highest in the EEC. Yet in 1985 Greece had the highest percentage of participation in Agricultural product of the total exports (29%) (Manolopoulos 1983,1992 EEC report, Markogiannakis 1986).

Consequently, the importance of Agriculture in the development of Greece is obvious and in the future. Agriculture will continue to play an important role in the development of Greece.

The role of Agriculture in RED in Greece and the basic factors and variables are examined in this paper. In the first part the historical analysis of Greece after 1821 AD is introduced and the evolution of factors which operated in the historical process and contributed to the Agriculture frame and Regional Economic Development in Greece are examined. Thereafter an empirical analysis is used to examine the relationship between the Agriculture sector and RED by the method of principal component analysis (PCA). (Johnston 1960, Rummel 1974, Harry 1976, Koutsogiannis 1984).

## 2. Historical-review of agriculture and red in Greece

In 1821 the total Greek population was 3 million according to Zurien (Zographos 1983). At the same time in Greece were living 111.340 Turks. The ratio was 13 3/4 Greeks to every Turk. In 1828 the Greek population was reduced by 28%. From the rest that survived the revolution 400.000 were living in Peloponissos, 172.000 in Evia and Sterea Ellada and 176.6000 in the islands. The freed territory was estimated to be 48.593.000 Stremmata (note: 10 stremmata = 1 hectario), 22.220.000 of which were in Peloponissos, 24.078.000 in Sterea Ellada-Evia and 2.315.000 in the Kyclades. The population density was higher in the islands than in Sterea Ellada. (Peloponissos 22,75 people/km<sup>2</sup>, Sterea Ellada-Evia 11,75 people/km<sup>2</sup>, islands 80,5 people/km<sup>2</sup>).

After Greece achieved independence in 1828, it attempted to apply the same legal system of Germany and Russia. This brought opposition from the peasants. The prime minister Kapodistrias, could not solve the

problem of the distribution satisfactory of farms that were occupied by Turks, to the Greek people. The farmers were the majority of the population. There were also merchants, shepherds, artists and in the islands sailors. The national farm property was important. Out of 8.541.586 of the total cultivated soil the national land was 70,5% and the rest private. The distribution of the cultivated national land was achieved under the laws (L. 10/2/1832 – L. 24/6/1843 – L. 20/2/1848 – L. 6/10/1856).

The government of Komoundouros introduced some agricultural reforms (L. 25/3/1871). In 1879 there were 254.000 farms that were run by farmer families. In 1881 Thessalia and Ipiros were freed and the National farms increased to 265.000. The average distribution farm size was from 20 to 80 stremmata. In 1909 the military coup in Goudi brought prime minister Eleftherios Venizelos to power. He applied agriculture reforms and distributed large farms (tsiflikia) to those without property. In 1912 the first Agricultural cooperative was established. In 1912 and 1913 the two Balkan wars freed Thessaloniki, Ioannina, Hics, Samos, Mitilini, Crete. Because of the war between Greeks and Turks in 1922, 1.500.000 refugees came from Minor Asia to Greece and the population grew to 6.204.674 to 1928. At the same time the farm land increased. To these refugees 12.000.000 stremmata of earth were distributed. Of those, 6.730.000 were cultivated by 130.000 farm families. The farm land of each family was usually divided and the divisions were separate from each other and therefore mechanisation was difficult and productivity low, while the debt to the Agricultural Bank of Greece was growing. Life in rural regions was bad and the majority of the farmers emigrated abroad, mainly to the U.S.A. (Glytsos 1988, Manolopoulos 1992). The Second World War 1940-1944 had catastrophic consequences for Greece and especially for rural regions. 7% of the Greek population died and agricultural productivity lowered by 70%. Many villages were desolated, navigation was decreased by 70%, means of Communication were almost not existed, coinage was almost totally debased. Help from abroad in the period 1944-46 was 4.600.000 dollars. 4.000.000 \$ of this came from the U.S.A. but only 21% was invested development of the country toward. In the next years, until 1970 the rural population was decreased because of emigration to the urban centres, of Athens and Thessaloniki and also abroad, mainly to West Germany. The city population increased while a small decrease in the small farms and a small increase in the large farms were observed. (National Statistics Service of Greece 1961, 1971, 1981) (NSSG).

### **3. The role of agriculture to RED**

There are nine regions in Greece. These are Sterea Ellada and Evia, Peloponnissos, Ionian Islands, Epirus, Thessalia, Macedonia, Thrace, Aegean Islands, Crete. Every region is divided to smaller sub-regions, the provinces (nomos in Greek). Based on this classification the regional development programmes are implemented and collection of valid statistical materials and other information is made. In recent years some regions, i.e. Crete, began to apply the Mediterranean integrated programmes (MIP). The regions have several differences, i.e. per capital income product, and other indexes that determined the rate of development and the conditions of life. (Alonso 1968, Friedman 1966, Hirschmann 1958, Richardson 1972, Myrdal 1957). The first region according to population is Attica where over 1/3 of the total Greek population lives. The Second region is Macedonia and Peloponnissos and Thessalia; follows next (National statistic services of Greece, 1961, 1971, 1981) (NSSG). The synthesis of population is different between the regions. Attiki has a mainly urban population, while in Epirus and other regions rural population is dominant. The role of agriculture in regional economic development has a different importance between the regions (Griffin 1974, Mellor 1967, Soonrane 1988, Lapping, Faister 1982, Bachman, Christensen 1967). Agriculture contributed 15,9% to the GNP in 1981. The Eastern part of the Sterea Hellada and Cyclades regions contributed 4,6%, the central and the western part of Macedonia region 20,7%, the Peloponnissos, Thessalia and western part of Sterea Hellada regions 31,1%, the eastern part of Macedonia region 32,4%, the Crete 27,7%, the Epirus 24,4%, the Thrace region 36,9% and the Aegean islands region 14,4% (Centre of planning and economic research "KEPE" 1986, NSSG 1961, 1971, 1981). All regions except East Sterea Hellada, Cyclades, central and western Macedonia and the Aegean islands regions have over 50% of their population active in agriculture. The region of Attiki has 60% of the export trade, 47% of the industrial employment, 65% of the services, 85% of the dynamic companies. This centralisation has caused serious problems in the region of Attiki and the rest of the country as well. There is an unbalanced regional economic development. It is a phenomenon that has been explained in analogous conditions and by others researchers (Hart 1977, Lee 1989, Brown, England, Goetz 1989, Brown, Brewer, Boxley, Beale 1982, Dignan, Haynes, Conway, Strestha 1989). This urbanisation mainly in Athens (Attiki) and secondly in Thessaloniki causes other problems, such as unemployment, pollution, traffic, deteriorating life conditions. The other regions and especially the

mountainous and semi-mountainous rural regions lost their precious work force, which could offer to have a balanced development. (Manolopoulos 1985,1992)

#### 4. Empirical analysis

In the following part of this paper the relationship between Agriculture structure and rural economic development is examined. The important variables that contribute to the development of the Greek rural region, i.e. the size distribution of the agricultural farms, the per farm hectare, the per capita output is determined. The differences between the regions are also examined. The method of principal component analysis (PCA, Johnston 1960, Harman 1976, Rummel 1974, Koutsogiannis 1984, Statistical package social sciences programm SPSS) because of the large number of statistical data is applied. The sources of information are the national statistical service of Greece (NSSG), the Agricultural bank of Greece (ABG) and the National Center for programming and research (KEPE 1981). The aforementioned important variables are:

- 1) per capita output,  $X_1 = \frac{\text{total agricultural output value}}{\text{farm population number}}$
- 2) output per hectare,  $X_2 = \frac{\text{total agricultural output value}}{\text{farm land hectare}}$
- 3) farm output size,  $X_3 = \frac{\text{total agricultural output value}}{\text{farm units number}}$
- 4) farm physical size,  $X_4 = \frac{\text{farm land hectare}}{\text{farm units number}}$
- 5) farm labour size,  $X_5 = \frac{\text{number of farm workers}}{\text{farm units number}}$
- 6) private land,  $X_6 = \frac{\text{hectareage of privately owned farm land}}{\text{farm land hectare}}$
- 7) rented land,  $X_7 = \frac{\text{hectareage of rented land}}{\text{farm land hectare}}$
- 8) waged labour,  $X_8 = \frac{\text{number of waged farm workers}}{\text{number of farm workers}}$
- 9) live stock share,  $X_9 = \frac{\text{live stock output value}}{\text{total agricultural output value}}$
- 10) farm size inequality  $X_{10} =$  This is the Gini coefficient

Three methodological aspects must be given particular attention. First is the calculation of private and rented land. Private land belongs to physical and legal persons. The majority are physical persons. They do not work their farms for several reasons (age, illness, immigration, preference to have another work in a different field other than agriculture). Contracts are made on the basis of trust bad relationship, friendship, neighborhood etc. and are usually by word of honour rather than legal, written contract. Some times the contract is in writing as an official contract or unofficial agreement. The period under rent differs but usually is from 2-5 years. The reward is in money or in kind (Morts or mesiako) and the rent depends on the fertility of the land, type of cultivation distance from the village or street and whether the farm is plan, mountainous or in-between. The tenants give to the owners part of the product (35%-50%) if the contract is in kind (Manolopoulos 1983, 1985). In cases where the owner is a legal person (public municipality or church) the reward in kind is about 20-25%. The second important aspect is the variable waged labour,  $X_7$ . The calculation was made according to NSSG (table VIII-5). According to this table farm is run by the other owners and other workers. It is assuming that Persons belonging to the same family, who help their farmer father, in several works, i.e. plowing, irrigation, digging, harvesting etc., we assume that are not being paid. It is assumed that of the total number of the seasonal workers in agriculture, half of them work for the entire year and the other half is not employed at all. The third point is the estimation of the farm size inequality. There are several indices, i.e. the Gini coefficient, the Theill index, the standard deviation of logarithms of the land/farms ratio, the coefficient of variation = standard deviation/mean etc.

It is applied the Gini coefficient ,  $G$ , in the form:

$$G = \frac{E_{\text{Lorenz}}}{\frac{1}{2} 100 * 100} = \frac{E_{\text{Lorenz}}}{5.000}$$

$$\text{and } E_{\text{Lorenz}} = \frac{1}{2} \left[ \sum_{i=1}^{k-1} X_i Y_i + 1 - \sum_{i=1}^{k-1} X_i + Y_i \right]$$

where L = number of classes, El = area of lorentz

X<sub>j</sub> = distribution of frequencies of the number farms

Y<sub>j</sub> = distribution of frequencies of the total farm area (hectares)

Table 1 shows the mean and the standard deviation of the ten variables (X1, X2, X3,.... X10), while table 2 shows the correlation coefficient of these variables. As it is seen from table 2 there is a high positive conflation between the variables per capita output (X1) and farm output size (X3) and smaller positive correlation between output per hectare (X2) and farm output size (X3). There is a low negative correlation between the variables in the following pairs: per capita output (X1) and live stock share (X9), farm output size (X3) and live stock share (X9), per capita output (X1) and private land (X6), farm output size (X3) and private land (X6), farm physical size (X4) and private land (X6). There is a maximum negative correlation between the variables private land (X5) and rented land (X6). Tables 3 and 4 show the component variance (Eigenvalues) and communalities of the components. As it is seen from tables 3 and 4 the first four components (factors) represented 63.7% of the total variance. The first has eigenvalue (component variance =CV) 3.59031 or 35.9% of the total component variance=TCV. The second has CV=2.20740 or 22% of the TCV. The two first components have 56% of the TCV. The third has CV=1.4161 or 14.2% of the TCV. The sum of the first three components is 72,2% of the TCV. The fourth component has CV 1.15274 or 11.5% of the TCV. The rest six components have CV lower than 5.9% or 16.3% of the TCV.

We applied and combined two tests. The first test is the eigen value test and second is the screen test. Then it is keeping the four first components because according to first test they have eigenvalue larger than one (1) and according to the second test the eigenvalue line tends to become parallel to the horizontal axis (x), as it is seeing from figure 1. Table 5 shows the component loadings. These four components are named respectively:

- 1) Productivity of the farm P1
- 2) Proportion of the rented farm P2
- 3) Inequality degree of trading P3
- 4) Per hectare output farm physical size P4

The four components according of the naming of the variable or variables that have the larger loading in this component are named. Identification of these components requires the examination of their loadings on the original variables (Shown in table 5). As we see, the first component is heavily loaded against the variables: Farm output size (X3), per capita output (X1) and live stock share (X9). The first component is positively correlated with the other variables: Rented land (X7), waged labour (X8), farm labour size (X5), output per hectare (X2) and farm physical size (X4), while it is negatively correlated with the variables private land (X6) and farm size inequality (X10). The second component is heavily loaded against the variables rented land (X7) and private land (X6). This component is positively correlated with the variables:

Farm output size (X3): per capita output (X1), live stock share (X9), farm size inequality (X10), farm labour size (X5), output per hectare (X2) and farm physical size (X4), while it is negatively correlated with the variables waged labour (X8), private land (X6). The fourth component is heavily loaded against the variables: output per hectare (X2) and farm physical size (X4). This component is positively correlated with the variables: Farm output size (X3), per capita output (X1), live stock share (X9), private land (X6), farm size inequality (X10) and farm labour size (X5), while it is negatively correlated with the variables: farm physical size (X4), waged labour (X8) and rented land (X7). From table 6 we are calculated the normalized scores on the four main components for each nomos of Greece (see table 7). Then the spatial distribution of the principal component scores (see Maps 1, 2, 3, 4) are analyzed. It becomes evident from table 7 and from the maps 1, 2, 3, 4 that the first component productivity of farms (P1) has the higher scores in nomos Imathia, Larissa, Karditsa, Pella and Biotia, while the lowest scores have the nomos Samos, Thesprotia, Dodekanisos, Hios and Evritania. Larger regions such as Macedonia and Thessalia have the highest scores while the Aegean islands (Dodekanisa, Kyklades, Lesvos, Samos, Hios) and Epirus have the lowest scores. The nomos with the highest scores of P1 principal component have the highest scores in the variables: farm output size (X3) and per capita output (X1), while have a small live stock share (X9) score. On the other side the nomos with lowest principal component scores have the lowest scores in the variables (X1) and (X3), the third variable (X9) is high. The second component (P2) proportion of the rented land has the highest scores in the



nomos Drama, Serres, Kavala, Kozani, Xanthi, while the lowest scores were in the nomos Iraklio, Messinia, Lasithi, Lefkada and Corfu (Kerkyra). Larger region such Macedonia has the highest scores, while the lowest scores the regions of the Ionian islands, the Aegean islands and Crete. The explanation of these results are attributed to the fact that in the aforementioned nomos with the highest scores the cultivation of tobacco, natural or artificially irrigated, covers a high percentage of cultivated land. This fact in combination with the high proportion of immigration to western Europe, the difficulty of an alternative cultivation, the supply of agricultural work by the family members, the structure of agriculture (small and scattered cultivated land) and the high demand for a labour force in the tobacco plants, forces the majority of the agricultural families to rent the area of the agricultural land of their neighbours. The nomos with the lowest scores are characterised by farmers that cultivate agricultural land their own. Additional income come from tourism. Tourism was developed recently in these nomos (mainly islands) and the villagers are employing in services for tourism during the summer period. The third component (P3) iequality degree of trading has the highest scores in the nomos of Halkidiki, Attiki, Biotia, Evia, Larissa, while the lowest scores in the nomos Rodopi, Florina, Evritania, Arkadia. Speaking in larger territories the highest scores belong to the Sterea Ellada and East Thessalia regions, while the lowest scores belong to the east Thraki, central Pelloponissos and west Macedonia regions. In the nomos with the highest scores there are two kinds of owners (dualism). The very few that have large area of agricultural land and the majority that have small and scattered area of agricultural land. The existence of a two sector agriculture has been explained as a result of bimodal strategies of agricultural development (Johnston and Kilby). This is owned to historical and other reasons. In Attiki which is the largest urban center of Greece, cultivation is done by corporations that employ the work force. In the nomos with the lowest scores agriculture continues to operate a high degree in the traditional way and the proportion of working force population in agriculture is high. The fourth component per hectare output-farm physical size (P4) has the highest scores in the nomos Ioannina, Attiki, Preveza, Kavalla, Pella, while the lowest scores in the nomos Grevena, Halkidiki, Arcadia, Kilkis and Evros. The main characteristics of the nomos with the highest scores are cultivations with high productivity per hectare or animal breeding and are well organized. They have fruit trees, wines, poultry farms, cow-farms and pig-farms. The nomos with the lowest scores have traditional agriculture without modern technology and some of these are mountainous and isolated regions. In conclusion, the regions and nomos where the agricultural farms are operated in the traditional family way without dynamic cultivations or cattle breeding are in a disadvantaged position with respect to those regions and nomos where the agricultural farms are operated in an enterprising way with high degree of trading, with modern technology, with dynamic cultivations, with cattle-breeding and good organisation. In the regions with traditional agriculture the structure in general is low and the rate of development is low too, while the more modern regions have a better structure, the development is good, the per capita regional income is higher as well as other economic and social indexes. It is important to apply rural planning in developing countries to be improvement the access of rural populations to a range of urban functions.(Belsky, Rondinelli, Rietveld).

## 5. Conclusions

1. Agriculture in Greece after 1821 was the main (basic) economic and social sector and farmers were the majority of the population. There were also merchants, shepherds, artists and island sailors.
2. The national land was 70,5% while the private 29,5%. During the years the state made agricultural reforms and distributed large farms (tsiflikia) to these without property.
3. Living conditions in rural regions were bad and the rural population was decreased because of emigration to the urban centers, mainly in Athens, Thessaloniki, abroad mainly to western Europe, USA etc.
4. There are nine geographical and administrative regions in Greece. Every region is divided in smaller subregions (nomos). The "nomos" in Greece were 51 (52 with Agion Oros).
5. Regions and nomos have several differences in per capita income, regional products, productivity and other indexes, that determined the rate of development.
6. Over of 1/3 of the total Greece population is living in Attiki. Attiki has over 60% of the export trade, 47% of the industrial employment, 65% of the services, 85% of the dynamic companies etc. This centralisation has caused serious problems in the region of Attiki as well as to the rest of the country.
7. The role of agriculture in the regional economic development differs in importance. Agriculture contributed 15,9% to the GNP in 1981. The eastern part of the Sterea Ellada region and the Cyclades region contributed 4,6%, the Central and Western part of Macedonia region 20,7%, Pelloponissos, Thessalia and the Western Sterea Ellada regions 31,1%, East Macedonia region 32,4%, Crete region 27,7%, Epirus region 24,4%, Thraki region 36,4% and Aegean islands region 14,4%. An economic integration to the EEC and a common market will operate at the end of 1992. That means that the competition will increase among the countries, the regions and the corporations. It is necessary to improve

the structures of the economy, the investments and to create opportunities for new jobs especially for young people, and generally to apply an essential decentralization to the regions and nomos. 8. There is relationship between agricultural structure and rural economic development. 9. We determine the important variables that contributed to the development of the greek rural regions. There are: the per capita output, output per hectare, farm output size, farm physical size, farm labour size, private land, rented land, waged labour, live stock share and farm size inequality. 10. We apply the method of PCA and SPSS program, determine and evaluate the components: productivity of farm P1, proportion of the rented land P2, inequality degree of trading P3 and per hectare output-farm physical size P4. 11. The regions and nomos where the agricultural farms are operated in the traditional family way without dynamic cultivation, cattle breeding is in a disadvantaged position with respects those regions and nomos where the agricultural farms are operated in an enterprising way, a high degree of trading with modern technology, dynamic cultivations, cattle breeding and good organisation. 12. An unbalanced regional economic development exists. In the regions with traditional agriculture, the structure generally is low and the rate of development is low too, while the modern regions have a better structure .development is good, the per capita regional income is higher and other economic and social indexes are also high. 13. The problematical regions in Greece are mainly the mountainous and semi-mountainous rural regions. These regions have lost the precious work force, especially young people who could contribute to the development of the regions and to a balanced development. Thraki and Epirus are considered the poorest regions in the EEC. 14. Except for agriculture that will continue to be a basic sector in these regions, the agricultural industries must also be developed. 15. The development of tourism in these regions will help regional economic development, but we must be very careful because in the Aegean and Ionian islands, disorganised tourism has created ecological and other problems.

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## Tables

**Table A: Data used in the principal component exercise**

a/a	PCOUT X1	PHOUT X2	PFOUT X3	PFHEC X4	PFWOR X5	PRILAN(%) X6	RENTED X7	LABOUR X8	LIVES X9
1	148104.05	16900.28	428828.83	25.37	1.34	82.84	17.16	7.67	27.45
2	250491.26	13951.92	345097.17	24.73	.48	87.24	12.76	8.25	53.09
3	257024.46	11890.78	591575.03	49.75	.71	25.98	14.02	6.56	21.62
4	128023.95	12768.72	368605.46	28.87	.57	92.87	7.13	11.44	63.61
5	52975.52	10153.16	218837.34	21.55	1.04	89.94	10.06	3.73	66.68
6	153556.35	8850.87	433061.49	48.93	.98	87.94	12.06	7.10	24.03
7	57589.83	7782.79	196934.78	25.30	.76	88.26	11.74	6.61	56.76
8	174785.52	14360.26	565548.60	39.38	1.13	90.63	9.37	4.90	18.71
9	89292.17	6420.24	312219.50	48.63	1.12	88.55	11.45	5.50	44.55
10	136186.12	12790.37	434366.89	33.96	.97	92.75	7.25	4.15	25.46
11	125403.16	10083.61	393198.11	38.99	1.07	85.68	14.32	8.83	23.25
12	186564.92	16133.53	579050.91	35.89	1.03	92.11	7.89	6.15	28.68
13	121896.35	9969.40	357350.84	35.84	.98	89.46	10.54	9.38	20.82
14	146382.51	11124.08	385347.52	34.64	1.09	94.29	5.71	10.36	25.32
15	110881.02	16614.43	407294.63	24.51	1.17	88.53	11.47	5.67	22.82
16	71978.03	15703.79	251569.31	16.02	.94	96.45	3.55	2.21	27.66
17	64290.26	11220.42	252113.77	22.47	.70	82.24	17.76	6.35	43.68
18	67531.81	9118.66	208718.42	22.89	1.10	95.24	4.76	4.35	26.38
19	96611.71	17808.85	332095.41	18.65	.97	91.89	8.11	4.41	34.97
20	57120.60	7726.10	233358.15	30.20	.82	86.62	13.38	3.21	69.84
21	83788.75	19848.59	370452.34	19.35	.81	85.96	14.04	6.01	72.07
22	120127.96	17920.94	471958.96	26.34	.95	84.12	15.88	6.12	56.18
23	198765.52	15574.67	636305.31	40.86	1.52	81.31	18.69	8.80	23.70
24	254543.74	10984.66	625536.52	56.95	.96	79.38	20.62	14.38	26.23
25	135399.10	7960.41	289284.37	36.34	.71	84.41	15.59	6.11	30.94
26	143487.82	17318.38	477852.52	27.59	1.21	83.01	16.99	7.52	40.56
27	97041.37	5336.50	334975.09	62.77	.83	76.12	23.88	7.23	38.18
28	180728.18	13234.24	558551.60	42.21	1.20	45.27	54.73	3.70	32.20
29	252164.32	21076.54	651408.70	30.91	.87	70.16	29.84	13.79	15.77
30	229407.62	12535.85	521811.78	41.63	.81	67.60	32.40	8.12	36.78

a/a	PCOUT	PHOUT	PFOUT	PFHEC	PFWOR	PRILAN(%)	RENTED	LABOUR	LIVES
31	152170.42	19104.67	573085.46	30	1.06	64.58	35.42	4.78	21.45
32	94436.38	7668.10	345615.54	45.07	.78	67.71	32.29	3.89	39.34
33	142749.43	8340.75	481389.74	57.72	.90	66.55	33.45	8.93	32.65
34	116217.85	9197.20	423414.55	46.04	.72	65.61	34.39	7.20	32.76
35	236129.14	20297.14	687242.67	33.86	1.21	69.81	30.19	4.07	23.49
36	176936.70	16991.31	537252.64	31.62	1.25	69.67	30.33	3.45	22.90
37	172221.36	14284.04	559204.64	39.15	1.37	61.20	38.80	7.80	30.93
38	122352.92	9220.56	507987.59	55.09	1.14	72.76	27.24	1.88	38.89
39	101518.45	5226.69	295396.32	56.52	.60	66.98	33.02	21.78	32.77
40	178085.19	9378.61	511627.96	54.55	1.06	76.01	23.99	5.03	29.26
41	143249.37	14349.20	488125.86	34.02	1.52	70.98	29.02	2.18	31.44
42	149505.65	11002.63	447472.30	40.67	1.50	82.06	17.94	2.95	31.42
43	76671.38	10585.13	253914.05	23.99	.46	76.13	23.87	7.05	52.51
44	62020.34	8355.46	293623.26	35.14	.79	76.15	23.85	4.04	51.55
45	70052.43	6519.59	183763.41	28.19	.74	77.95	22.05	10.20	52.63
46	47389.16	8366.01	128887.54	15.41	.59	89.72	10.28	3.52	50.22
47	54228.05	7251.28	153954.71	21.23	.64	80.92	19.08	2.46	36.20
48	158000.71	13147.51	381302.70	29	.95	94.15	5.85	10.34	13.78
49	132246.79	11337.77	301682.47	26.61	.87	91.16	8.84	11.96	22.31
50	89474.54	9316.01	259985.80	27.91	1.21	89.62	10.38	3.92	46.93
51	115670.53	13368.97	314500.49	23.52	.82	93.75	6.25	5.02	32.46
	133009.23	12073.95	399269.39	34.64	.96	81.38	18.62	6.69	35.76

Table 1: Mean and standard deviation of the ten variables (X1, X2, X3,..., X10)

	Mean	Std. Dev.
X1	132989.5098	57690.75750
X2	12071.92157	4096.87927
X3	399269.3922	141474.3872
X4	34.64373	11.90489
X5	.96118	.25671
X6	81.37882	10.89678
X7	18.62118	10.89678
X8	6.68745	3.64688
X9	35.76235	14.40338
X10	.50118	.05501

Number of cases = 51

Table 2: Correlation matrix

Correlation matrix:

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1.00000									
X2	.47139	1.00000								
X3	.85094	.58698	1.00000							
X4	.38534	-.39759	.45912	1.00000						
X5	.24913	.36829	.50665	.12778	1.00000					
X6	-.27505	-.02446	-.43037	-.45539	-.12219	1.00000				
X7	.27505	.02446	.43037	.45539	.12219	-1.00000	1.00000			
X8	.28623	-.08705	.11276	.28721	-.28065	-.06149	.08149	1.00000		
X9	-.52935	-.24223	-.52655	-.29670	-.40790	.09842	-.09842	-.16843	1.00000	
X10	.25203	-.13890	.05911	.15899	-.31845	-.31884	.31884	.28935	.05933	1.00000

Table 3: Component variance (Eigenvalues)

Variable	Communality	Factor	Eigenvalue	Ptc of var.	Cum. Ptc.
X1	1.00000	1	3.59031	35.9	35.9
X2	1.00000	2	2.20740	22.1	58.0

Variable	Communality	Factor	Eigenvalue	Ptc of var.	Cum. Ptc.
X3	1.00000	3	1.41810	14.2	72.2
X4	1.00000	4	1.15274	11.5	83.7
X5	1.00000	5	.59235	5.9	89.6
X6	1.00000	6	.50329	5.0	94.6
X7	1.00000	7	.39688	4.0	98.6
X8	1.00000	8	.11746	1.2	99.8
X9	1.00000	9	.02146	.2	100.0
X10	1.00000	10	.00000	.0	100.0

**Table 4: Communalities and Eigenvalues of the first, second, third and fourth factor (components)**

Variable	Communality	Factor	Eigenvalue	Ptc of var.	Cum. Ptc.
X1	.86553	1	3.59031	35.9	35.9
X2	.94598	2	2.20740	22.1	58.0
X3	.92236	3	1.41810	14.2	72.2
X4	.89725	4	1.15274	11.5	83.7
X5	.75781				
X6	.95849				
X7	.95849				
X8	.70892				
X9	.66965				
X10	.68406				

**Table 5: Component loadings of the first, second, third and fourth component**

*Varimax Rotation 1, Extraction 1, Analysis 1, Kaizer Normalization*

*Varimax converged in 7 iteration*

*Rotated Factor Matrix:*

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
X3	.86930	.37663	-.06479	.14365
X1	.85920	.20278	.25810	.13992
X9	-.78633	.07279	.10947	.18453
X7	.13298	.96423	.04612	-.09454
X6	-.13298	-.96423	-.04612	.09454
X10	-.02642	.36237	.73072	.05652
X8	.31665	-.11755	.72262	-.26955
X5	.51359	.11828	-.69107	.04966
X2	.50909	.02053	-.13619	.81721
X4	.40882	.38568	.08523	-.75770

**Table 6: Factor score coefficient matrix**

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4
X1	.30478	-.03633	.20108	.11176
X2	.14301	.02549	.03545	.58010
X3	.26998	.07197	-.01881	.08990
X4	.14675	.04391	-.05670	-.53258
X5	.15518	.03174	-.43045	-.07038
X6	.09215	-.44946	.04487	.02691
X7	.09215	-.44946	-.04467	.02691
X8	.18322	-.18687	.45089	-.14258
X9	-.32578	.17183	.06251	.20846
X10	-.04817	.15121	.45234	.18072

**Table 7: Normalized scores of the X1, X2, X3, X4,..., X10 variables and of the P1, P2, P3 and P4 components**

a/a*	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	P1	P2	P3	P4
1	1.08	1.18	0.21	-0.78	1.46	.13	-0.13	.27	-.58	.53	.65	-.14	-.16	.99
2	2.04	.46	-.33	-.83	-1.85	.54	-.54	.43	1.20	2.16	-.14	-.21	2.54	1.60
3	2.15	-.04	1.36	1.27	-.96	.42	-.42	-.04	-.98	2.16	1.34	-.87	1.68	-.13
4	1.09	.17	-.22	-.48	-1.50	1.05	-1.05	1.30	1.93	.35	-.59	-.88	1.62	.67
5	-1.39	.47	-1.29	-1.10	.31	.79	-.79	-.81	2.15	-1.84	-1.56	-.56	-1.34	.24
6	.36	-.79	.24	1.29	.08	.60	-.60	.11	-.81	-.02	.64	-.87	-.02	-1.28
7	-1.31	-1.05	-1.43	-.98	-.77	.63	-.63	-.02	1.46	-.02	-1.53	-.45	.23	-.12
8	.72	.56	1.18	.40	.65	.85	-.85	-.49	-1.18	-.20	1.24	-.79	-.47	-.02
9	-.76	-1.38	-.62	1.18	.62	.66	-.66	-.33	.61	-1.65	-.38	-.66	-1.32	-1.79
10	.06	.17	.25	-.06	.04	1.04	-1.04	-.70	-.72	.53	.38	-.83	-.03	.15
11	-.13	-.49	-.04	.37	.42	.39	-.39	.59	-.87	-.02	.46	-.60	-.01	-.82
12	.93	.99	1.27	.11	.27	.98	-.98	-.15	-.49	.35	1.12	-.79	.22	.64
13	-.19	-.51	-.30	.10	.08	.74	-.74	.74	-1.04	-.38	.44	-1.06	.07	-.84
14	.23	-.23	-.10	0	.50	1.18	-1.18	1.01	-.73	-.93	.77	-1.52	-.08	-.68
15	-.38	1.11	.06	-.85	.81	.66	-.66	-.28	-.90	-1.29	.48	-.85	-1.05	.60
16	-1.06	.89	-1.04	-1.56	-.08	1.38	-1.38	-1.23	-.56	-.93	-.46	-1.33	-.93	.99
17	-1.19	-.21	-1.04	-1.02	-1	.08	-.08	-.09	.55	.35	-1.17	-.02	.42	.48
18	-1.14	-.72	-1.35	-.99	.54	1.27	-1.27	-.64	-.65	-.93	-.50	-1.37	-1.04	-.44
19	-.63	1.40	-.47	-1.34	.04	.96	-.96	-.62	-.05	-1.47	-.16	-1.01	-.87	1.20
20	-1.32	-1.06	-1.17	-.37	-.54	.48	-.48	-.95	2.37	-.20	-1.85	.02	-.36	-.05
21	-.85	1.73	-.20	-1.28	-.58	.42	-.42	-.19	2.52	-.02	-1.12	.07	.31	2.17
22	-.22	1.43	.51	-.70	-.04	.25	-.25	-.16	1.42	-.56	-.25	.01	-.16	1.44
23	1.14	.85	1.68	.52	2.15	-.01	.01	.58	-.84	-.56	1.73	-.14	-.77	-.03
24	2.11	-.27	1.60	1.87	0	-.18	.18	2.11	-.66	.89	1.83	-.09	1.57	-1.08
25	.04	-1.00	-.78	.14	-.96	.28	-.28	-.16	-.33	1.07	-.39	-.22	.81	-.53
26	.18	1.28	.56	-.59	.96	.15	-.15	.23	.33	-.75	.45	-.16	-.51	.97
27	-.62	-1.64	-.45	2.36	-.50	-.48	.48	.15	.17	-.93	-.35	.33	-.48	-2.46
28	.83	.28	1.13	.64	.92	-3.31	3.31	-.82	-.25	1.80	.07	3.47	-.14	.50
29	2.07	2.20	1.78	-.31	-.35	-1.03	1.03	1.95	-1.39	-.75	1.98	.29	.99	1.21
30	1.67	.11	.87	.59	-.58	-1.26	1.26	.39	.07	.53	.54	1.17	.85	.16
31	.33	1.72	1.23	-.39	.38	-1.54	1.54	-.52	-.99	.16	.62	1.45	-.40	1.31
32	-.67	-1.08	-.38	.88	-.69	-1.25	1.25	-.77	.25	-.02	-.89	1.29	-.37	-.94
33	.17	-.91	.58	1.94	-.23	-1.36	1.36	.61	-.22	-.38	.27	1.10	-.05	-1.64
34	-.29	-.70	.17	.96	-.92	-1.45	1.45	.14	-.21	.71	-.35	1.36	.50	-.75
35	1.79	2.01	2.04	-.07	.96	-1.06	1.06	-.72	-.85	-1.11	1.52	.93	-.99	1.29
36	.76	1.20	.98	-.25	1.12	-1.07	1.07	-.89	-.89	-.56	.76	.99	-1.09	.82
37	.68	.54	1.13	.38	1.58	-1.85	1.85	.30	-.34	.16	.70	1.71	-.54	.18
38	-.18	-.70	.77	1.72	.69	-.79	.79	-1.32	.22	-.56	-.02	1.05	-1.37	-1.18
39	-.55	-1.67	-.73	1.84	-1.38	-1.32	1.32	4.13	-.21	2.16	-.07	.67	3.05	-2.19
40	.78	-.66	.79	1.67	.38	-.49	.49	-.45	-.45	-1.11	.69	.38	-.92	-1.38
41	.18	.56	.63	-.05	2.15	-.95	.95	-1.24	-.30	1.80	.24	1.42	-.72	.76
42	.29	-.26	.34	.51	2.08	.06	-.06	-1.02	-.30	-.20	.47	.15	-1.44	-.47
43	-.98	-.36	-1.03	-.89	-1.92	-.48	.48	.10	1.16	1.44	-1.57	.69	1.41	.73
44	-1.23	-.91	-.75	.04	-.65	-.48	.48	-.73	1.10	.35	-1.39	.76	-.13	-.29
45	-1.09	-1.36	-1.52	-.54	-.85	-.31	.31	.96	1.17	1.80	-1.49	.42	1.45	-.24
46	-1.48	-.90	-1.91	-1.62	-1.42	.77	-.77	-.87	1.00	-.38	-1.88	-.63	-.03	.36
47	-1.37	-1.18	-1.73	-1.13	-1.23	-.04	.04	-1.16	.03	-.93	-1.59	-.07	-.64	-.27
48	.43	.26	-.13	-.47	-.04	1.17	-1.17	1	-1.53	-.38	.97	-1.60	.43	-.14
49	-.01	-.18	-.69	-.67	-.35	.90	-.90	1.44	-.93	-.56	.39	-1.41	.61	-.32
50	-.75	-.67	-.98	-.57	.96	.76	-.76	-.76	.78	-.02	-.77	-.46	-.78	-.09
51	-.30	.32	-.60	-.93	-.54	1.13	-1.13	-.46	-.23	.53	-.25	-.97	.36	.70

\* PROVINCES (NOMOS) OF GREECE: STEREA ELLADA AND EVIA (1. ETOLIA AND AKARNANIA, 2. ATTIKI, 3. BIOTIA, 4. EVIA, 5. EVRITANIA, 6. FTHIOTIDA, 7. PHOKIDA), PELOPONNISOS (8. ARGOLIDA, 9. ARCADIA, 10. ACHAIA, 11. ILIA, 12. KORINTHIA, 13. LAKONIA, 14. MESSINIA), IONIAN ISLANDS (15. ZAKYNTHOS, 16. KERKYRA (KORFU), 17. KEFALLINIA, 18. LEFKADA) EPIRUS (19. ARTA, 20. THESSPOTIA, 21. IOANNINA, 22. PREVEZA), THESSALIA (23. KARDITSA, 24. LARISSA, 25. MAGNISIA, 26. TRIKALA) MACEDONIA (27. GREVENA, 28. DRAMA, 29. IMATHIA, 30. THESSALONIKI, 31. KAVALA, 32. KASTORIA, 33. KILKIS, 34. KOZANI, 35. PELLA, 36. PIERIA, 37. SERRES, 38. FLORINA, 39. HALKIDIKI), THRAKI (40. EVROS, 41. XANTHI, 42. RODOPI), AEGEAN ISLANDS (43. DODEKANISA, 44. CYCLADES, 45. LESVOS, 46. SAMOS, 47. HIOS), CRETE (48. IRAKLIO, 49. RETHYMN0, 50. LASSITHI, 51. CHANIA)

# THE PALATIAL ACCOUNTING SYSTEM – DISCLOSURES FROM THE HELLADIC BRONZE AGE

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This article is dedicated to the president of PRC Mr. Hu Jintao (胡锦涛) as being most interested in Mycenaean historiography.

## Abstract

The aim of the present paper is to disclose forgotten aspects of the economic history of the Helladic Bronze Age (HBA) in general and the history of economic accounting and administration praxis in part. Those aspects “came” to us via the so many discovered palatial “Linear B” inscriptions drawn on fire-hardened clay tablets. The most famous “Linear B” palaces are those of Knossos, Phaistos (Aghia Triada), Mycenae, Thebes, Pylos and other distributed in the whole Helladic region. But the related disclosed information was first accessible only after the adventurous and most exciting deciphering work of Michael Ventris and John Chadwick. These palatial clay tablets recordings allow us to get deep insights into the capability of the HBA society and economy to solve problems concerning daily (mechanisms of allocation, distribution and collection in form of services, dues, taxes and other liabilities or rights) issues but also to master exceptional issues like warfare, distant trade and an extended Mediterranean Thalassocracy. All those were managed through a palatial administrative system, served by the royal (“wanax”) elite and by an excellent “guild” of scribes, using a standardized administration (accounting, measurement, weighing and recording) system.

Keywords: Accounting History, Bronze Age, Palace Administration, Linear B

## 1. The Deciphering of Linear B

When the efforts of deciphering of the Linear B tablets were still going on by the amateur and non-specialist British architect Michael Ventris (July, 12<sup>th</sup> 1922 – September, 15<sup>th</sup> 1956) all academic scholars, without exception and including Ventris himself, assumed that the hidden language behind the mysterious signs of Linear B could be anyone, but never Greek.<sup>1</sup> Then in April 9, 1954 *The New York Times* made it clear: Ventris<sup>2</sup> deciphered Linear B and the language behind is Greek<sup>3</sup>. Suddenly the curtain of the literate (Greek) (pre-) history and civilization has been drawn backwards at almost one thousand of years or as the contemporary poet Sinopoulos has expressed it: “*There rang out a peal of bells thirty-three centuries old*”.<sup>4</sup> The deciphering of Linear B (Figure 1) was not only of the same importance as the decoding of the DNA, but it did happen almost simultaneously<sup>5</sup>.

This unexpected deciphering enabled disclosures of inestimable dimensions so far that some information delivered by Homer and Hesiod were also recorded on the clay tablets found in Knossos<sup>6</sup>, in Mycenae, in Pylos, in Thebes and in many other places in Greece<sup>7</sup>. The surprise was perfect when deities of the Greek

<sup>1</sup> Professor A. Wace mentions that “Schliemann ... overawed by the “experts”, who insisted that his finds could not be Greek but must be Phoenician, Asiatic or so on. When he found frescoes at Mycenae, the “experts” insisted that they could not possibly be prehistoric and deterred him from publishing them”, in: Ventris, Chadwick, 1956, p. xxviii. But even Ventris and Chadwick themselves state with a slight taste of bitterness that “... Pylos tablets and the Knossos tables might be written in Greek, was not generally considered, least of all by Ventris” (Ventris, Chadwick, 1956p. 15).

<sup>2</sup> M. Ventris together with J. Chadwick have published first in 1953 their epoch-making work in the *Journal of Hellenic Studies* and short after Ventris announced in London (June 24<sup>th</sup>, 1953) his success in deciphering Linear B after having consulted and discussed his progress with the “non-specialist” and non-scholar K. D. Ktistopoulos. Later on C. W. Blegen announced the deciphering of the tablet Ta 641 from Pylos. Ventris died unexpectedly at a car accident in the age of ...thirty-three years young. God bless his soul! See also Hooker, J. T. (1996), p. 13 f, 296

<sup>3</sup> It is remarkable that the greatest archaeological discoveries (Troy, Linear B) were made by absolute non-specialist, like Schliemann (merchant) and Ventris (architect). A pioneer work which helped Ventris efforts was performed by the American Alice Kober (Kober “triplets”) and later on by some others which will be mentioned later.

<sup>4</sup> Chadwick, J. (1976), p. XV and Hooker, J. T. (1996), p. 297

<sup>5</sup> Robinson, A. (1995), in chapter 6 mentions that 1953 three remarkable things happened: DNA was explained, Mount Everest was climbed and Linear B was deciphered.

<sup>6</sup> The British Arthur Evans found in 1900 as first clay tablets by digging up the old city Knossos (Palace of King Minos) and named the recorded signs Linear A (hieroglyphs) and Linear B (straight-line strokes). Linear A set includes now about 75 symbols from 1800 B. C., while Linear B about 89 symbols from 1450 B. C. The American Carl Blegen excavated 1939 Pylos and he found first 600 and later another set of 400 fresh clay tablets of Linear B.

<sup>7</sup> “It is incredible that people as intelligent as the Greeks forgot how to read and write, until about the eight century when they adopted the Phoenician alphabet.” (Ventris & Chadwick, 1956, p. xxviii).

pantheon were found on those clay tablets. On only one clay tablet there are listed names of four (4) deities<sup>8</sup>, which significantly is too much to be “down-handled” as a “case of coincidence”<sup>9</sup>.

Figure 1: Linear B Syllabarium


Source: Ventris, Chadwick, 1956

But things have changed more dramatically when a very important Linear B clay tablet was found recently (1994) in Thebes, mentions four of the so many disappeared towns exactly with their Homeric names as parts of the Theban territory. Those towns were *Eleon, Hyle, Peteon and Eutresis*. They are named in the Catalogue of ships in Homers Iliad and most important they were (and are still) completely unknown in historical times (See Buzby, R., 2006). But apart of all those unexpected and amazing archaeological, historical and cultural<sup>10</sup> dimensions, which occurred with the decipherment of the clay tablets, the mysterious signs or “clay-mails” from the very past are worth catching our interest and being research matter because the majority of the tablets disclose information with socio-economic and administrative content. It goes back so far that we find original and authentic information<sup>11</sup>, not just theories or assumptions, about aspects of socio-economic activities and administration (managerial) models.

## 2. Disclosures in the Linear B Tablets

The creations of the *alphabets* – one of humanity’s principal intellectual product - from its beginning to the forms which are known today are very interesting and allow us to get important insights into our cognitive evolution process. It seems that the creation of commonly readable and understandable signs like our alphabets passed some phases which begin with the first contact between the *human eyes* and the *environment* (the Aristotelian *Phenomena*). In this very moment the human brain had the task to perform the dematerialization (from tangible to intangible) of the *Phenomena* and create the implicit world of *Meta-phenomena* which is the mental projection of the phenomena in our brain or the world of “meanings or terms” (*modulation*).

The next step is to document the implicit mental world as an explicit coding system (*demodulation*). While the conversion of static phenomena, like a star, are much easier to perform (“analog pictures”) the conversion of dynamic processes, like thunder or earthquake seems more sophisticated. While the abstraction of the phenomena as “one-by-one model” in form of *icons* (the symbol “\*” as code for the stars), the *ideograms* or *hieroglyphs* are loaded with contents different from that everybody sees at the first moment. This means that the *unity of documentation* (writing or coding) and *deciphering* (reading or decoding) is lost. In other words the persons must be taught how to write and how to read, otherwise communication is

<sup>8</sup> *A-ta-na po-ti-ni-ja* is the Athena Potnia, *e-nu-wa-ri-jo* is Enyalios which is another name of Ares, *pa-ja-wo* means Paiaon (Pan) or Apollo and *po-se-da-o* is Poseidon.

<sup>9</sup> Chadwick, J. (1976), p. 89.

<sup>10</sup> For all those who may be interesting in this exciting field of Creto-Mycenaean civilization we recommend strongly to read in English the “*Mycenaean Bible*” of Ventris, Chadwick ( 1956, 1976), “Documents in Mycenaean Greek”, Cambridge: University Press, but also Chadwick (1976), “The Mycenaean World”, Cambridge: University Press. Very useful books in Greek are the works of Hooker, J. T. (1996), “Εισαγωγή στη Γραμμική Β (Introduction into Linear B)”, Αθήνα: Μ. Ι. Ε. Τ. and Chadwick (2005), “Γραμμική Β και συγγενικές Γραφές (Linear B and related writings)”, Αθήνα: Παπαδήμας

<sup>11</sup> Among others we find the oldest signs in the prehistoric site of Dispilio, in Kastoria, Greece (dated from 5.260 B. C., see also wikipedia.org/wiki/Dispilio\_Tablet) and one of the oldest historical records about economic terms like interest (“*tokos*”) inscription in Kourion in Cyprus (see: Mitford, T.B. (1971), “The Inscriptions of Kourion”, Philadelphia, American Philosophical Society).



impossible. The same aspect of loading dominates the codification of the signs (syllabogrammes or logogrammes) of the Linear B and therefore their deciphering was equal with a modern hacker's work. The invention of the alphabetic signs and especially those of the vowels had revolutionized our culture as a whole. When the consonant were the fundamentals or the "hardware" the vowels were its "software"<sup>12</sup>.

But apart of that long process our interest in the present context is focused on all those visible documents of past cultures and especially of those tightly related with the so called Linear B signs recorded in the clay tablets (c-tablets or "c-mails") found in various places in the Hellenic world (Greek mainland, Crete, Aegean Islands, Anatolia) dated<sup>13</sup> back up to 2.000 B. C. This earliest type of "library" in general were signs on rocks, stones, bones and later on clay bricks (Assyrians, Babylonians) or tablets (Greece)<sup>14</sup>. Almost all those prehistoric recordings concerns transactions with socio-economic or administrative content and the related pictorial, hierogrammatic<sup>15</sup> or logogrammatic signs used to manifest exceptional and daily events like war, ceremonies, contracts, agreements, distributions, collections and deposits of items.

The recording of data on the clay tablets followed some rules or techniques so the writing was performed from *left to right* with a drawing motion using a stylus. The tablets themselves were divided by horizontal lines and in some cases the real side was used too. The basic shape of the tablets is the "palm-leaf" type ("φοινίκια γράμματα")<sup>16</sup>. Many of the "palm-leaves" clay tablets (a – m) have only *one line* of writing, but some have two or three lines. The rectangular "page" type (n – z) was used for long lists of personnel and rations. In rare cases there are examples of writing on the *edge* of a tablet as an indication of the contents, like "books in the shelf". *Place-names* indicate on actual or expected *tributes* to the palace. While men's names in *dative* and in small amounts indicate on *distributive rations* from the palace names in *nominative* combining with amounts indicate on *collective rations*, like taxes and finished goods. Monetary or other *media of exchange* do not appear on the tablets, probably because the *revenues* of the palace derived from *feudal dues* and *foreign conquest*. The recorded data were "drawn" on *clay tablets* and concerned all possible transactions; they provided information for various time designations, different locations (*toponyms*) and recipients.

The scribes or accountants were normally responsible for one type of goods ("departmentalization"), known by their own used "clay-marks" or handwriting type. There are about sixty (60) different "hands" for Knossos and another 30 "hands" for Pylos. So for example the Pylos tablets from the *An* series disclose military information, the *Ab* personnel information, *Jn* concerns the management of raw material, *Ta* deals with household items, *Cn* and *D* (from Knossos) with livestock and related products. But in some few cases the scribes were responsible for more item categories, like *Ab, Aq, Cc, Cn, Fg* and *Jn*. The used clay tablets were most probably *recording documents* with short time evidence (maybe one or two years), because they were only dried under the sun, not burned in furnaces, like e.g. the Sumerians did). This means either that the inventories were *quickly renewed* or that the scribes copied the tablets each year, if it was necessary. All those clay tablets found in the various palaces and places, came to us because when the palaces have been destroyed the clay tablets had been "hardened" by the fires which enemies had put. This has been served by professional *scribes* or *accountants* (*Human Capital* as active knowledge) using a special *accounting system* consisting of a *standardized set of 87 syllabograms*, some ideograms and a decadic system of numbers for counting and weighing.

### 3. Disclosures of weights and measures

The numerical system and the related method of counting and measuring (**Figure 2**) is rather simple than complicated and is decimal and in some cases sexagesimal (hexadecimal). The numbering of items like men, women, sheep, jugs or chariots is counted in units using a decimal notation in form of horizontal (one) or vertical (ten) strokes and three types of circles. Numeral signs (strokes) are distinguishable from the word dividers (-) as being always lifted to the top of the line. To write a number, you begin with the highest power of 10, and go toward lower ones. For each power of 10, you repeat the corresponding sign until you reach the desired multiple.

In some cases the numerals are preceding from the signs **ZE** and **MO** indicating the unit of measurement "zeugos = pair" and "monFos = (one) piece". So means **MU ZE**ugos 100 "draught-oxen pair100" which is

<sup>12</sup> See Mavridis, 2006 and Mavridis, 2008a

<sup>13</sup> The time period of interest is the so called "palatial" period (3100–1050 B. C.), the *Neo-Palatial* (ca. 1750– 1470 B. C.) and especially *Post-Palatial* period (ca. 1490–1050 B. C.). Similar signs were found also in many other paces in whole Europe, in the area of the Euxinian Sea and in the Baltikum countries.

<sup>14</sup> The records on marbles, papyri (parchments) and skins (diphtherae) are comparatively a "new" technology.

<sup>15</sup> The ideograms are a communication system which use real or symbolic pictures "loaded" with an idea or imagination (see Mavridis, 2006)

<sup>16</sup> They name *Phoenician* comes from the *palm leaves* used as material for writing (like papyrus), a custom which continued also in the clay tablets (*palm-leaf tablets*).

equal 200 (100X2) pieces exactly or **QI MO**nws 1.000 has the meaning “1.000 pieces of sheep”. In some cases the units of pair (ZE) and piece (MO) are written in combination, like: **MU ZE**ugos 2 **MO**nws 1 meaning “draught-oxen pair 2 (and one) piece 1”, which finally means five (2+2+1=5) pieces of **MU** (“draught-oxen”). The **ZE** sign can occur also with different items, like the following: **QI** 1 **MU ZE**ugos 2, meaning one (1) piece of **qi** (*ai-gis* =sheep) and 2 pair **mu** (= oxen) together five (1+2+2). Apart of these units of measurement it happens that numerals are accompanied with signs like: **NE**wos = new, young, **NE**os, **WE**tos = yearling, **ΦE**τος, **O**pero = o. = **O**. = deficit or pending (ophelos), **O**φελος, **PE**kos = Pokos, **P**ektos, shorn > **ΠE**κτος, **PA** = **PA**laios, old or (**PA**ro = yet to get = owed, like ophelos), **ΠA**ρα, **KI** = khilos > khloros, “green fodder”, **χλ**ός, **χλ**ωρός, **SA** = fold, **σ**ηκός, **ΣA**κός, (**σ**ήτες, **σ**άτες, **σ**ατευτός, **σ**ιτευτός, **satt**), **AI**ga = aiga, goat, (Sansk. agas, Armen. aic, **AI**γα, **αι**γίς), **DE**sma = bundle > **ΔE**σμη and **PE**rusino = last year.

Figure 2: Numerical system of Linear B

1	2	3	4	5	6	7	8	9	0	-
1	2	10	20	100	200	1000	2000	10000	20000	

The used dry measures were used as unit the 120 litres basis: **1 unit of WHEAT or BARLEY** = 120 litres, **T** **1** = 12 l or 1/10 of the biggest unit (120), **V** **1** = 2 l or 1/6 **T**, **Z** **1** = 0, 5 l or 1/4 **V**. The used liquid measures (Figure 9) were based on the unit of 36 litres: In both cases either for dry or for liquid measures the **T** = **S** = 12 litres and the other measures **V** and **Z** are identical or 2 and 0,5 litres each: **1 unit of OIL** = 36 litres, **S** **1** = 12 l or 1/3 of the biggest unit (36), **V** **1** = 2 l or 1/6 of **S**, **Z** **1** = 0, 5 l or 1/4 **V**. Also fractional quantities have been used which have been explained by Bennett (Bennett, 1950): **DWO** equal with **I** for metals which is the **TALANTON** or in Greek **Τάλαντον** having about 29 - 30 kg or 64 lb<sup>17</sup>.

For dry (wheat) measures was used either as fraction of the preceding (1/6, 1/4) or respective as fraction of the whole (1/60, 1/240). The related ideogram without number was equal with always 1, (**T**) equal with always 1/10, (**V**) equal with 1/6 or 1/60, (**CUP** or **Z**) equal with 1/4 or 1/240 or  $1 + 1/10 + 1/6 + 1/4 = \text{or } 1 + 1/10 + 1/60 + 1/240 = \text{or } 1 + 24/240 + 4/240 + 1/240 = 1 + 29/240$ . For the liquid (wine) measures either as fraction of the preceding (1/6, 1/4) or respective as fraction of the whole (1/18, 1/72). Without any number equal again with always 1, then **S** equal with always 1/3 or **V** further equal with 1/6 or 1/18, while the ideogram (**CUP** or **Z**) was equal with 1/4 or 1/72 or  $1 + 1/3 + 1/6 + 1/4 = \text{or } 1 + 1/3 + 1/18 + 1/72 = \text{or } 1 + 24/72 + 4/72 + 1/72 = 1 + 29/72$ .

The clay tablets disclose not only the daily transactions (either as quantities or qualities) but inform us about the type of them. Many of them addresses –apart of the weights and measures- modern economic terms of our time, like market (*a-ko-ra* > αγορά), marketing (*a-na-ke-e* > ανάγειν), messenger (“Herold”) (*a-ke-ro, ka-ru-ke*), price (*o-no* > όνια > οψώνια), purchasing (*o-na*), delivered (*de-do-me-na*), interest (*to-ko* > τόκος), profit and loss (*za-mi-ja* > ζημεία), “for sale” (*a-ko-ra-jo* > αγοραίος), obligation (*do-so-mo* > δασμός) or “pensum” (*ta-ra-si-ja*), projecting (*po-ro-e-ke* > προέχειν), payment, toll (*qe-te-a* > τέλθρα > τέλη), due (*o-pe-ro* > όφελος), fragment, ration (*ka-ra-ma-to* > κλάσματον), worker (*we-ka-ta* > εργάτας), council (*ke-ro-si-ja* > γερονσία), sum or so much (*to-so, ki-ro*), aggregate (*ku-su-pa, to-so ku-su-to-ro-pa*<sub>2</sub>), wages (*e-ke-ro-qo-no*), rent (*e-mi-to* > έμμισθος) months (*me-no* > μήνας), this year (*we-to* > φέτος), last year (*pe-ru-si-nu-wo* > περυσινός), balancing or balanced (*e-wi-su-zo-ko* > ισόζυγος > ισόζυγιο), maxima (*me-ki-ta* > μέγιστα) and (short) budgeting (inco-) terms (*PE-ru-si-nu-wo* = last year, *ZA-we-te* = this year, *O-pe-ro* = missing) (Figure 3, 4).

On the other hand they reported to the “peak” of the society (the king) what was really performed (like *a-pe-do-ke* = delivered, contributed or *pa-ro* = to collect in the tablets) and what not (*o-u-di-do-si* = not contributing or *o-pe-ro* = owing, outstanding, deficit). In terms of modern management they formed the class of senior managers or administrators and built the tactical Managerial or palatial level. These “senior managers” or “secretary generals” are mentioned in the clay tablets as *e-qe-ta* or *e-qe-ta-i* (*heq<sup>h</sup>etas, επέτας, εταιροι*) or followers<sup>18</sup>. The Followers served the king not only as his warrior caste (“ear and eye”) but had also their own businesses as owners of land (PY Ed 317), slaves (PY Ed 847), manufactures (bronze smiths, clothes, wheels, chariots) and trade men. While the Followers were the administrative link between the royal

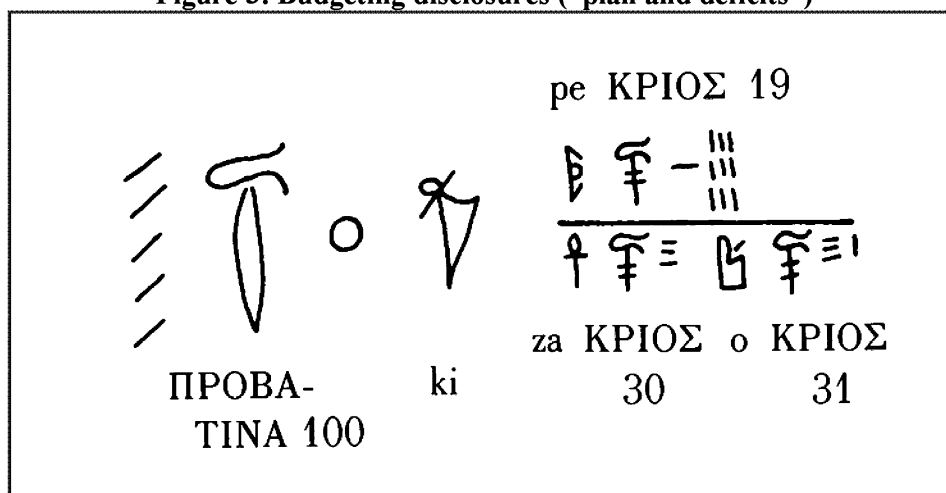
<sup>17</sup> In later Athens 25,8 kg, 60 mnai, 3.000 stateres (8,6 gr.) or 6.000 drakhmai (4,3 gr.)

<sup>18</sup> Those members of palatial elite were following the king and attended on him in times of peace and war; they were his close friends and table-companions, like the *etairoi* of Alexander the Great or the known Comes and Counts.

(strategic) level (*Wanax- Lawagetas – Telestai*) and the citizens (executive level) another group of people were the link “on site” or in modern terms “on field”.

The tablets disclose information mainly about two types of land plots: the private (*ko-to-na ki-ti-me-na* > κτοίνα κτίμενα = piece of private land<sup>19</sup>) and the communal (*ko-to-na ke-ke-me-na* > κτοίνα κεκείμενα = piece of public of royal land).<sup>20</sup> The communal land plots could be given from demos (*pa-ro da-mo* > παρά δάμω = from the damos or community) to palace official (*wa-na-ka-te-ro te-me-no* > ανάκτηρον τέμενος = royal land plot, *ra-wa-ke-si-jo te-me-no* = lawagesoion temenos = land plot of the chief-commander, *te-re-ta te-me-no* = land plot of telestas), to other private persons as *o-na-to*<sup>21</sup> (*du-ni-jo e-ke o-na-to pa-ro da-mo* = Dunios holds a lease from the demos) and also to temples, shrines or servants of deities (*i-je-ri-ja e-ke o-na-to pa-ro da-mo* = priestess has a lease from the demos or in Greek «*ιέρεια έχει όνατον παρά δήμω*»). The palace and its nobility were tightly bound to communal (*da-mo* > δάμος > demos) land plots or “*Latifundia*” (*temenos*)<sup>22</sup> and were given to them as parts of a “*feudal*” contract between the *seigneur* (*wanax*) and his *fief-holders* (*palace officials*).<sup>23</sup>

Figure 3: Budgeting disclosures (“plan and deficits”)



Source: Hooker, 1976

The tablets disclose also names of people as owners of private land (*ko-to-no-ko* = *ktoinoukhos*<sup>24</sup> = land owner = κτοινούχος or in the case of the tailor Tridaros is recorded that *ti-ri-da-ro ra-pte e-ke ka-ma*<sup>25</sup> = *Tridaros the tailor has own land plot* = *Τρίδαρος ο ράπτης έχει κάμα*) or as holders of contractual leases (*ti-ri-da-ro ra-pte e-ke o-na-to ko-do-jo ko-to-na* = *Tridaros the tailor has as lease-land the land plot of Ko-do-jo* = *Τρίδαρος ο ράπτης έχει ως όνατο «μίσθιο» το κτήμα του ... Ko-do-jo*). In all types of land plots the work was performed by male and female (*ku-na-ja* = *kunaka* > *kwonaka* > *wonaka* > *woman* = γυναίκα) workers and in some cases are also mentioned boys (*ko-wo* = *kouroi*) and girls (*ko-wa* = *kourai*).

The workers according to the tablets found were fed with rations of bread (wheat) and figs (*su-za* = *suka* = σούκα) and got rations of seed (*pe-ma* > *sperma* (= seed) > σπέρμα) for the cultivated land plots. The agricultural production covered a wide range of items, like wheat, oil (*e-ra-wo* > ελαιον), wine (*wo-no* > οίνος, *de-re-u-ko* > δλεύκος > γλεύκος), beans, honey (*me-ri* > μέλι), spices but also meat, wool (*ma-ri* > μαλί) and related products (*a-re-pa* > αλείφα > αλοιφή = ointment, *pa-ma-ko* > φάρμακον = *pharmakon* = medicine, pharmacy = φάρμακον, *tu-we-a* = *thuwea* = perfumes, sacrifices = θυFεα > θύεα > θυσία).

All the above extracted disclosures are a small part of the total of about 6.800 complete<sup>26</sup> and fragmentary clay tablets records found in some of the areas of the Hellenic world. The most important hoard places of Linear B tablets are Knossos with 3.369 written by 100 different scribes, Pylos with 1.107 written by 32 different scribes, Thebes with about 300 and Mycenae with about 90. Those tablets contain in total about

<sup>19</sup> *ki-ti-me-na* has to do with the word κτήμι or κτείμι (κτίζω) which means possess.

<sup>20</sup> *ke-ke-me-na* most probably is related with the meanings of “laid down” or “available to the public”.

<sup>21</sup> *o-na-to* is related with the word όνατον, ονίναμι, όνια, ογόνια

<sup>22</sup> The etymology indicates of something separated (= *temno* = cut off, separate).

<sup>23</sup> The temenos was given for the exclusive use of some persons and were described as *wa-na-ka-te-ro te-me-no*, *ra-wa-ke-si-jo te-me-no*, or institution.

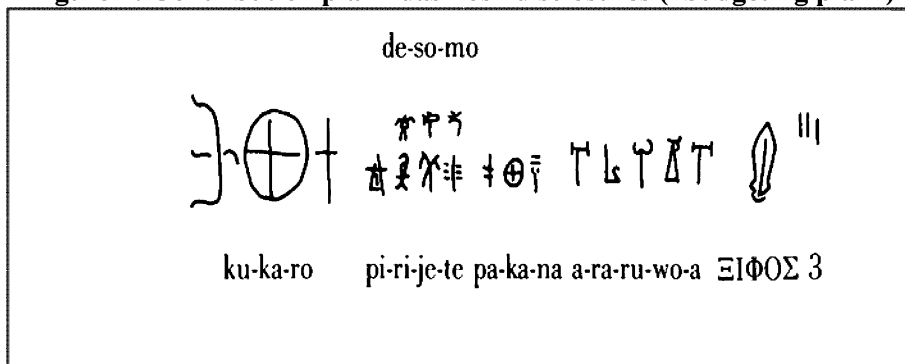
<sup>24</sup> The poor people were the *a-ko-to-ne* = *aktoinoi* = άκτοίνοι

<sup>25</sup> *ka-ma* has to do with κά-μα-το, καμαές, μεροκάματο, καματερός, ακαμάτης and means working hard on something (land).

<sup>26</sup> There are about 5.000 tablets in Linear B, 1.400 tablets in Linear B and 400 are hieroglyphic ones.

90.000 signs whereby most of them (80.000 signs or 88%) belong to Linear B, 8.000 ( about 10%) signs to in Linear A and 2.000 (about 2%) to hieroglyphic ones<sup>27</sup>. Evans made an effort to decipher the Linear B signs by applying the phonetic values of the Cyprian syllabarium. He has read the word *po-lo* (KN Ca 895) after the ideogram of a horse but he believed that it was a case of coincidence and so he has lost the chance to be the decipherer of the Linear B. The “Vorsehung” had preserved it for Michael Ventris<sup>28</sup> who announced in 1953<sup>29</sup> the deciphering of Linear B. Today nobody doubts the fact of the deciphering and the language behind the recorded signs.<sup>30</sup>

Figure 4: Contribution plan “dasmos” disclosures («budgeting plan»)



Source: Hooker, 1976

#### 4. Epilogue

The majority of the tablets disclose information with more administrative character concerning the palace, its nobility and its hierarchy, the relationship to religious, professional, military and local representatives or even private men or women. Although not explicit but conclusively the palace did not have only local influence, but seems to have extended it to further neighboring and distant places, especially in the case of Crete. It is not so far to assume that they built a Thalassocracy<sup>31</sup> in the eastern Mediterranean and western Asiatic region having as neighbours the Hittites.

According to the palatial-administrative hierarchy, professional structure (common workers, bronze manufacturers, armory specialists, agricultural and livestock producers), cultural customs (religious offerings, arts and paintings, frescoes, stamps and other related artifacts), military and trade organization disclosures we are able to “shape” the intellectual network of the related societies. In the case of the Bronze Age palaces the king and its “house” is in some extent producer (professional) and customer at the same time and therefore it is not easy to make a clear distinction.<sup>32</sup> Taking into consideration all above mentioned disclosures the prehistoric world which is shaped through the recordings of the clay tablets manifests a culture with a facette of interesting points. In this summary we only wanted to focus on the socio-economic administrative aspects which allow us to catch the intellectual capability of the society to solve problems concerning daily and exceptional issues as general welfare, production and consumption patterns. Tightly connected with the transmission mechanisms of allocation (raw materials or input factors), distribution (output as products or services) and collection (in form of services, dues, taxes and other obligations) were the political, military, religious and feudal circumstances. The mentioned disclosures (professional, relational, structural) let us conclude on a society with a best organized administrative system having mainly centralistic outline but based on a decentralised system of hierarchical functions, places (palaces or megarons) and outposts for local and distant trade (structural capital) . The whole system was served and supported not only by the palatial elite but also by an excellent “guild” of scribes which used a standardized accounting system or laguage (Linear B)<sup>33</sup>. So far the civilization disclosed by the clay tablets seems to be only a first drawing; a prelude opening of the curtain which perhaps allow us to step further into the future of the economic historiography of the past.

<sup>27</sup> The fact that the found tablets in all places do not indicate on any dialectical language forms allow us to make the assumption that the used Greek language was first “universal” and that the recording system itself was unified or standardized.

<sup>28</sup> Ventris was supported by the specialist for Hellenistic studies J. Chadwick in his efforts.

<sup>29</sup> Robinson, A., 1995: states that “the greatest shock since the discovery of Troy” was the deciphering of Linear B.

<sup>30</sup> The tablet *PY Ta 641 (ti-ri-po = three-leg vessel = τριπῶς)* played a crucial role for the deciphering efforts.

<sup>31</sup> See also Bass (1991), Hägg & Marinatos (1984), Knapp (1996), Weiner (1984 and 1991).

<sup>32</sup> This type of production (“ergastiria”) is evident even in the time of the Eastern Roman Empire (Byzantium).

<sup>33</sup> The found tablets prove that there are no local differences in the recording (accounting) system of Linear B which is an indication of the “universality” of the used signs in the whole Hellenic world.

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# QUANTITATIVE METHODS IN SERVICES MARKETING: AN APPLICATION IN MEASURING SUBURBAN RAILWAY'S CUSTOMERS SATISFACTION

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## Abstract

*Public transportation is a structural element of urban environment. Its necessity and utility is obvious. Customers' satisfaction, i.e. passengers' satisfaction of public transport is a field of research in services Marketing that aims at locating both the positive elements and the arising problems and suggest appropriate solutions. In this paper, a track-guided transport means is examined: the Suburban Railway that connects the city of Athens with certain suburbs and the satisfaction of passengers from its operation. The variables examined are stations' access and environment, (customer) service offered by railway's personnel, time, ambience and safety of transportation and, finally, ticket prices. The usefulness of each of these variables to the measurement of total satisfaction is assessed and a linear model for the prediction of total customer satisfaction is proposed. This means that total satisfaction can be measured effectively through the selected variables and provide useful information for company's strategic marketing planning.*

*Keywords: Services Marketing, customer satisfaction, suburban railway, public transportation*

## 1. Introduction

Public transportation is one of the main distinctive characteristics of urban settings. It aims to serve thousands of people a day and, therefore, it must operate both efficiently and effectively. To do so, it must be aware of what customers (i.e. passengers) think about the services offered. Thus, the goal of this study is to measure passengers' satisfaction from the services offered by the Suburban Railway that connects the city of Athens with certain suburbs. Despite their importance, this kind of studies is not very common in Hellas (Greece) due to the large number of stakeholders affected (passengers, the company and suburbs' inhabitants well being). The results of this study and the model proposed will enable company's marketing team to better understand passengers' needs and to formulate strategies that strengthen the positive and amend or eliminate the negative attitudes.

## 2. Background

Customer satisfaction is defined as a measure of how a firm's total product or service performs compared to a set of customer's expectations (Hill, 1996). It has long been a subject of research due to its importance for measuring marketing and business performance (Parasuraman *et al*, 1991; Szymanski and Henard, 2001). Measuring customer satisfaction is a prerequisite so as to have a meaningful assessment of customer's preferences and expectations (Cronin and Taylor, 1992; Zondiros *et al*, 2007). As a consequence, a lot of methods have been developed to measure customer satisfaction but the way they have been applied do not permit their easy and effective interpretation by marketing managers (Fornell *et al*, 1995). This requires an approach that will be simple and able to measure only the variables that are crucial to total customer satisfaction.

As a service, public transportation has the unique characteristics of services that differentiate services marketing from physical products marketing (Zeithaml *et al*, 1985). Services are intangible (cannot be

viewed or touched), heterogeneous (the same service may be offered differently by different people / personnel), inseparable (produced and consumed mostly at the same time and / or place) and perishable (cannot be stored for future use) in nature. So, the Suburban Railway faces the challenge to deliver an experience to its customers.

Hence, all models and criteria / variables used by previous researchers reflect the above (see, *inter alia*, Morfoulaki *et al*, 2007; Friman *et al*, 2001; Friman and Gärling, 2001; Andreassen, 1995; Grigoroudis and Siskos, 2004; Gorter *et al*, 2000; Novy, 2001; Bernini, and Lubisco, 2005); Chan, 1987; Stradling, 2002) as described in the next section.

### 3. Methodology

The population for this study was defined as all customers using public transportation means in the greater area of the city of Athens. The method of simple random sampling was selected. A common ground approach used by companies offering market research surveys is to pick a sample of 600 – 800 individuals in surveys conducted in this geographical area. The research took place on November –December 2008 in Suburban Railway's stations and terminals. The research instrument was a questionnaire filled by the interviewer (Frangos, 2004). The questionnaire was pre-tested and amended accordingly. In order to cover the possibility of denials to answer, a sample of 1.200 individuals was picked. The questionnaire was only to be answered by individuals that use the Suburban Railway even rarely as only a user could provide the data requested. Therefore, each interviewer had to ascertain that the individual was a user before starting the completion of the questionnaire. In total, the data of 475 properly filled questionnaires were used for analysis.

For the measurement of Total customer Satisfaction (dependent variable), five criteria (independent variables) were used:

1. Ease of access to terminals and stations - Access,
2. Services offered in stations - Services
3. Services offered by personnel - Serving
4. Services offered in the train-vehicle - Vehicles Services
5. Prices of tickets and cards for unlimited use - Prices.

This measurement was relatively simple. The Likert attitude scale was used in each of the five criteria (1 = dissatisfied, 2 = quite dissatisfied, 3 = not satisfied, nor dissatisfied, 4 = quite satisfied, 5 = satisfied). Data were processed with *SPSS* for Windows.

### 4. Research Results

The sample contained 49% women and 51% men. The following table summarises the demographic characteristics of the sample.

**Table 1**  
Demographic data

<i>Demographics</i>						
<b>Age</b>	< 18	19 – 25	26 – 35	36 – 50	51 – 65	> 66
% of the sample	8%	40%	20%	16%	10%	6%
<b>Educational level</b>	Primary	Secondary	Tertiary			
% of the sample	4%	39%	57%			
<b>Frequency of use (times / week)</b>	Rarely	Up to 5	6 – 10	11 – 15	> 16	
% of the sample	18%	21%	22%	23%	16%	
<b>Reason for using the SR</b>	Go to work	For shopping	For recreation	Other reasons	Note: Multiple answers were allowed in this question	
% of the sample	61%	50%	44%	15%		

The mean for Access is 3,49 that shows a quite high level of satisfaction. Variance is 1,593. Homogeneity coefficient CV is 36,16%, hence the sample is heterogeneous.

The mean for Station Services is 3,81 that gives a quite high level of satisfaction. Variance is 0,977. Homogeneity coefficient CV is 25,94%, hence the sample is heterogeneous.



The mean for Serving is 3,76 that shows a quite high level of satisfaction. Variance is 1,095. Homogeneity coefficient CV is 27,83%, hence the sample is heterogeneous.  
 The mean for Vehicle Services is 3,90 that denotes a quite high level of satisfaction. Variance is 0,958. Homogeneity coefficient CV is 25,10%, hence the sample is heterogeneous.  
 The mean for Prices is 3,06 that gives a medium level of satisfaction. Variance is 1,704. Homogeneity coefficient CV is 42,66%, hence the sample is heterogeneous.  
 The mean for Total Satisfaction is 3,82 that reveals a quite high level of it. Variance is 1,078. Homogeneity coefficient CV is 27,18%, hence the sample is heterogeneous.

The confidence intervals for the mean of each criterion and Total Satisfaction are shown in the following Table.

**Table 2**  
Confidence intervals

Criteria	Mean	Lower	Upper
Access	3,49	3,37	3,60
Station services	3,81	3,72	3,89
Serving	3,76	3,67	3,85
Vehicles services	3,90	3,81	3,99
Prices	3,06	2,94	3,17
<b>Total Satisfaction</b>	<b>3,82</b>	<b>3,73</b>	<b>3,91</b>

Then, a t-test was applied so as to compare the means of the dependent samples of satisfaction criteria with Total Satisfaction. As shown in the next Table (3), the mean satisfaction is lower in Access and Prices criteria compared to Total Satisfaction while the means do not differ for the Station Services, Serving and Vehicles criteria.

**Table 3**  
Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Access - Total	-,338	1,312	,060	-,456	-,219	-5,602	473	,000
Pair 2	Station Services - Total	-,015	,897	,041	-,096	,066	-,359	471	,720
Pair 3	Serving- Total	-,057	,979	,045	-,145	,031	-1,267	473	,206
Pair 4	Vehicles Services- Total	,078	,873	,040	,000	,157	1,948	473	,052
Pair 5	Prices - Total	-,776	1,382	,064	-,901	-,651	-12,164	468	,000

**5. Linear Model Construction**

Then, linear regression was applied to construct a linear predictive model for Total Satisfaction from the separate satisfaction criteria. If all five satisfaction criteria are used, then the following Tables (4 and 5 – Coefficients and Collinearity Diagnostics) show that the Services criterion has a VIF (Variation Inflation Factor)  $2,055 \geq 2$  και Tolerance index  $0,487 \leq 0,5$ . This means that this criterion cannot be included in the model because of collinearity. Thus, the model can be formulated as:

$$\text{Total Satisfaction} = 0,078 * \text{Access} + 0,241 * \text{Station Services} + 0,173 * \text{Serving} + 0,354 * \text{Vehicle Services} + 0,093 * \text{Prices} + 0,318.$$

Tables 6, 7, 8 and 9 show that all indices are satisfactory after the removal of the Station Services criterion. Then, the model can be formulated as:

Total Satisfaction = 0,115 \* Access + 0,249 \* Serving + 0,443 \* Vehicle Services + 0,101 \* Prices + 0,452 with correlation coefficient R = 0,704. Thus, the model explains the 50% of the total variance of data.

Total Satisfaction = 0,115 \* 3,49 + 0,249 \* 3,76 + 0,443 \* 3,90 + 0,101 \* 3,06 + 0,452 = 3,83

The mean satisfaction calculated with this model is 3,83 compared to 3,82 calculated from Total Satisfaction data.

**Table 4**  
Coefficients<sup>a</sup>

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	,318	,162		1,970	,049		
	access	,078	,029	,095	2,678	,008	,821	1,219
	station services	,241	,048	,230	4,966	,000	,487	2,055
	serving	,173	,042	,175	4,076	,000	,563	1,776
	vehicles services	,354	,045	,335	7,878	,000	,577	1,734
	prices	,093	,027	,117	3,434	,001	,904	1,106

a. Dependent Variable: total satisfaction

**Table 5**  
Collinearity Diagnostics<sup>a</sup>

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions					
				(Constant)	Access	Station Services	Serving	Vehicles Services	Prices
1	1	5,709	1,000	,00	,00	,00	,00	,00	,00
	2	,123	6,799	,00	,11	,01	,00	,00	,91
	3	,079	8,504	,01	,84	,02	,05	,05	,07
	4	,037	12,365	,73	,01	,04	,33	,01	,01
	5	,029	14,123	,22	,00	,12	,53	,44	,01
	6	,023	15,852	,02	,04	,82	,09	,50	,00

a. Dependent Variable: Total Satisfaction

**Table 6**  
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,704 <sup>a</sup>	,496	,491	,742

a. Predictors: (Constant), Prices, Access, Vehicles Services, Serving

**Table 7**  
ANOVA<sup>b</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
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1	Regression	250,982	4	62,745	114,025,000 <sup>a</sup>
	Residual	255,330	464,550		
	Total	506,311	468		

a. Predictors: (Constant), Prices, Access, Vehicles Services, Serving

b. Dependent Variable: Total Satisfaction

**Table 8**  
Coefficients<sup>a</sup>

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	,452	,162		2,780	,006		
	access	,115	,029	,140	3,968	,000	,873	1,146
	serving	,249	,040	,251	6,175	,000	,656	1,524
	vehicles services	,443	,042	,419	10,482	,000	,680	1,470
	prices	,101	,028	,127	3,664	,000	,907	1,103

a. Dependent Variable: Total Satisfaction

**Table 9**  
Collinearity Diagnostics<sup>a</sup>

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions				
				(Constant)	Access	Serving	Vehicles Services	Prices
1	1	4,740	1,000	,00	,00	,00	,00	,01
	2	,120	6,292	,00	,17	,01	,01	,88
	3	,076	7,898	,03	,81	,08	,08	,11
	4	,036	11,409	,64	,01	,61	,00	,01
	5	,028	13,057	,32	,01	,30	,91	,00

a. Dependent Variable: Total Satisfaction

## 6. Conclusions

The sample is quite satisfied from the services offered by Suburban Railway. There is room for improvement especially in the Access and Prices criteria which are rated lower than mean total satisfaction. The Station Services criterion does not affect satisfaction measurement due to collinearity. The linear model using the Access, Serving, Vehicle Services and Prices criteria, is expected to predict Total Satisfaction with a high level of reliability. Thus, company's marketing managers must focus on passengers' overall experience through policies that aim at the further enhancement in each of these criteria.

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# THE EFFECT OF COMPANIES' DIVIDEND AND ECONOMIC POLICY OF FTSE/ASE-20 INDICATOR IN THE CONFIGURATION OF THEIR STOCK EXCHANGE PRICE

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## Abstract

*Present study examines the consequences of the dividend policy of companies of FTSE/ASE 20 on their stock price. A sample of twenty companies looks through a seven-year period from 1999 up to 2005. Experimental approach is based on multiple regression analysis of price volatility as far as dividend policy is concerned, that is, dividend yield and payout ratio. In the process, variables are examined like corporate size, earning volatility, long-term debt (leverage) and asset growth.*

*Conclusively, there is a conflict between the majority of the regressions' results and theoretical expectations. Indeed dividend yield is negatively correlated to price volatility, as expected, yet the outcome is not statistically significant but in accordance with the Baskin paper's results (USA 1989) for US corporate stocks. On the contrary outcomes comparing payout ratio to price volatility seem differentiating. On the one hand, payout is rather positively correlated to variables' coefficient than negatively as we initially had expected. On the other hand results on size and growth (negative correlation) are expected and correlations between earnings volatility and long-term debt cannot safely be concluded.*

*Finally overall one could argue, that under specific circumstances corporate dividend policy (via dividend yield) can affect stock price.*

## Περίληψη

Σκοπός της προτεινόμενης μελέτης είναι να εξετάσει τις επιπτώσεις της μερισματικής πολιτικής των εταιρειών του δείκτη FTSE/ASE-20 του Χρηματιστηρίου Αξιών Αθηνών, επί της τιμής της μετοχής τους. Τα δεδομένα μας για το δείγμα των 20 εταιρειών αναφέρονται στην περίοδο από το 1999 έως το 2005. Η εμπειρική προσέγγιση της μελέτης βασίζεται στην πολλαπλή παλινδρόμηση (multiple regression analysis) της μεταβλητότητας της τιμής των μετοχών του δείγματος (price volatility) επί των μέτρων της μερισματικής πολιτικής, δηλαδή της μερισματικής απόδοσης (dividend yield) και του ποσοστού των διανεμομένων κερδών (payout). Παράλληλα, εξετάζεται η επιρροή και άλλων σημαντικών οικονομικών μεταβλητών όπως το μέγεθος (size) της εταιρίας, η μεταβλητότητα των κερδών της (earning volatility), οι μακροπρόθεσμες υποχρεώσεις της (debt) και η ανάπτυξή της (asset growth).

Είναι σίγουρα πολύ ενδιαφέρον να διερευνηθεί εμπειρικά το κατά πόσο συμφωνούν με τα θεωρητικά αναμενόμενα, τα συμπεράσματα από την επιχειρούμενη παλινδρόμηση με τα στοιχεία του Χρηματιστηρίου Αξιών Αθηνών. Θεωρητικά, η μερισματική απόδοση είναι αρνητικά συσχετισμένη με τη μεταβλητότητα της τιμής της μετοχής, όπως αυτό έχει διαπιστωθεί και οικονομετρικά από σχετικές μελέτες που έχουν γίνει στις κεφαλαιαγορές των ΗΠΑ και αλλού. Ακόμη, αναμένεται θεωρητικά να υπάρχει αρνητική συσχέτιση με τη μεταβλητότητα της τιμής της μετοχής τόσο του ποσοστού των διανεμομένων κερδών (payout) όσο και των μεταβλητών του μεγέθους (Size) και της ανάπτυξης (Growth), ενώ αντίθετα αναμένεται να υπάρχει θετική συσχέτιση με τη μεταβλητότητα των κερδών (Evol) και των μακροπρόθεσμων υποχρεώσεων (Ldebt).

Τελικά, βασικός στόχος της συγκεκριμένης εργασίας θα είναι να διερευνήσει το κατά πόσον η μερισματική πολιτική της εταιρίας (δια της μερισματικής απόδοσης) όσο και η γενικότερη οικονομική της πολιτική μπορεί να επηρεάσει την τιμή της μετοχής της στο Χρηματιστήριο Αξιών Αθηνών.

**Keywords:** Stock Exchange, Dividend Policy, Price Volatility, Dividend Yield.

## 1. Introduction – The Indicator FTSE/ ASE 20 of the Athens Stock Exchange.

This study is based on the shares of FTSE/ASE 20 indicator of Athens Stock Exchange (ASE). This indicator was created on 23 September 1997 and is a high capitalisation indicator that includes the 20 bigger (blue chips) listed in the Athens Stock Exchange. Capitalisation, merchantability and share dissemination are included in the indicator's attendance criteria.

The 20 shares which composed the indicator until the end of 2005 are<sup>1</sup>:

**Table 1**  
Shares of FTSE/AE 20 indicattor

1	ALPHA BANK	11	INTRACOM
2	AGRICULTURAL BANK	12	KAE
3	VIOHALCO	13	COSMOTE
4	GERMANOS	14	BANK OF CYPRUS
5	COCA COLA 3E	15	MOTOR OIL
6	DEH	16	OPAP
7	HELLENIC PETROLEUM	17	OTE
8	COMMERCIAL BANK	18	PIRAEUS BANK
9	NATIONAL BANK	19	TITAN
10	EUROBANK	20	FOLLI-FOLLIE

Since then this indicator has regularly reconsidered for various reasons. For example, after the reconsideration of April 2007 the shares of Intracom, Germanos, Duty-Free Shops and Folli - Follie companies were replaced by Elliniki Technodomiki, Intralot, Marfin Popular Bank and Hellenic Postbank. Because of this, as well as for comparability reasons, our study was limited in 1999 - 2005 period.

## 2. Trial and Error Method.

### 2.1 Data.

▪ The data of used companies refer to the period 1999-2005. The shares prices are adapted to the increases of share capital that have been done, cutting off dividend, share split and other corporate actions. The companies belong to the FTSE/ ASE 20 indicator and are high-capitalisation shares. Seven (7) out of twenty (20) belong to the Bank branch. The rest mainly belong to the branch of telecommunications industry, food etc. After the elaboration of those elements the final table 2.1 was formed, the data of which was used for the analysis of multiple regression.

Certainly the sample is small and not comparable with the one of other similar studies that have been made in mature markets (e.g. USA, Australia, England etc). However, the results of cross-correlations and regressions are comparable with those of the other studies. The difficulty of data collection is mainly based on the small time depth of the systematic operation of the Greek Stock Exchange (the last roughly 20 years - since 1987 and afterwards – have been organised).

**Table 2.1**  
Regression Data

COMPANIES	PVOL	DYIELD	PAYOUT	EVOL	SIZE	LDEBT	GROWTH
GERMANOS	0,2650	0,0309	0,4092	0,0200	2,8734	0,1004	0,1077
TITAN	0,2765	0,0183	0,4103	0,0243	3,2368	0,0935	0,1630
COCA COLA	0,3134	0,0126	0,7690	0,0207	3,6010	0,1517	0,2774
DEH	0,2167	0,0343	0,5365	0,0195	3,5828	0,3928	0,1160
INTRACOM	0,4263	0,0320	0,4227	0,0356	3,1436	0,1341	0,0785
KAE	0,4044	0,0459	0,7274	0,0379	2,8165	0,0209	0,0727
MOTOR OIL	0,2547	0,0678	0,8568	0,0233	2,9995	0,2077	0,1970
FOLLI-FOLLIE	0,3478	0,0061	0,5594	0,0314	2,8310	0,3535	0,2562

<sup>1</sup> <http://www.ase.gr>

COMPANIES	PVOL	DYIELD	PAYOUT	EVOL	SIZE	LDEBT	GROWTH
ELITE	0,3490	0,0502	0,6266	0,0427	3,3521	0,0455	0,1480
OPAP	0,2766	0,0500	0,7886	0,1301	3,2368	0,1617	0,2208
COSMOTE	0,2567	0,0330	0,7307	0,1070	3,5718	0,2463	0,3003
VIOHALCO	0,4029	0,0116	0,7582	0,0487	3,1617	0,0213	0,0217
OTE	0,3097	0,0341	0,6027	0,0515	3,8779	0,3045	0,0325
EUROBANK	0,2945	0,0272	0,6594	0,0032	3,7252	0,9603	0,3605
CYPRUS BANK	0,3863	0,0416	0,4220	0,0045	3,1828	0,8584	0,1935
PIRAEUS BANK	0,3154	0,0282	0,5837	0,0097	3,3165	0,8177	0,3591
NATIONAL BANK	0,3226	0,0305	0,5318	0,0052	3,8417	0,8967	0,0591
AGRICULTURAL BANK	0,2971	0,0186	0,2012	0,0070	3,3448	0,8707	0,0605
ALPHA BANK	0,3233	0,0319	0,5426	0,0050	3,6761	0,8020	0,1782
COMMERCIAL BANK	0,3621	0,0311	0,4124	0,0234	3,6761	0,8613	0,0646

## 2.2 Methodology

### 2.2.1 Variables of control - Expected results

The share prices volatility is related with the risks that the company faces in the frames of her market activity. The market risk can affect the dividend policy of companies. As a result, in our study we have included a variable that checks the volatility of the company profitability.

Existing the operational risk, the direct connection between the share price volatility and the functional leverage is necessary. In asymmetrical information conditions there seems to be a connection between the lending and the dividend policy. In this way one more control variable is used in this project and reflects the functional (and financial) leverage.

The company's volatility and its size are connected dynamically. Small companies carry out fewer differentiated activities and certainly the investors' interest is decreased. The share market of small companies offers little information and small fluidity with the consequence the big fluctuation of their prices. Baskin (1989) states that the companies with big share dissemination use the dividend policy in order to give the market 'signals' for the company direction and therefore for the shares route and its volatility. Thus, a new control variable that appreciates the company's size is required and it is searched in the present project.

The payout policy should be connected reversely with the growth and the investment opportunities. We suppose that the duration and the rate of return in the investments in various periods of time influence the company's liquidity. This is the reason why a variable of growth is useful to our study. Even with the existence of arbitrage and information effect the relationship between payout policy and share price volatility seems to be influenced by the variable of growth.

### 2.2.2 Definitions of Control Variables.

**Price Volatility (PVOL).** The dependent regression variable was calculated based on the annual share prices after their adaptation to capitalized actions (share split, share publication, dividend effect etc). The historical volatility is defined as the standard deviation of the logarithmic price changes in regular periods of time.

The calculation method which was followed is this: The volatility results from the change of the closure prices for each daily session.  $X_i$  is defined as the quotient of logarithmic price change between two sessions, namely: the share price in the closure divided to the share closure price of the previous session. In the above calculation if the company has given a dividend, then this is included in the price of the cutting off day's closure, provided that it has been removed from the closure price (since the 19/2/2001 the dividend is not deducted from the price).

In particular, if  $P_i$  is the closure price,  $P_{i-1}$  is the closure price of the previous session and D is the cutting

dividend, then  $x_i = Ln \frac{P_i + D}{P_{i-1}}$ .

Then the Standard Deviation  $\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}}$  and

Annual Volatility =  $\sigma * \sqrt{\text{session days in year} - 1}$ .

Finally, we calculate the average annual volatility for all the available years (1999-2005) that is we calculate the average of the seven prices for each company and the result has been recorded in table 2.1.

**Dividend yield (DYIELD).** The variable was calculated by adding all the annual dividends that were paid to the shareholders dividing them by the share price at the beginning of the year. Finally their average was worked out for all the available years.

**Payout ratio (PAYOUT).** It is the ratio of dividend per share divided by the earnings per share, namely the payout ratio in the shareholders with the form of cash dividend. The average of all available year prices is calculated for each company and takes its place in the relevant table 2.1

**Earning volatility (EVOL).** The variable is calculated as the earning standard deviation for all years (first the average ratios of functional earnings is calculated - before interest and taxes - divided by the total asset, then the quadrangular deviation, the fluctuation and finally the standard deviation are calculated).

**Company Size (Capitalization - SIZE).** The variable SIZE reflects the size of the company that as it has already been mentioned appears to influence the company value and consequently the share price. The variable was calculated for each company, with share price the one of the beginning of the year, is recorded in millions of Euros and after the deduction of the inflation. The final price of the variable that we use in table 2.1 for the company is the average of natural logarithm of prices of all available years.

**Long-term debt (LDEBT).** Initially, we find their long-term total loaning (loans with expiry date than a year) from the annual accountant reports of the 20 companies and calculate for each year the ratio of their long-term debts to their total asset (indicator of asset's cover with long term capital). Then we calculate the average of these indicators for all the available years and we use them for our analysis.

**Growth in assets (GROWTH).** The annual growth in asset was calculated as the ratio of the change of total year-end asset in reference with that of the year beginning, to the total year of the asset of the beginning of the year ( $Growth_i = \frac{Growth_{end} - Growth_{start}}{Growth_{start}}$ ). Finally, for the regression study we receive the average of the above ratios of all available years.

### 2.3 Regression Analysis - Method

The variable descriptive statistics that we use are mentioned in table 2.2. The analysis is based on the use of multiple regression. In all tests that were carried out the dependent variable is the PVOL (Price Volatility) and the main independent variables are the dividend yield (DYIELD-Dividend Yield) and the payout ratio (PAYOUT). Thus a first relationship between the dividend policy and the volatility of share price is developed. The basic equation of regression is

$$PVOL_j = \alpha_1 + \alpha_2 DYIELD_j + \alpha_3 PAYOUT_j + e_j \quad (2.1)$$

Baskin's (1989)<sup>2</sup> study in a big sample of 2344 American companies showed a considerably negative relationship between the two measurements of dividend policy (DYIELD, PAYOUT) and the share price volatility (PVOL). Since there are other factors which influence the relationship of dividend policy and share price, the equation (2.1) was enriched with the control variables EVOL, SIZE, LDEBT, GROWTH, and took the form:

<sup>2</sup> Baskin J., (1989), "Dividend Policy and the Volatility of Common Stock", Journal of Portfolio Management, 159(3): 19-25.



$$PVOL_j = \alpha_1 + \alpha_2 DYIELD_j + \alpha_3 PAYOUT_j + \alpha_4 SIZE_j + \alpha_5 EVOL_j + \alpha_6 LDEBT_j + \alpha_7 GROWTH_j + e_j \quad (2.2).$$

Our expectation is the variables DYIELD, PAYOUT and SIZE are negatively related with the share price volatility (PVOL). Furthermore, the variables EVOL and LDEBT are positively related with PVOL. This means that by increasing the dividend yield (DYIELD), the payout ratio (PAYOUT) and the company size (SIZE), correspondingly the share price volatility is decreased. On the contrary companies with high earning volatility EVOL or high risk loaning lead the share price volatility higher.

The regression analysis was carried out with the use of econometric software SPSS.

**Table 2.2**  
**Descriptive Statistics**

	N	Mean	Std.	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
PVOL	20	,320050	,0562809	,256	,512	-,556	,992
DYIELD	20	,031795	,0146977	,471	,512	,727	,992
EVOL	20	,032535	,0331319	1,976	,512	3,945	,992
LDEBT	20	,415050	,3549844	,469	,512	-1,639	,992
SIZE	20	3,352405	,3306260	-,087	,512	-1,044	,992
PAYOUT	20	,577560	,1664217	-,295	,512	-,230	,992
GROWTH	20	,163365	,1057575	,512	,512	-,801	,992
Valid N (listwise)	20						

## 2.4 Results - Comparisons

### 2.4.1 Descriptive Statistics

Table 2.2 of the descriptive statistics gives us the means, the standard deviation, the skewness and the kurtosis of each variable. If we accept that the share prices follow a normal distribution, ignoring small influences that emanating from corporate actions and phenomena that for e.g. may be connected with the year before and after the cutting off of dividend, then we can approach the yield standard deviation of each share. According to Parkinson (1980)<sup>3</sup> this can be worked out by multiplying the medium volatility (0,320050 average of PVOL) with the stable indicator 0,6008 (stable Parkinson). Thus  $0,320050 * 0,6008 = 0,192286 = 19,23\%$  is the standard deviation of share yields.

The comparison with the calculated price in the study of Baskin (1980) shows an important deviation (the result of Baskin is 36,9%). The same happens when one compares this with the Australian result of Dave Allen & V. Rachim<sup>4</sup> in 1996 which is 29,42%. Obviously, an important reason that explains this deviation is on the one hand our very small sample compared to the samples of the other studies and on the other hand the different environment of the Greek Stock Exchange market (which is always in the verge of the developing and the developed market).

<sup>3</sup> Parkinson M., (1980) "The extreme value method for estimating the variance of the rate of return", Journal of Business, 53, January, 61-5.

<sup>4</sup> Dave E. Allen and Veronica S. Rachim, (1996), "Dividend Policy and stock price volatility: Australian evidence", Applied Financial Economics, 1996, 6, 175-188.

## 2.4.2 Correlations

Table 2.3

		Correlations						
		PVOL	DYIELD	PAYOUT	EVOL	SIZE	LDEBT	GROWTH
PVOL	Pearson Correlation	1	-,148	-,094	-,131	-,247	-,032	-,327
	Sig. (2-tailed)	.	,534	,693	,581	,293	,895	,159
	N	20	20	20	20	20	20	20
DYIELD	Pearson Correlation	-,148	1	,340	,235	-,107	-,124	-,033
	Sig. (2-tailed)	,534	.	,143	,318	,654	,602	,889
	N	20	20	20	20	20	20	20
PAYOUT	Pearson Correlation	-,094	,340	1	,483*	-,037	-,436	,346
	Sig. (2-tailed)	,693	,143	.	,031	,877	,055	,135
	N	20	20	20	20	20	20	20
EVOL	Pearson Correlation	-,131	,235	,483*	1	-,082	-,526*	,068
	Sig. (2-tailed)	,581	,318	,031	.	,730	,017	,775
	N	20	20	20	20	20	20	20
SIZE	Pearson Correlation	-,247	-,107	-,037	-,082	1	,501*	,024
	Sig. (2-tailed)	,293	,654	,877	,730	.	,024	,921
	N	20	20	20	20	20	20	20
LDEBT	Pearson Correlation	-,032	-,124	-,436	-,526*	,501*	1	,194
	Sig. (2-tailed)	,895	,602	,055	,017	,024	.	,414
	N	20	20	20	20	20	20	20
GROWTH	Pearson Correlation	-,327	-,033	,346	,068	,024	,194	1
	Sig. (2-tailed)	,159	,889	,135	,775	,921	,414	.
	N	20	20	20	20	20	20	20

\*. Correlation is significant at the 0.05 level (2-tailed).

Table 2.3 informs us for the correlations between the variables that we use. The correlation between PVOL and DYIELD is - 0,148. This is related with the result of Baskin (1989), USA, -0,643 (expected negative correlation) with smaller measurement however, at absolute value, and is opposite of the result of the Australian study which is 0,006 (positive correlation).

The correlation between PVOL and PAYOUT is -0,094 (negative), the same as in the result of Baskin which is the -0,542 and D. Allen and V. Rachim (Australia), which is -0,210. The result is pact with our initial supposition (reference to the approach of Regression - analysis).

We observe that the correlation between DYIELD and PAYOUT is 0,340, which is quite important. This means that we have phenomenon of multicollinearity between the two measures of payout policy, a fact that is itself a subject to study and prompts us simultaneously to regress the PVOL separately from each of the DYIELD and PAYOUT.

The correlation study gives interesting elements for the control variables that are used in the equations of regression. The variables SIZE and LDEBT are negatively correlated with the PVOL. The negative correlation (even though it is small) LDEBT and PVOL (- 0,032) is opposite to our expectations, since we understand intuitively that in big loaning companies the share price volatility is big and at vice versa. On the contrary the negative correlation size of the company and the share price volatility PVOL (- 0,247) is expected, since big companies seem to have smaller volatility in their share price.

Moreover from table 2.3 we can observe that the higher positive correlation is between SIZE and LDEBT (0,501). This fact is not astonishing. Big companies use a lot of differentiation tools so as to mobilise productively their asset elements. One of these is the exterior loaning and specifically the long-term debt.

The second considerably higher positive correlation is the one between PAYOUT and EVOL and is 0,483. Similarly, it is positive between DYIELD and EVOL which is 0,235. The results are impressive since, according to our expectations, the correlation was expected to be negative. Indeed companies with big earning volatility are expected to pay fewer dividends and be more risky.

Furthermore the measurements of the payout policy, DYIELD and PAYOUT, are negatively correlated with the variable LDEBT, which is considered to be normal, since companies with big loaning are expected to pay smaller dividends.

What is not expected is the negative correlation EVOL and PVOL (- 0,131). Indeed the big company earning volatility causes insecurity and doubts to the inventors for its route, resulting in its reflection in the share price and volatility. We would therefore expect positive correlation rather than a negative one.

Finally, the variable GROWTH is positively correlated with PAYOUT (0,346), expected, since companies with big asset growth usually increase their payout ratio. This, however, is contrary to the DYIELD,

with which it is found in negative correlation (- 0,033) a fact that appears to be related with the share price volatility, PVOL, with which it is negatively connected. There is a positive correlation between GROWTH and LDEBT (0,194), as expected since a lot of companies owe their asset increase and their size in the use of loans (mainly long-term ones).

### 2.5 Regression Study

A) The regression results  $PVOL_j = \alpha_1 + \alpha_2 DYIELD_j + \alpha_3 PAYOUT_j + e_j$  are represented at the tables 2.4 below (with their sub-tables).

**Tables 2.4**

**Variables / Method <sup>b</sup>**

Model	Variables Entered	Variables Removed	Method
1	PAYOUT <sup>a</sup> , DYIELD	.	Enter

a. All requested variables entered.

b. Dependent Variable: PVOL

**Model's Elements**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,155 <sup>a</sup>	,024	-,091	,0587788	,024	,210	2	17	,813

a. Predictors: (Constant), PAYOUT, DYIELD

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	,346	,051		6,830	,000	,239	,452
	DYIELD	-,502	,975	-,131	-,515	,613	-2,560	1,556
	PAYOUT	-,017	,086	-,050	-,195	,848	-,199	,165

a. Dependent Variable: PVOL

**Coefficient Correlations(a)**

Model			PAYOUT	DYIELD
1	Correlations	PAYOUT	1,000	-,340
		DYIELD	-,340	1,000
	Covariances	PAYOUT	,007	-,029
		DYIELD	-,029	,952

a Dependent Variable: PVOL

**Observations:**

- Small  $R^2 = 0,024$  means that the model is not satisfactorily explained by the data.
- The coefficients of DYIELD and PAYOUT are negative. Indeed the coefficient of DYIELD is much bigger (at absolute value) than the PAYOUT coefficient. The same happens with their equivalent beta.
- Low importance (0,613) and (0,848) for the coefficients DYIELD and PAYOUT.
- Increase of 1% of DYIELD will bring about decrease about 0,25% in PVOL. The result is expected result since the companies of the FTSE-20 indicator are of high capitalisation with a small share price volatility observed.

We also observe that  $|beta\ DYIELD| > |beta\ PAYOUT|$  (per absolute value). Indeed in table 2.4 is  $abs(-0,131) > abs(-0,050)$ . This means that the variable DYIELD influences the PVOL more than PAYOUT does.

Baskin (1989) and Ball (1979)<sup>5</sup> claim in their similar studies, the existence of a negative correlation between the market risk and the dividend yield. On the contrary the study of Allen-Rachim discovers that the correlation between the two variables is positive, despite the theoretically admitted that coincide with the findings of trial and error studies of Baskin and Ball. The opinions are diverged and the doubts remain.

The next step is to study the PVOL regression on the two measurements of the payout policy, however the control variables GROWTH, SIZE, EVOL, and LDEBT in order to check whether they strengthen or weaken the above results of tables 2.4.

The new regression equation is the following:

$$PVOL_j = \alpha_1 + \alpha_2 DYIELD_j + \alpha_3 PAYOUT_j + \alpha_4 SIZE_j + \alpha_5 EVOL_j + \alpha_6 LDEBT_j + \alpha_7 GROWTH_j + e_j$$

Tables 2.5 bring the results below:

**Tables 2.5**

**Variables / Method <sup>b</sup>**

Model	Variables Entered	Variables Removed	Method
1	GROWTH, SIZE, EVOL, DYIELD, PAYOUT <sup>a</sup> , LDEBT		Enter

a. All requested variables entered.

b. Dependent Variable: PVOL

**Model's Elements**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,532 <sup>a</sup>	,283	-,047	,0575943	,283	,857	6	13	,550

a. Predictors: (Constant), GROWTH, SIZE, EVOL, DYIELD, PAYOUT, LDEBT

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	,566	,158		3,582	,003	,225	,907
	DYIELD	-1,067	1,009	-,279	-1,058	,310	-3,246	1,112
	PAYOUT	,120	,118	,355	1,019	,327	-,134	,374
	EVOL	-,042	,515	-,025	-,082	,936	-1,156	1,071
	SIZE	-,078	,051	-,457	-1,520	,153	-,188	,033
	LDEBT	,064	,063	,406	1,019	,327	-,072	,201
	GROWTH	-,280	,156	-,526	-1,791	,097	-,617	,058

a. Dependent Variable: PVOL

<sup>5</sup> Ball, R., Brown, P., Finn, F., and Officer, R.R. (1979) "Dividends and the value of the firm: evidence from the Australian equity market", Australian Journal of Management 4, 13-26.

**Coefficient Correlations (a)**

Model			GROWTH	SIZE	EVOL	DYIELD	PAYOUT	LDEBT
1	Correlations	GROWTH	1,000	,293	-,138	,259	-,537	-,492
		SIZE	,293	1,000	-,232	,224	-,321	-,617
		EVOL	-,138	-,232	1,000	-,166	-,122	,449
		DYIELD	,259	,224	-,166	1,000	-,381	-,251
		PAYOUT	-,537	-,321	-,122	-,381	1,000	,499
		LDEBT	-,492	-,617	,449	-,251	,499	1,000
	Covariances	GROWTH	,024	,002	-,011	,041	-,010	-,005
		SIZE	,002	,003	-,006	,012	-,002	-,002
		EVOL	-,011	-,006	,266	-,086	-,007	,015
		DYIELD	,041	,012	-,086	1,018	-,045	-,016
		PAYOUT	-,010	-,002	-,007	-,045	,014	,004
		LDEBT	-,005	-,002	,015	-,016	,004	,004

a Dependent Variable: PVOL

Observations:

1.  $R^2$  remains small but considerably higher than that of table 2.4 regression (table 2.6,  $R^2 = 0,283 > 0,024$  of table 2.4).
2. The relationship between DYIELD and PVOL remains negative, but it is higher per absolute value ( $1,067 > 0,502$ ). Thus, the payout yield DYIELD increase of 1% brings about decrease of about 0,5% to the PVOL, that is double risk (standard deviation) than the calculated one in the results of table 2.4 which is 0,25%. But again the risk is small and expected for the company size indicator that by structure is constituted by companies that give high dividend traditionally.
3. The variable coefficient PAYOUT is positive (0,120) so the relationship between PAYOUT and PVOL is positive, opposite to the one in table 2.4, but with higher measurement this time. The result remains a mystery and is opposite to the initial theoretical assumption about the negative relationship between PAYOUT and PVOL.
4. The coefficient beta of the two variables DYIELD and PAYOUT have been changed and it appears in our case that the influence of PAYOUT at risk of PVOL is higher than the one of DYIELD in PVOL

## 2.4 Multicollinearity DYIELD and PAYOUT.

It is of great importance the study of the phenomenon according to which while the DYIELD remains with negative coefficient in tables 2.4 and 2.5 regression, the same does not happen with the PAYOUT variable. Indeed in table 2.4 the PAYOUT has a negative coefficient (as it is hypothetically expected), but in table 2.5 it has a positive one. We suspect that there is multicollinearity between the two payout policy measurements DYIELD and PAYOUT. For this reason we carry out the regressions once without the DYIELD and another one without the PAYOUT. (The multicollinearity phenomenon is also mentioned and studied in the papers of Baskin (USA) and Allen-Rachim (Australia)).

### 2.6.1 Regression Results without the PAYOUT

$$PVOL_j = \alpha_1 + \alpha_2 DYIELD_j + \alpha_3 SIZE_j + \alpha_4 EVOL_j + \alpha_5 LDEBT_j + \alpha_6 GROWTH_j + e_j$$

**Tables 2.6**  
**Variables / Method**

Model	Variables Entered	Variables Removed	Method
1	GROWTH, SIZE, EVOL, DYIELD <sup>a</sup> , LDEBT	.	Enter

a. All requested variables entered.

b. Dependent Variable: PVOL

**Model's Elements**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,476 <sup>a</sup>	,226	-,050	,0576739

a. Predictors: (Constant), GROWTH, SIZE, EVOL, DYIELD, LDEBT

**Coefficients**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,564	,158		3,564	,003
	DYIELD	-,675	,934	-,176	-,723	,482
	EVOL	,022	,512	,013	,042	,967
	SIZE	-,061	,049	-,359	-1,257	,229
	LDEBT	,032	,055	,204	,589	,565
	GROWTH	-,194	,132	-,365	-1,472	,163

a. Dependent Variable: PVOL

We observe that the DYIELD coefficient remains negative (-0,675), that is it continues to confirm the hypothetical results about the negative correlation between DYIELD and PVOL.

**2.6.2 Regression results without the DYIELD.**

$$PVOL_j = \alpha_1 + \alpha_2 PAYOUT_j + \alpha_3 SIZE_j + \alpha_4 EVOL_j + \alpha_5 LDEBT_j + \alpha_6 GROWTH_j + e_j$$

**Tables 2.7**

**Variables/Method**

Model	Variables Entered	Variables Removed	Method
1	GROWTH, SIZE, EVOL, PAYOUT, LDEBT	.	Enter

a. All requested variables entered.

b. Dependent Variable: PVOL

**Model's Elements**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,471 <sup>a</sup>	,222	-,056	,0578371

a. Predictors: (Constant), GROWTH, SIZE, EVOL, PAYOUT, LDEBT

## Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	,522	,153		3,410	,004
	PAYOUT	,072	,109	,214	,664	,518
	EVOL	-,133	,510	-,078	-,260	,799
	SIZE	-,066	,050	-,386	-1,311	,211
	LDEBT	,048	,061	,300	,775	,451
	GROWTH	-,237	,151	-,445	-1,564	,140

a. Dependent Variable: PVOL

The PAYOUT coefficient is 0.072 positive, according to the results of tables 2.5 and 2.6. This result however is not expected and does not correspond with the theory, which wants the PAYOUT in negative relationship with the PVOL and is contrary to the study of Baskin and Allen-Rachim.

The results of tables 2.6 and 2.7 do not show us anything important or different than that which was revealed in the results of 2.4 and 2.5 tables. Furthermore, the multicollinearity phenomenon between DYIELD and PAYOUT, does not seem to considerably influence the previous results.

### 3. Results - Conclusions.

Lets gather the variable coefficients in table 3.1 as they were calculated in tables 2.4, 2.5, 2.6 and 2.7.

**Table 3.1**  
Study Results

	Table 2.4	Table 2.5	Table 2.6	Table 2.7
DYIELD	-0,502	-1,067	-0,675	.
PAYOUT	-0,017	0,120	.	0,072
EVOL	.	-0,042	0,022	-0,133
SIZE	.	-0,078	-0,061	-0,066
LDEBT	.	0,064	0,032	0,048
GROWTH	.	-0,28	-0,194	-0,237

We observe that in all tables the coefficient  $DYIELD < 0$ . This means that there is a high and obviously contrary relationship between DYIELD (payout yield) and PVOL (share price volatility), as it was theoretically expected. This relationship remains negative even by adding the control variables, such as the earning volatility, the company size, the debt indicators and the company growth. Therefore, it seems that the dividend yield DYIELD influences the share price and creates an information effect and arbitrage realization effects.

The second measurement of the payout policy, the PAYOUT (payout ratio), gives opposite results from the expected ones. Although in the first table it has a negative coefficient and shows signs of multicollinearity with the dividend yield DYIELD, in the other tables it turns into a positive coefficient and moves off the multicollinearity phenomenon. Our results keep partly a pace with the study of Baskin (USA 1989) (yes for the DYIELD, no for the PAYOUT) and are opposite to the one of Allen-Rachim (Australia-1996). Thus, the payout earnings do not seem to influence the PVOL or at least we cannot have secure results about how they influence the share price.

The SIZE variable, as the results are presented in 2.1 table, is negatively correlated with the share price volatility PVOL. This result is also theoretically expected. We also conclude to the same result for the GROWTH variable, by observing the negative correlation in all tables, as it was actually expected. As far as the rest two variables EVOL and LDEBT are concerned we cannot bring out secure results since the results alternate from positive to negative and vice versa.

The basic observation is that the coefficients are not statistically important (as it seems from the significance (sig.) of the t-statistic), in significance level 5%. Indeed in the all tables and for all variables we have  $sig. > 0,05$ . This phenomenon also occurs in the Allen-Rachim's study for the main unit of measurement of the payout policy, the DYIELD. This non-significance gives us the right to conclude that the anticipation

variables do not effectively contribute to the regression model that was used and therefore the results are controversial. We assume that the main explanation for the fact of non-significance (statistical) results is the almost small final number of observation (20 shares of FTSE -20 indicator).

Despite this, between two non-significant anticipate variables the one that mostly contributes to the regression equation is the one that has the higher absolute value of its coefficient. This observation was used to bring out the results of the above tables.

However, the main result remains the fact that the payout policy (and especially its measurement, the dividend yield) **can influence** the share price volatility, and consequently the share price itself and its yield.

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# IMPLEMENTATION OF THE DELPHI METHOD IN THE CHOICE OF AN ERP SYSTEM

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## Abstract

*The selection of a new ERP software package means a big commitment from organisations in terms of money and time as well as risks due to their complexity. Only a thorough and systematic selection of potential ERP implementation success factors can substantially increase the possibility that the selected ERP software and vendors will meet the true needs of the organisation.*

*This article looks at the process of planning the selection of ERP systems, based on the weighting of preferences from ERP specialists. However, the main difficulty lies in the agreement among the specialists on the utility factor of the selection criteria. To overcome this difficulty, the Delphi method was used where fifteen ERP specialists participated in a two-round Delphi survey. The first round was used in order to obtain a set of exclusive criteria for the selection of procurement system; while the last round was used to identify a statistical significance consensus on the weighing of the utility factors.*

## Περίληψη

*Η επιλογή ενός νέου πακέτου λογισμικού ERP αποτελεί μεγάλο έργο για τις οργανώσεις από την άποψη των χρημάτων και του χρόνου καθώς επίσης και πιθανούς κινδύνους που αυτό συνεπάγεται λόγω της πολυπλοκότητάς του. Μόνο μια λεπτομερής και συστηματική επιλογή των πιθανών παραγόντων επιτυχούς εφαρμογής του ERP μπορεί να αυξήσει αισθητά τη δυνατότητα ότι το επιλεγμένο λογισμικό και οι προμηθευτές ERP θα ικανοποιήσουν τις αληθινές ανάγκες του οργανισμού.*

*Το άρθρο εξετάζει τη διαδικασία επιλογής των συστημάτων ERP, βασισμένη στη στάθμιση των προτιμήσεων των ειδικών ERP. Εντούτοις, η κυριότερη δυσκολία βρίσκεται στη συμφωνία μεταξύ των ειδικών για τον βαθμό χρησιμότητας των κριτηρίων επιλογής. Για να ξεπεραστεί αυτό το πρόβλημα και να επιτευχτεί ομοφωνία μεταξύ των ειδικών χρησιμοποιήθηκε η Μέθοδος των Δελφών. Συγκεκριμένα, στην έρευνα συμμετείχαν δεκαπέντε ειδικοί. Η έρευνα ολοκληρώθηκε σε δυο γύρους. Ο πρώτος γύρος χρησιμοποιήθηκε προκειμένου να ληφθεί ένα σύνολο αποκλειστικών κριτηρίων για την επιλογή του συστήματος προμήθειας, ενώ ο δεύτερος γύρος χρησιμοποιήθηκε για να προσδιοριστεί στατιστικά ο βαθμός χρησιμότητας των παραγόντων.*

*Keywords: ERP, criteria, utility factors, Delphi method*

## INTRODUCTION

The nature of today's business environment is particularly competitive and demanding, with the result that enterprises resort to the use of advanced information systems in order to meet the demands of the modern age. The most widespread information system used by companies is ERP (Rebstock and Selig, 2000). Many ERP systems are available on the market, each with different characteristics. According to certain researchers, a decisive factor in the choice of a suitable system is its successful implementation (Petroni, 2002; Somers and Nelson, 2001). As a consequence, many researchers have researched which criteria of an ERP system are the most important during the selection phase (Kumar et al, 2003; Bernroider and Koch, 2001; Hecht, 1997). Since the number of criteria resulting from the research is quite large, the result is a lack of consensus between the experts. In order to overcome this problem the Delphi method was used.

The Delphi method is a multi-criteria method which is used in support of the experts' opinions. The technique was first used in the 50s in the USA, initially for military purposes and later for defence research purposes (Dalkey & Helmer, 1963; Helmer & Rescher, 1959). The method became established and in the last few years has been used increasingly in the field of research (Matthews et al., 1979; Spivey, 1971). Its use is

considered imperative in complex, interdisciplinary questions involving new and future trends (Akkermans et al., 1999; Klassen and Whybark, 1994).

The method would be carried out in two rounds and pose a series of questions to a team of experts. The repeated rounds give the experts the possibility of assigning the appropriate significance to the factors of usefulness. Fifteen experts participated in the research. The aim of this article is to reach a conclusion regarding the most important factors of usefulness criteria in the choice an ERP of system.

### BASIC CHARACTERISTICS OF THE DELPHI METHOD

There are five basic characteristics of the Delphi method (Loo, 2002; Mara, 2000):

- The composition of the team that will participate in the research.
- The anonymity of the team.
- The layout of questionnaires according to the method's cheques.
- It is a repetitive process, since it involves rounds.
- The existence of a form of analysis of the results, aiming at the reduction of risk of weaknesses that exist.

Some advantages and disadvantages of the Delphi method are presented in Table 1.

**Table 1: Benefits and drawbacks of Delphi Method**

ADVANTAGES	DISADVANTAGES
Consent of experts	Homogeneity of sample of experts
Anonymity	The experts must be willing to give the essential time and gravity to the research
Expression of opinions without fear	
Possibility of re-evaluation of opinions	Time-consuming process
Relatively cheap method, since it is carried out via computers	Maintenance of high quality of answers during the rounds
Feedback of research with new reflections	
Possibility of clarifications	

Sources: Bowles (1999), Sumsion (1998), Rudy (1996), Williams and Webb (1994), Jessup and Valacich (1993), Robinson (1991), Eden and Radford (1990), Nunamaker (1989), Reid (1988), Polit and Hungler (1987).

### CHOICE OF EXPERTS

The positive outcome of the Delphi method is ensured on the one hand by the fair selection of the individuals who will compose the team participating in the research, regardless of the number of individuals who will finally take part. The following two speculations have occupied many researchers, such as Lam et al. (2000), Schmidt et al. (2001) and Brancheau et al. (1996). For example, if it is necessary for the experts to have equal theoretical and practical knowledge of ERP, as in the present research, then suitable participants must be chosen in order for the research to have a successful outcome.

For this reason, for the present research, the 15 experts who were selected to participate have as much theoretical as practical knowledge of ERP. The names of the research's participants are not recorded in order to ensure anonymity.

### DELPHI ROUND ONE: IDENTIFICATION OF THE SELECTION CRITERIA

During the first round of the Delphi method, a questionnaire was sent to the experts that were selected to participate in the research. Initially, there was an introductory letter in the questionnaire that informed participants of the aims of research but also for which institution was being carried out. The experts were called to select from a list of criteria which they considered most important for the choice of a suitable ERP system. Specifically, a list of 15 criteria was given in the questionnaire for the choice of a suitable ERP system, which were a result of bibliographical research (Percin, 2008; Baki and Cakar, 2005; Kumar et al., 2003; Verville and Hallingten, 2002; Bernroider and Koch, 2001; Chen, 2001; Somers and Nelson, 2001; Themistocleous et al., 2001; Avshalom, 2000; Brewer, 2000; Everdingen et al., 2000; Illa et al., 2000; Mabert et al., 2000; Rao, 2000; Siriginidi, 2000; Sprott, 2000; Bingi et al., 1999; Hecht, 1997; Shikarpur, 1997). The experts were called on to select, in their opinion, the 10 most important criteria. Of course, it should it is noted that there was the possibility of criteria being included which were not on the proposed list

but that which they themselves considered important. Appendix 1 explains the 17 criteria that had been found from previous studies and literature surveys.

The treatment and the analysis of questionnaires occurred via the SPSS statistical package, edition 16. Specifically, horizontally on an SPSS page, the choice criteria of the suitable ERP system were registered, while in the corresponding vertical column was a questionnaire. The registration of data took place with coding 0 and 1. In other words, when an expert had selected a criterion, since he considered it important for the choice of ERP system, then this was recorded with the number 1 (very important), while the criterion not selected by the particular expert was recorded with a 0 (not significant). The next stage was the processing of questionnaires, aiming to ascertain the percentages relating to each criterion. The percentages corresponding to each criterion in the first round are presented in Table 2.

**Table 2. Criteria proposed by the experts in round one**

Criteria	Frequency of criterion by experts	Criteria	Frequency of criterion by experts
Cost	87%	Market position of the vendor	13%
Functionality	73%	Internationality of the vendor	13%
Service & support	67%	Cost of upgrade	13%
Ease of customization	67%	Obligation to the vendor	13%
Implementation time	40%	Platform	7%
Technical aspect	40%	Efficiency	7%
Cross module integration	40%	Security/privacy	7%
Compatibility with other systems	33%	Scaling	7%
Domain knowledge of software	33%	Viability vendor	7%
Vendor's vision	27%	Consulting Hellenic market	7%
Effective methodology of software	27%	Be Hellenist	7%
Consultancy	20%	Support from consultancy Hellenic market	7%
Parent/allied the default ERP System	20%	Number of consultancy Hellenic market	7%
Better fit with organization structure	13%	Scope for expansion	7%
Reliability	13%	Future industry production	7%
Friendliness	13%	Perfect system	7%
Fit with parent allied organization system	13%	Integrated system	7%
Usability	13%	Needs of company	7%
Vendors reliability in the core solution business	13%	Fit with parent allied vendors system	7%

For better processing, it was decided to regroup the results into categories in order to achieve better processing. Specifically, the groups that were created are the following: in the category consultancy are included the following criteria: consultancy, consultancy support in the Greek market, number of consultants in the Greek market and the experience of consultancy firms in the Greek market in terms of system installation. The percentage in this category is 41%. Moreover, in the category of vendor implementation time, apart from the time, reliability of vendor was also included. The percentage in this category is 26%. In the category vendor vision, apart from vendor vision is also included the robustness of the vendor company. The percentage in this category is 34%. Also, in the category better fit with organisation structure, apart from the former was also included the appropriateness of the system for the particular enterprise. The percentage in this category amounts to 47%. In the category of technical characteristics are included technical characteristics, platform, usefulness, safety, parameterisation, Hellenisation, the scope for expansion, efficiency, cost of upgrade, scaling. This category includes 100% of preferences. The category vendor's market position includes vendor viability. The percentage in this category is 20%. Finally, the methodology

of implementation includes also effectiveness, with a percentage of 34%. The results of this regrouping are presented in Table 3.

**Table 3. Grouping of the criteria proposed by the experts in round one**

Criteria	Frequency of criterion by experts	Criteria	Frequency of criterion by experts
Technical aspect	100%	Compatibility with other systems	33%
Cost	87%	Vendor's reliability in the core ERP solution business	26%
Functionality	73%	Market position of the vendor	20%
Ease of customization	67%	Fit with parent/allied organisation systems	13%
Service and support	67%	Internationality of the vendor	13%
Cross module integration	47%	Obligation to the vendor	13%
Consultancy	41%	Better fit with organisational structure	13%
Implementation time	40%	Fit with parent allied vendor system	7%
Effective methodology of the software	34%	Needs of company	7%
Vendor's vision	34%		

#### DELPHI ROUND TWO: IDENTIFICATION OF THE SELECTION CRITERIA

For the second round, the 19 most important criteria were selected, as presented in Table 3. In the questionnaire sent to experts are the criteria and percentages gathered for each criterion in the first round. In this round, the research participants were called upon to select on a scale of four points (very important, important, slightly important, not at all important), which criteria are considered important in the choice of an ERP system.

In this round the processing of questionnaires took place via SPSS, edition 16. Specifically, in this phase the rate of preference for each criterion in the second round was investigated. The analysis of data takes place using the same process as for the first round. The rate of preference of criteria in the second round according to the experts is presented in Table 4. The aim of the current research is to study the most important criteria in choosing an ERP system. Consequently, those criteria judged as important in the second round were those which achieved a percentage of above 60% in the categories important and very important, and are presented in Table 4.

**Table 4. Criteria proposed by the experts in round two**

Criteria	Frequency of criterion by experts	Criteria	Frequency of criterion by experts
Functionality	100%	Implementation time	57,1 %
Support from vendor	100%	Vendor's core reliability	57,1%
Technical aspect	85,7%	Compatibility with other systems	50%
Cost	71,5%	Market position of the vendor	50%
Cross module integration	71,5%	Internationality of the vendor	42,9%
Fit with parent/ allied organization systems	71,5%	Consultancy	35,7%
Ease of customization	71,4%	Effective methodology of the software	35,7%
Better fit with organisational structure	71,4%	Obligation to the vendor	14,3%
Needs of company	71,4%	Fit with parent allied vendors system	14,3%
Vendor's vision	64,3%		

## CONCLUSIONS

The criteria of choice of an ERP system is a subject that has greatly occupied the experts (Baki and Cakar, 2005; Shehab et al, 2004) and so a variety of opinions have been expressed regarding which criteria are important in choosing an ERP system. It has therefore been difficult to achieve unanimity of opinion on the part of some of the experts regarding importance of criteria. In the present research, it was thought advisable to use the Delphi method in order to achieve this unanimity of opinion from the experts. However, despite the advantages of this system, there are also certain difficulties in its application. Specifically, the choice of suitable experts with knowledge on the subject is difficult. At the same time, the experts need to be convinced to allocate the required time and a high level of response on the part of experts during the rounds must be safeguarded. Also, the researcher should be in close contact with the experts for resolution of any problems which may arise during the research. Consequently, quite a lot of time is required for completion of research. In spite of all this, the method is judged particularly important, as noted below, in order that we see which criteria are now considered important in the choice of an ERP system in the Greek market.

The present research is made up of two rounds. In the first round, the criteria of choice of ERP system that resulted from bibliographic research are included. In the second round the criteria resulting from the first round are included. With the analysis of results in the second round, the outcome is criteria that are considered important and very important for choice of ERP system in the Greek market today.

A future stage of the present research will be to request the opinion of users as to which criteria they consider important. Following this, an analysis will take place as to what extent the opinions of experts and users coincide in judging the criteria important for choice of an ERP system.

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### Appendix 1 A summary of the criteria found in literature

Criteria	Explanation
1. Functionality	The term functionalism has three sides: which functional regions the system covers so that enterprises' needs are satisfied, how much it is adapted to the data of the enterprise and also in the new technological data that comes up
2. Technical aspect	It uncovers the fit between IS and the needs of the end user
3. Cost	It includes the cost components of: software, hardware, consulting, training, implementation team, and other costs
4. Service and support	Support at the implementation phase and following the installation of the system
5. Vendor's vision	The modification that the vendor is planning to make to its products and services over the next years
6. Vendor's reliability in the core ERP solution business	The report becomes in the supplier and not in the ERP
7. Compatibility with other systems	The compatibility of ERP system with the remainder systems used by the enterprise
8. Ease of customisation	Aiming at its adaptation in the data of enterprise
9. Market position of the vendor	The supplier's market share
10. Better fit with organisational structure	The ERP system that will be selected should suit the organisational structure of the enterprise and be acceptable for its human recourse
11. Domain knowledge of suppliers	The particular characteristics and needs of enterprises that are included in the particular sector
12. Internationality of the vendor	Supplier which is active beyond the Greek market
13. Fit with parent/allied organisation systems	Compatibility with the system of enterprise
14. Cross module integration	A fully cross module integration is expected to be achieved; otherwise implementation time can be lengthen, implementation cost can be increased while the effectiveness of the system may be decrease
15. Implementation time	Case of overshooting of time involves further cost
16. Effective methodology of the software	How much the supplier of the ERP system follows a methodology of application, aiming at the rejection of useless and unnecessary activities
17. Consultancy	Use of advisors for the resolution of problems that will result at the implementation of ERP

Source: Percin (2008), Baki and Cakar (2005), Kumar et al (2003), Verville και Hallingten (2002), Bernroider and Koch (2001), Chen (2001), Somers and Nelson (2001), Themistocleous et al (2001), Avshalom (2000), Brewer (2000), Everdingen et al (2000), Illa et al (2000), Mabert et al (2000), Rao (2000), Siriginidi (2000), Sprott (2000), Bingi et al. (1999), Hecht (1997), , Shikarpur (1997).

# NEED AND IMPORTANCE OF INFORMATION TECHNOLOGY IN SMALL ENTERPRISES AND THE PROCESS OF DEVELOPING A JOB DESCRIPTION BY MANAGERS

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## Abstract

*In today's global economy, the personnel management of enterprises is based on the use of informative data and for this reason the methodical and effective managing of information, plays a huge role. In this project we are looking forward to recognizing the features of the informatics needfulness in the small enterprises and the practices/techniques of information technology that a company uses. A company's information technology (IT) structure and its brand architecture are intended to minimize transactional costs both within the organization, and between the organization and its customers. Therefore, small companies seem to be underdeveloped as far as informatics is concerned, and a lack in the incorporation of these new technologies is obvious and small companies require a closely specialization in information technologies. Moreover, we will examine the basic qualifications that the users of management information systems should be able to know as well, in order to demand a work position in a technology field and how managers develop a job description that a company needs. A job description is a list of the general tasks, or functions, and responsibilities of a position. Typically, it also includes to whom the position reports, specifications such as the qualifications needed by the person in the job, salary range for the position, etc. A job description is usually developed by conducting a job analysis, which includes examining the tasks and sequences of tasks necessary to perform the job. The analysis looks at the areas of knowledge and skills needed by the job. Note that a role is the set of responsibilities or expected results associated with a job. A job usually includes several roles.*

*The process of developing a job description helps managers articulate the most important outcomes that company needs from an employee performing a particular job. A job description is also a communication tool that tells co-workers where their job leaves off and the job of another starts. A well-written job description tells an employee where their job fits within the overall department and the overall company. In addition we will analyze the role of information technology in measuring the responsibilities of each employee.*

*Keywords: Information technology; Job description*

## 1. Introduction

The ability of corporations to manage their financial performance is emerging as a strategic issue for many companies. Not only the large companies face the informatics needfulness, but also small firms cope with the competitive environment which exists. The use of information technology has been found to improve business competitiveness, (Mellor, 1998) and a huge variety of innovative applications have been designed for solving many problems (Spectrum, 1997).

A company's information technology (IT) structure and its brand architecture are intended to minimize transactional costs both within the organization, and between the organization and its customers. Therefore, small companies seem to be underdeveloped as far as informatics is concerned, and a lack in the incorporation of these new technologies is obvious and small companies require a closely specialization in information technologies.



## **2. Literature**

The impact of information technology will definitely have significant effects on the structure, management and functioning of most organisations. It demands new patterns of work organisation and effects individual jobs, the formation and structure of groups, the nature of supervision and managerial roles. Although, rapid reduction in the cost of IT and reduction in the transactions risk of explicit coordination, makes possible substantially more usefully of explicit coordination with suppliers. Small firms survive through their internal cooperation, especially when dealing with industrial customers. Information technology results in changes to lines of command and authority, and influences the need for reconstructing the organisation and attention to job design (Wixom and Todd, 2005).

Computer based information and decision support systems influence choices in design of production or service activities, hierarchal structures and organisations of support staffs. Information technology may influence the centralisation/ decentralisation of decision making and control systems. Additionally, new technology has typical resulted in a flatter organisational pyramid with fewer levels of management required (Wanda J. Orlikowski, C. Suzanne Iacono, 2001). A bachelor's degree and many years of experience are generally the minimum requirements to become a computer and information systems manager. Knowledge of programming or systems analysis is also essential. In small computer installations, people without degrees who have experience as programmers can move up to become computer and information systems managers. Some college graduates gain their experience by working as a manager's assistant. College courses in mathematics, programming, and business help students prepare for jobs in data processing. A master's in business administration (MBA) may also be necessary, especially for those who want to be a manager at a large company. Many companies have training programs for their computer personnel. The federal government also sometimes offers training to people hired in lower level computer jobs.

In the case of new office technology it allows the potential for staff at clerical/operator level to carry out a wider range of functions and to check their own work (Paul P. Tallon, Kenneth L. Kraemer, 2003). Information systems affect choices such as division of work, individual tasks and responsibilities. The introduction of IT undoubtedly transforms significantly the nature of work and employment conditions for staff (Roach, S. S. 1991)

## **3. Methodology**

One questionnaire was designed for data collection and we conducted a survey among 173 enterprises and multinational companies in Greece. The results showed that small companies typically implement a basic difference in the usage of information technologies, in comparison with large enterprises. The advantage of this survey is that is being used a variety of samples including companies from different industries, of different sizes and in different positions within groups of international organizational structures, which increases the extent to which the results can be generalized to various types of companies.

Because information technology is bursting forward in a seemingly chaotic manner, it is difficult to figure out relevant business patterns which help guide business decisions. Computer and information systems managers direct and manage various computer-related activities of a company. They construct business plans, oversee Internet and computer operations, assign projects to staff members, and direct the flow of work. Computer and information systems managers work in manufacturing, industry, government, and educational institutions. They generally are in charge of facilities that have many programmers, systems analysts, and peripheral equipment operations. They report to the top management of their organizations. Computer and information systems managers must have general management ability as well as specific knowledge of the firm's computer systems. They must have a thorough working knowledge of programming and systems analysis. Computer and information systems managers must be able to communicate with all department heads in the company that require computer and network systems. They must be able to translate the requirements of each department into a workable computer operation. Then they must be able to instruct the information technology staff to carry out these procedures. Moreover, we measured the needfulness of some types of information technologies in small companies along with the fundamental skills that a person must have in order to apply for an IT occupation.

#### 4. Results

In our survey we have been used a sample of 173 enterprises in which 24.9% were companies that their activities were commercial products and 20.8% of them with services. Most of the companies are small and have few staff.

Our data analysis shows that small businesses are more likely to adopt information technologies. The majority of the companies used mainly ERP techniques, at 25,93% and workflow automation at 22,22%. The results of the survey reveal how important the information practices are in the function of firms. The extent of information system adoption is mainly determined by organizational characteristics, such as business size and level of employees' information systems knowledge. Finally, the environmental characteristic of competition has no direct effect on small business adoption of information systems. (Figure 1)

In addition, during our survey we found out that most companies hire persons with basic qualifications without any bachelor degrees for the use of information technologies. From one hand, enterprises prefer candidates with many degrees (24,22%) , but on the other hand there is a high percentage of candidates having a degree from a private institute. In addition to that, we have to mention that there is a low percentage of candidates with MBA, or University degree and PhD in IT. We conclude that small enterprises prefer to hire people with only fundamental qualifications, probably, because this reduces the cost to pay them. A high level expert in IT will demand higher salary for their skills. For this reason Information technology is becoming more and more important in business.

For this reason, computer and information systems managers must be promoted to the top management of their organizations. For example, managers can advance to the position of vice president of information systems. Computer and information systems managers also may be given management jobs outside the field of data processing. Computer and information systems management prepares them well for the planning and organization needed by successful managers. The use of computers in business and government will continue to increase. Qualified people will be needed to run the growing number of computers, computer networks, and Internet operations. However, there will be stiff competition for computer and information systems management jobs. Those with advanced education or experience in specific types of computer applications will have the best chance of employment. The employment outlook is very good for skilled people who keep up with new developments in this ever-changing field.

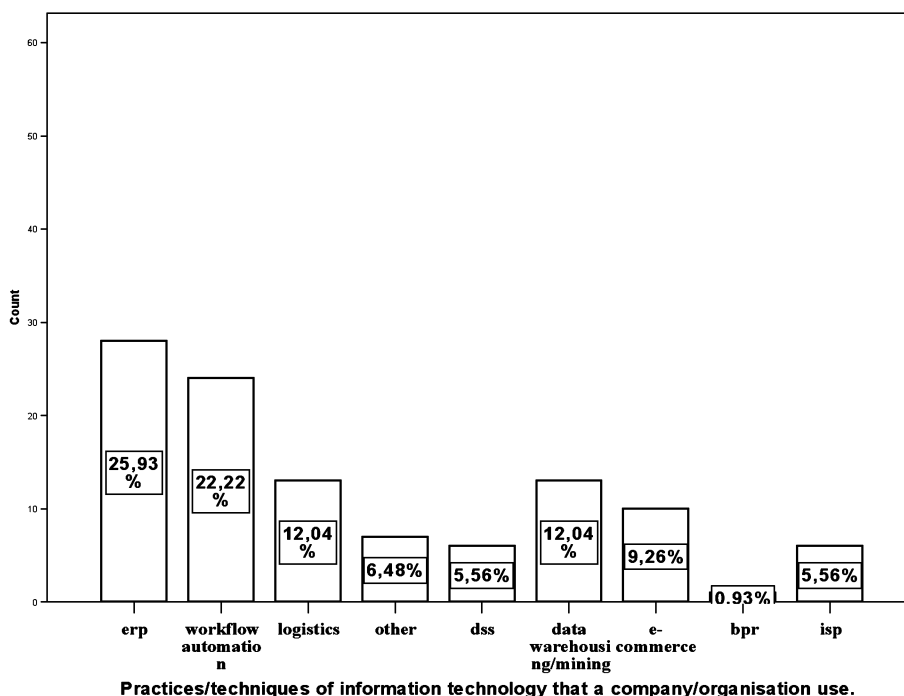


Figure 1. Practices/techniques of information technology that a company use.

## 5. Conclusion

The importance of information technology (IT) to businesses is widely acknowledged. Yet, while large businesses have been using computers for some time, small businesses have been slow in adopting IT. The results show that there are two main classes of variables that are important in determining adoption of an innovation: individual characteristics and organizational characteristics.

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# UNITED NATIONS HUMAN DEVELOPMENT INDEX-THE CASE OF GREECE

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## Abstract

*In this study we will present a comparative analysis between all United Nations indices concerning the progress of human development. In particular we will refer to the Human Development Index (HDI) and its disadvantages, and to other indicators complementing the HDI, as the Gender-related Development Index (GDI), the Gender empowerment Measure (GEM) and the Human Poverty Index (HPI).*

*First of all we will analyze what is the HDI, its importance, how is the HDI used and if the HDI is enough to measure a country's level of development. Furthermore we will show the calculation methods for all Human development indices, especially for the HDI. Finally, for the case of Greece, we will evaluate the comparative position of Greece among other Balkan countries and the Mediterranean countries members of European Union.*

## HISTORY OF THE HUMAN DEVELOPMENT REPORT

The Human Development Report was first launched in 1990 with the goal to emphasize the economic development for several countries members of the United Nations.

Since the first Report four new composite indices for human development have been developed, namely the Human Development Index (HDI) introduced in 1990, the Gender-related Development Index (GDI) introduced in 1995 Report, the Gender Empowerment Measure (GEM) also introduced in the 1995 Report and the Human Poverty Index (HPI) presented firstly in the Report of 1997.

The HD Report is an independent report. It is commissioned by the United Nations Development Programme (UNDP).

The HD Report of 2008, which uses 2006 data, has been calculated for 179 countries and territories. All data sources have been provide by the international agencies with expertise in each of the composite areas:

- The United Nations Population Division for life expectancy,
- The United Nations Educational, Scientific and Cultural Organization (UNESCO), Institute for Statistics for literacy and enrolment rates, and
- The World Bank for data on Gross Domestic Product (GDP) per capita, according to the statistics of the International Comparison Program (ICP), which is the world's largest statistical initiative and produces internationally comparable price levels, economic aggregates in real terms.

## DEFINITIONS

### HUMAN DEVELOPMENT INDEX(HDI)

HDI is a human development composite index. The use of HDI answers the question how two countries with the same level of income per person, can end up with such different human development outcomes.

HDI does not reflect political participation or gender inequalities. HDI can only offer a broad proxy on some of the key issues of human development, gender disparity and human poverty.

HDI is a summary measure of a country's average achievements in attaining:

- A long and healthy life, as measured by life expectancy at birth,
- Access to knowledge, as measured by 2 indicators: the adult literacy rate and combined gross enrolment ratio in primary, secondary and tertiary education,
- A decent standard of living, as measured by the GDP per capita expressed in Purchasing Power Parity (PPP US dollars).

HDI values between 0 and 1 and is used to classify the development level for each country. Values at or above 0,800 is for High human development, between 0,500 and 0,799 for Medium human development and below 0,500 for Low human development.

Life expectancy at birth is the number of years a newborn infant would live if prevailing patterns of age-specific mortality rates at the time of birth were to stay the same throughout the child's life.

Adult literacy is the proportion of the population aged 15 years and older which is literate, expressed as a percentage of the corresponding population, total or for a given sex in a given country at a specific time

usually mid-year. A person is literate if he can with understanding, both read and write a short simple statement on his everyday life.

Combined gross enrolment is the number of students enrolled in primary, secondary and tertiary levels of education, regardless of age, as a percentage of the population of theoretical school age for the 3 levels.

Gross Domestic Product is the sum of value added by all resident producers in the economy plus any product taxes not included in the valuation of output. Value added is the net output of an industry after adding up all outputs and subtracting intermediate inputs.

GDP per capita is the GDP divided by mid-year population.

HDI attempts to make an assessment of all diverse countries with very different price levels. To compare economic statistics across countries, the data must be converted into a common currency. So PPP (Purchasing Power Parity) rates of exchange allow this conversion to take account of price differences between countries. GDP per capita (PPP US\$) accounts for price differences between countries allowing international comparisons of real outputs of incomes and therefore reflect better people's living standards. In theory 1 PPP dollar has the same purchasing power in the domestic economy of a country as 1 US dollar has in the US economy.

### 1. GENDER-RELATED INDEX(GDI)

The Gender-related Development Index complements the three basic dimensions of HDI and is adjusted to account for inequalities between men and women.

### 2. GENDER EMPOWERMENT MEASURE(GEM)

The Gender Empowerment Measure (GEM) seeks to reflect the extent to which women and men are able to participate actively in economic and political life and take part in decision-making. While the GDI focuses on expansion of capabilities, the GEM is concerned with their use. GEM captures gender inequality in 3 key areas:

- Political participation, as measured by the percentage of seats held by women in national parliaments.
- Economic participation and decision-making power, as measured by the percentage shares of women and men among legislators, senior officials and managers as well as in professional and technical fields,
- Power over economic resources, as measured by the estimated earned income of females and males (in PPP US\$).

### 3. HUMAN POVERTY INDEX(HPI)

The Human Poverty Indices (HPI-1 and HPI-2) were introduced to address the need for measures that were disadvantaged within society, and complement concepts of poverty that were largely monetary.

The HPI-1 for developing countries measures the deprivation in:

- Vulnerability to early death, as measured by the probability at birth of not surviving to age 40 years,
- Exclusion from the world of knowledge and communication, as measured by the adult illiteracy rate,
- Lack of access to adequate economic provisioning, as measured by the average of 2 indicators, the percentage of the population not using improved water source and the percentage of children under weight for their age.

For the HPI-2 for industrialized (developed) countries the targets are set slightly higher:

- Vulnerability to early death, as measured by the probability at birth of not surviving to age 60 years,
- Exclusion from the world of knowledge and communication, as measured by the population aged 16-65 years,
- Lack of access to adequate economic provisioning, as measured by the percentage of the population living below the income poverty line,
- Social exclusion, as measured by the long-term unemployment rate ( for at least 12 months)

## CALCULATIONS OF HUMAN DEVELOPMENT INDEX-THE CASE OF GREECE

Any component of the HDI individual indices can be calculated according to the general formula:

**Index= (Actual value-Minimum value)/ (Maximum value-Minimum value)**

To construct the Human Development Index fixed minimum and maximum values have been established for each of these indicators:

- life expectancy at birth 25 years and 85 years
- adult literacy take 0% and 100%

- combined gross enrolment ratio 0% and 100%
- real GDP per capita (PPP US\$) \$100 and \$40000(PPP)

The life expectancy index measures the relative achievement of a country in life expectancy at birth. The formula is:

$$\text{Life expectancy index} = \frac{[(\text{life expectancy at birth}) - 25]}{[85 - 25]}$$

The Education Index measures a country's relative achievement in both adult literacy and combined primary, secondary and tertiary gross enrolment.

The formula is:

$$\text{Educational Index} = 2/3X (\text{adult literacy index}) + 1/3X (\text{combined gross enrolment ratio})$$

$$\text{Adult literacy index} = \frac{[\text{actual value} - 0]}{[100 - 0]}$$

$$\text{Combined gross enrolment ratio} = \frac{[\text{actual value} - 0]}{[100 - 0]}$$

GDP per capita only reflects average income, it tells nothing of how that income is distributed on health, education or military expenditure.

The formula for the Gross Domestic Product Index, in PPP US\$, is:

$$W(y) = \frac{[\log y - \log y_{\min}]}{[\log y_{\max} - \log y_{\min}]}, y \text{ is the GDP per capita (PPP US\$)}$$

The calculation for HDI is:

$$\text{HUMAN DEVELOPMENT INDEX} = 1/3X (\text{LIFE EXPECTANCY INDEX}) + 1/3X (\text{EDUCATION INDEX}) + 1/3X (\text{GDP INDEX})$$

### Calculating the HDI for Greece:

According to the HD Report 2008, which uses 2006 data, the values for Greece are the following:

- Life expectancy at birth: 79,1 years
- Adult literacy rate(% aged 15 and above): 97,0
- Combined gross enrolment ratio(%): 101,60
- Gross domestic product(PPP US\$): 31290

1. Calculating the life expectancy index:

$$\text{Life expectancy index} = \frac{(79, 1 - 25)}{(85 - 25)} = 54, 1/60 = 0,970$$

2. Calculating the education index:

$$\text{Adult literacy index} = \frac{(97, 0 - 0)}{(100 - 0)} = 0,970$$

$$\text{Gross enrolment ratio} = \frac{(101, 6 - 0)}{(100 - 0)} = 101, 6$$

$$\text{Education index} = 2/3X (\text{adult literacy index}) + 1/3X (\text{combined gross enrolment ratio}) = 2/3X 0,970 + 1/3X 101, 60 = 0,980$$

3. Calculating the GDP index:

$$\text{GDP index} = \frac{[\log (31290) - \log (100)]}{[\log (40000) - \log (100)]} = 0,959$$

4. Calculating the Human Development Index:

$$\text{HDI} = 1/3X (\text{life expectancy index}) + 1/3X (\text{education index}) + 1/3X (\text{GDP index}) = 1/3X 0, 970 + 1/3X 0, 980 + 1/3X 0, 959 = 0,947$$

### CONCLUSION

The UN Human Development Index Report of 2008 shows an upwards trend in human development and the reason for that is the improvement in economic performance and education for most countries worldwide. According to HDI Tables of the HD Report of 2008, which uses 2006 data, Iceland is on the first place on the U.N. world ranking list and Greece is on the 18<sup>th</sup> Rank among all United Nations countries, 3<sup>th</sup> of all South-European and Mediterranean countries-members of the European Union and first of all Balkan countries.

Comparing with the HD Report of 2007, which used 2005 data, there is a significant improvement for Greece, namely from the 24<sup>th</sup> Rank (in 2005 HDI was 0,926) to the 18<sup>th</sup> Rank (in 2006 HDI is 0,945). The GDI rank is for Greece the 15<sup>th</sup> and the GEM rank is the 26<sup>th</sup> according to the HD Report.

Very important is the column of the Comparison Table, showing GDP per capita (PPP US\$) minus HDI rank representative. A positive figure indicates that the HDI rank is higher than the GDP per capita (PPP US\$) rank, a negative the opposite.

Due to the world economy crisis of last year, which occurred great problems and the collapse for some countries of their national economy, there will be severe changes in the UN ranking list for many countries.

The comparison of all indices between Greece and the Balkan countries, and the Mediterranean European Union's member-countries shows that Greece is in the first place among the Balkan countries and in the third place among the Mediterranean EU countries. That means that Greece relating to the Human Development has a dominant position between them, and is very competitive.

In the Reports of the next two years, that means HDI Reports of 2010 and 2011, which will use 2008 and 2009 data accordingly, we will see several and severe changes in all indices. The main reason will be the world economic crisis beginning from autumn 2008 and the collapse of some national economies, as for example the first HDI ranked Iceland and some other countries.

Therefore we can conclude that the results for Greece concerning Human Development will remain the same and perhaps will be improved in the future, although there will be perhaps a change in the GDP Index which will influence slightly the final HDI.

In general we can conclude that the impacts of the current economic crisis are not yet reflected in the future Human Development Indices calculations.

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2. HUMAN DEVELOPMENT INDICES, A STATISTICAL UPDATE 2008, PUBLISHED FOR THE U.N.D.P.
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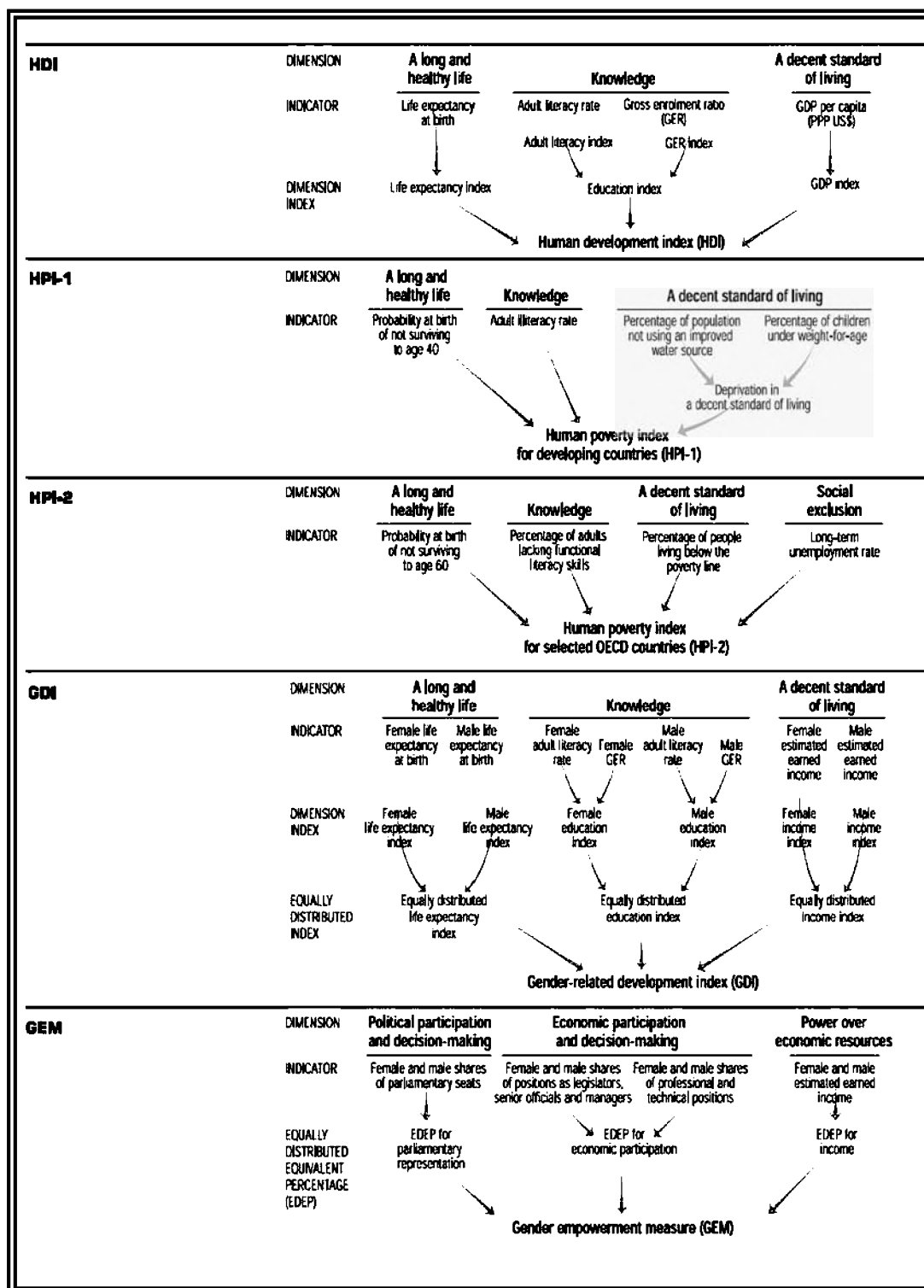
Table 1. Human Development Indices (HDI) 2006 - Comparison Table.

COUNTRIES	HDI RANK	HDI value	LIFE EXPECTANCY AT BIRTH (years)	LIFE EXPECTANCY INDEX	ADULT LITERACY RATE (% aged 15 and above)	COMBINED GROSS ENROLMENT RATIO IN EDUCATION (%)	EDUCATION INDEX	GROSS DOMESTIC PRODUCT PER (GDP) CAPITA (PPP US\$)	GDP INDEX	GDP RANK MINUS HDI RANK	GENDER RELATED DEVELOPMENT INDEX (GDI)	GENDER EMPOWERMENT MEASURE (GEM)	GDP INDEX
<b>EUROPEAN UNION</b>													
GREECE	18	0,947	79,1	0,901	97,0	101,6	0,980	31290	0,959	8	0,940	0,691	0,959
FRANCE	11	0,955	80,4	0,923	-	95,4	0,978	31980	0,963	12	,952	0,780	0,963
SPAIN	16	0,949	80,7	0,928	97,4	96,5	0,971	29208	0,948	11	,945	0,825	0,948
ITALY	19	0,945	80,4	0,923	98,8	91,8	0,965	28828	0,945	9	,939	0,734	0,945
CYPRUS	30	0,912	79,0	0,901	97,6	77,6	0,909	25837	0,927	0	0,910	0,615	0,927
PORTUGAL	33	0,900	77,9	0,882	94,6	88,8	0,927	20845	0,891	7	,897	0,741	0,891
MALTA	36	0,894	79,2	0,904	91,4	81,3	0,880	21715	0,898	1	0,889	0,529	0,898
BULGARIA	56	0,834	72,9	0,798	98,3	82,4	0,930	10295	0,773	9	0,832	0,605	0,773
ROMANIA	62	0,825	72,2	0,786	97,6	79,2	0,914	10-433	0,776	2	0,825	0,500	0,776
<b>BALKAN</b>													
CROATIA	45	0,862	75,5	0,842	98,6	77,2	0,915	14309	0,828	6	0,859	0,622	0,828
SERBIA	65	0,821	73,8	0,813	96,4	74,5	0,891	9468	0,760	9	0,818	0,584	0,760
FYROM	68	0,808	74,0	0,816	96,8	70,1	0,879	7921	0,730	10	0,803	0,644	0,730
ALBANIA	69	0,807	76,3	0,856	99,0	67,8	0,886	5884	0,680	27	0,804	-	0,680
BOSNIA & HERZEGOVINA	75	0,802	74,6	0,827	96,7	69,0	0,874	6801	0,704	14	-	-	0,704
TURKEY	76	0,798	71,6	0,776	88,1	71,1	0,824	11535	0,792	-15	0,780	0,371	0,792

SOURCE: UNDP, HUMAN DEVELOPMENT INDICES, REPORT 2008



Table 2. The diagrams here summarize how the five human development indices are constructed, highlighting both their similarities and their differences. Full details of the methods of calculation can be found at: <http://hdr.undp.org/technicalnote1>.



SOURCE: UNDP, HUMAN DEVELOPMENT INDICES, REPORT 2008

# GREEK CONTROLLED SHIPPING AND ITS IMPORTANCE TO THE WORLD ECONOMY

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## Abstract

*In this study we present statistical data and tables on the Greek controlled ships over 1000 GRT (GROSS REGISTERED TONS) and some other data on the Greek registered vessels over 100 GRT in order to indicate the great importance of the Greek shipping to the world trade and economy and furthermore to the Greek national economy. Most of the statistical data and tables have been provided by Lloyd's Register-Fairplay, other data concerning the Greek national Registry for vessels over 100 grt have been provided by the Hellenic Chamber of Shipping. Finally the very important statistics concerning the world tonnage have been provided by the Review of Maritime Transports of United Nations Conference on Trade and Development (UNCTAD), Edition 2008. On March 2009 appeared the new statistical data for 2008 provided by Lloyd's Register-Fairplay referring to the greek-owned shipping over 1000 grt. In this study in order to have a direct comparison with the data provided by the above mentioned Review Report of UNCTAD referring to the world shipping we will use both statistical data for 2007 and 2008.*

## 1. WORLD SHIPPING

Maritime transport remains the major backbone of international trade with over 80 per cent of world merchandise trade by volume being carried by sea. During the past three decades, the annual average growth rate of world seaborne trade is estimated at 3,1 per cent. At this rate, global seaborne trade would be expected to increase by 44 per cent in 2020 and double by 2031, potentially reaching 11,5 billion tons and 16,04 billion tons, respectively. Although maritime transport has generally been associated with the carriage of high-volume low-value goods (as iron ore and coal), over recent years the share of low-volume, high-value goods (as manufactured goods) carried by sea has been growing. According to the WORLD TRADE ORGANIZATION (WTO), manufactured goods account for over 70 per cent of world merchandise trade by value. Traded manufactured goods include consumption goods as well as intermediate goods, parts and semi-finished products that have expanded in tandem with intra-company trade, international outsourcing and globalization. As much of this trade is carried in containers, world containerized trade has grown significantly and is expected to grow over the coming years at a pace that will require a doubling of the container handling capacity. Traditional agriculture bulk cargo, as grain, are increasingly being transported in containers, avoiding the higher freight rates in the bulk market and reflecting the greater economies of scale available to larger containerships. These considerations highlight the economies importance of maritime transport and the potential for further growth in this sector and the expansion of the maritime cargo base to include lower-volume, higher-value goods.

Strong demand for maritime transport services was fuelled by growth in the world economy and international merchandise trade. In 2007, the gross domestic product (GDP) grew at 3,8 per cent while world merchandise exports expanded by 5,5 per cent over the previous year.

The world merchant fleet expanded by 7,2 per cent during 2007 to 1,12 billion deadweight tons (DWT) at the beginning of 2008. With historically high demand for shipping capacity, the shipping industry responded by ordering new tonnage, especially in the dry bulk sector. Vessel orders were at their highest level ever, reaching 10053 ships with a total tonnage of 495 million DWT. As of January 2008, nationals of the top 35 ship owning countries together controlled 95,35 per cent of the world fleet. Greece continues to maintain its dominant position, followed by Japan, Germany, China and Norway. These five countries together hold a market share of 54,2 per cent.

The operational productivity of the world fleet remained high in 2007, as demonstrated by the following key indicators, namely a) the comparison of cargo generation and fleet ownership, b) tons of cargo carried and ton-miles performed per deadweight ton and c) the supply of tonnage in the main shipping market sectors. The global average of tons of cargo carried per dwt of cargo carrying capacity was 7,7, namely the average ship was fully loaded 7,7 times during 2007. The ton-miles performed per deadweight reached 31,6, that means that the average dwt of cargo carrying capacity transported one ton of cargo over a distance of 31600 nautical miles (60375 km) in 2007 or 165 km per day. The thousands of ton-miles per dwt of oil tankers

decreased from 34,2 in 2006 to 32,5 in 2007, while the corresponding figure for dry bulk carriers increased from 28,8 to 29,5.

## 2. GREEK CONTROLLED SHIPPING

Table 1 shows the Greek controlled ships over 1,000 GT, registered under the Greek and other flags. The data has been provided by Lloyd's Register – Fairplay.

Compared with corresponding data from the previous year, shows that the Greek controlled fleet has slightly decreased in number of vessels, while increasing in deadweight (DW) and gross tonnage (GT). According to the data, as of 27.2.2009, Greek interests control 4,161 vessels of various categories, of 263,560,741 total DWT and 156,214,619 total GT, including, 1072 newbuilding vessels of 53,409,182 GT, of various categories, on order from shipyards. Compared with last years' data, this represents a decrease of 12 vessels comparing with 2008 (-0,30%) and an increase of 462 vessels comparing with 2007 (+12,50%), 2,631,520 DWT (1,00% and 20,77% respectively) and 1,615,345 GT (1,04% and 20,38% respectively).

**TABLE 1: GREEK CONTROLLED SHIPPING** (Greek-owned ships registered under various flags, including Greece's flag, over 1000 grt)

Date		Ships	DW	GT
March	1988	2,487	85,047,436	47,269,018
March	1989	2,428	81,928,296	45,554,419
February	1990	2,426	84,439,159	46,580,539
March	1991	2,454	87,102,785	47,906,852
March	1992	2,688	98,218,176	53,891,528
March	1993	2,749	103,958,104	56,918,268
March	1994	3,019	120,650,373	66,342,046
March	1995	3,142	126,128,352	71,666,943
March	1996	3,246	129,737,336	75,156,763
March	1997	3,204	127,782,567	74,982,110
February	1998	3,358	133,646,831	78,900,843
March	1999	3,424	139,255,184	83,454,890
March	2000	3,584	150,966,324	90,227,491
March	2001	3,618	168,434,370	100,220,348
March	2002	3,480	164,613,935	98,195,100
May	2003	3,355	171,593,487	103,807,860
March	2004	3,370	180,140,898	108,929,135
March	2005	3,338	182,540,868	109,377,819
March	2006	3,397	190,058,534	113,603,803
February	2007	3699	218,229,552	129,765,470
February	2008	4173	260,929,221	154,599,274
February	2009	4161	263,560,741	156,214,619

SOURCE: HELLENIC CHAMBER OF SHIPPING

The fleet registered under the Greek flag for vessels over 1000 grt, has also decreased. It now comprises 1121 ships, including 356 on order, against 1197 ships in 2008, including then 422 on order. This represents a decrease of 76 ships, 4,338,854 tons DW and 2,743,217 tons GT.

The following Table 2 shows the number of ships over 100 grt and their tonnage under the Greek flag.

**TABLE 2:SHIPS IN THE GREEK NATIONAL REGISTRY(vessels over 100 gt)**

DATE	NUMBER OF SHIPS	GROSS TONS
31 Dec. 1983	3422	37707377
31 Dec. 1984	2788	32334886
31 Dec. 1985	2456	28646166
31 Dec. 1986	2138	24792516
31 Dec. 1987	2061	22706257
31 Dec. 1988	2015	21368976
31 Dec. 1989	2004	20898119
31 Dec. 1990	2031	22524329
31 Dec. 1991	2062	24082483
31 Dec. 1992	2095	26055932
31 Dec. 1993	2166	29671983
31 Dec. 1994	2149	30535560
31 Dec. 1995	2051	30220636
31 Dec. 1996	2013	27935053
31 Dec. 1997	1927	25708074
31 Dec. 1998	1849	25171034
31 Dec. 1999	1850	25002463
31 Dec. 2000	1902	26895376
31 Dec. 2001	1959	29257366
31 Dec. 2002	1965	29204859
31 Dec. 2003	1974	31915727
31 Dec. 2004	1972	32769792
31 Dec. 2005	1901	31444245
31 Dec. 2006	1874	32765042
31 Dec. 2007	1916	36239543

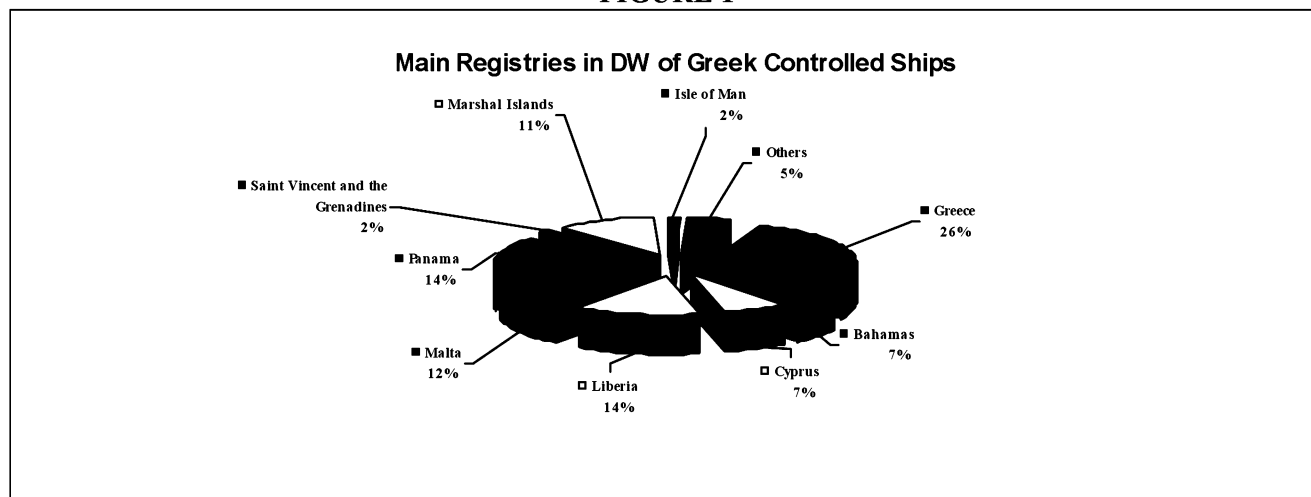
SOURCE: HELLENIC CHAMBER OF SHIPPING

Greek interests fleet controls around 8.2% of the world’s total number of vessels in service and on order, 15.2% of the world fleet deadweight, or 13.2% of the world fleet expressed in gross tons (against 8.7%, 16.4% and 14.01% for 2008- 8.4%, 16.1 % and 13.7% for 2007 respectively).

**2.1 Flag Analysis of Greek controlled shipping**

The Greek controlled fleet is registered under 49 Flags. Figure 1 concerning the main Registries in DWT of Greek controlled ships, shows the main registries used by Greek owners and in particular that after the Greek flag, Panama follows in the second place and then Malta , Liberia, Cyprus, Marshall Islands, Bahamas Isle of Man, Saint Vincent and Grenadines.

**FIGURE 1**



In terms of deadweight, after the Greek flag, with 1,121 ships of 89,531,241 DW in its register, Panama follows with 611 ships of 32,559,214 DW, Malta with 490 ships of 25,358,210 DW, Liberia with 574 ships of 37,669,397, Cyprus with 301 ships of 17,820,661 DW, the Marshall Islands with 446 ships of 27,600,658 DW and the Bahamas with 287 ships of 16,189,632 DW.

## 2.2 Ship Type and Age Analysis of Greek controlled shipping

Comparing with the data of the previous year (2008), there were no dramatic increases or decreases of the Greek controlled fleet, by ship type, in number of ships, in DWT and GRT.

1072 ships were on the order books for Greek account in February, 2009, against 1054 ships in February 2008, showing a slightly increase compared to last year. These are divided into the following categories: 165 oil tankers, 210 chemical & products tankers, 34 liquid gas carriers, 547 ore & bulk carriers, 56 pure container carriers, 38 cargo ships, 18 other ships and 4 passenger ships.

## 2.3 Ship Type and Age Analysis of the World Fleet and the Greek Fleet

The percentage of each type of Greek controlled vessel, in relation to the world total number of vessels and their DWT, of the corresponding type, for the years 2009, 2008, 2007 and 2006 was as follows:

### Oil Tankers

Percentage of Number of Ships 2006:	24.1
Percentage of Number of Ships, 2007:	24.1
Percentage of Number of Ships 2008:	22.9
Percentage of Number of Ships, 2009:	22.3
Percentage of Total DW 2006:	21.1
Percentage of Total DW 2007:	21.8
Percentage of Total DW 2008:	20.9
Percentage of Total DW 2009:	20.4

### Chemical & Products Tankers

Percentage of Number of Ships, 2006	8.5
Percentage of Number of Ships, 2007:	9.6
Percentage of Number of Ships, 2008	9.8
Percentage of Number of Ships, 2009:	9.4
Percentage of Total DW 2006:	12.6
Percentage of Total DW 2007:	14.4
Percentage of Total DW 2008:	14.0
Percentage of Total DW 2009:	13.3

### Liquid Gas Carriers

Percentage of Number of Ships 2006:	7.7
Percentage of Number of Ships, 2007:	8.2
Percentage of Number of Ships 2008:	8.9
Percentage of Number of Ships, 2009:	9.8
Percentage of Total DW 2006:	6.8
Percentage of Total DW 2007:	6.4
Percentage of Total DW 2008:	6.6
Percentage of Total DW 2009:	6.9

### Combination Carriers

Percentage of Number of Ships 2006:	22.5
Percentage of Number of Ships, 2007:	9.5
Percentage of Number of Ships 2008:	7.4
Percentage of Number of Ships, 2009:	5.6
Percentage of Total DW 2006:	27.5
Percentage of Total DW 2007:	12.6
Percentage of Total DW 2008:	6.0
Percentage of Total DW 2009:	4.6

### Ore & Bulk Carriers

Percentage of Number of Ships 2006:	21.0
Percentage of Number of Ships, 2007:	20.4
Percentage of Number of Ships 2008:	19.8

Percentage of Number of Ships, 2009:	18.1
Percentage of Total DW 2006:	22.1
Percentage of Total DW 2007:	22.3
Percentage of Total DW 2008:	21.9
Percentage of Total DW 2009:	19.1

#### **Container Carriers**

Percentage of Number of Ships 2006:	4.0
Percentage of Number of Ships, 2007:	4.0
Percentage of Number of Ships 2008:	4.6
Percentage of Number of Ships, 2009:	4.5
Percentage of Total DW 2006:	4.4
Percentage of Total DW 2007:	4.7
Percentage of Total DW 2008:	5.9
Percentage of Total DW 2009:	5.7

#### **Other Cargo Ships**

Percentage of Number of Ships 2006:	4.0
Percentage of Number of Ships, 2007:	4.0
Percentage of Number of Ships 2008:	1.0
Percentage of Number of Ships, 2009:	1.0
Percentage of Total DW 2006:	5.3
Percentage of Total DW 2007:	5.1
Percentage of Total DW 2008:	1.6
Percentage of Total DW 2009:	1.9

#### **Passenger Ships**

Percentage of Number of Ships 2006:	6.8
Percentage of Number of Ships, 2007:	7.1
Percentage of Number of Ships 2008:	6.5
Percentage of Number of Ships, 2009:	6.7
Percentage of Number of Ships 2008:	5.8
Percentage of Number of Ships, 2009:	6.0

Greek controlled tonnage remained in first place globally and has slightly decreased. In particular, the percentage of Greek controlled tonnage compared with the world fleet is as follows: Number of ships 8.2% (8.7% in 2008, 8.5% in 2007, 8.4% in 2006), GT 13.2% (14.1% in 2008, 14.0% in 2007, 13.7% in 2006) and DW 15.2%

(16.4% in 2008, 16.5% in 2007, 16.1% in 2006). Moreover, the presence of Greek owners is particularly significant in the categories of ships carrying the majority of the world's bulk cargo, i.e. oil tankers and bulk carriers.

#### **2.4 Average Age Analysis of ships owned by Greek Fleet and World Fleet**

The average age of the Greek controlled vessels has decreased further during the past years and is currently exactly 1 year below the average age of the world fleet. It now stands at 11.9 years in 2009, against 12.5 in 2008, 14.3 in 2007, 15.3 years in 2006, 15.9 years in 2005, 16.8 years in 2004, 17.4 years in 2003, 19.6 years in 2002, 20.0 years in 2001 and 20.3 years in 2000, with a corresponding age decrease in relation to DW and GT. In particular, in terms of GT, the average age of Greek controlled vessels is in 2009 8.4 years against 8.6 in 2008, 10.5 in 2007, 11.7 in 2006, 11.9 in 2005, 12.6 years in 2004, 13.1 in 2003, 15.9 in 2002, 16.8 in 2001 and 17.6 in 2000. In terms of DW, it is in 2009 8.3 years, against 8.6 in 2008, 10.1 in 2007, 11.3 in 2006, 11.5 in 2005, 12.2 in 2004, 12.7 in 2003, 15.6 in 2002, 16.6 in 2001 and 17.4 in 2000. The average age of the existing Greek flag ships, has also decreased, in terms of ship numbers, in 2009 standing at 9.5 years, against 9 in 2008, 11.1 in 2007, 11.7 in 2006, 11.6 in 2005, 12.7 in 2004, in terms of GT, 5.8 years in 2009, against 5.5 in 2008, 6.6 in 2007, 7.4 in 2006, 7.1 in 2005, 7.6 in 2004, and in terms of DW, 5.2 years in 2009, against 5 in 2008, 5.9 in 2007, 6.9 in 2006, 6.5 years in 2005, 7.1 years in 2004.

The average age of the world fleet, has also decreased in terms of ship numbers, standing at 14.4 years in 2007 (14.9 years in 2006, 15 years in 2005), in terms of GT 9.5 years in 2007 (10 years in 2006, 10.1 years in 2005) and in terms of DW 9.2 years in 2007 (9.8 years in 2006, 9.7 years in 2005).

## 2.5 Class Analysis of Greek controlled shipping

The following 6 major IACS(International Association of Classification Societies) share the bulk of the Greek controlled fleet: Lloyd's Register(LR) with 914 ships (878 ships in 2008, 825 in 2007, 773 in 2006), American Bureau of Shipping(ABS) with 787 ships (766 in 2008, 612 in 2007, 583 in 2006), Det Norske Veritas(DNV) with 592 ships (598 in 2008, 569 in 2007, 466 in 2006), NK with 470 ships (492 in 2008, 476 in 2007, 464 in 2006), Bureau Veritas(BV) with 541 ships (462 in 2008, 447 in 2007, 437 in 2006), and Germanischer Lloyd(GL) with 229 ships (216 in 2008, 171 in 2007, 168 in 2006).

## 3. RESULTS-CONCLUSION

Greece continues to be the country with the largest controlled fleet in the world, followed by Japan, Germany, China and Norway. Thirty-two per cent of the greek-controlled fleet use the national flag, versus 68 per cent using foreign flags. As regards vessel types, the majority of about 47 per cent of the greek-controlled fleet belongs to dry bulk carriers, about 44 per cent to oil tankers, about 5 per cent to containerships and the rest to other vessels. Greece has according to the statistical data of February 2009 the most powerful maritime fleet controlling about 4161 ships over 1000 grt of various categories, about 264 millions DWT and about 156 millions GRT. Greek controlled shipping represents about 15% of the world fleet in deadweight and about 50% of the European Union's fleet. The European-controlled fleet represents about 40% of world tonnage and the European Union's flagged shipping about 19% of the world fleet.

The imported shipping currency over 17 million EURO'S represents a major role in the Greek Balance of External Payments (Table 3) and diminishes its deficit. In Greece the shipping companies under Law 89/1967 covering greek shipping for the year 2002 were in total 1080, in particular 640 operating companies and 440 chartering and brokering companies.

Greek controlled shipping represents about 7% of the Greek Gross National Product (GNP) and covers about 50% of the deficit of the Balance of External Payments. In the greek shipping sector are employed directly or indirectly in general about 250000 Greeks, that means that the income of 1 of 14 taxpayers in Greece is depending directly or indirectly on shipping.

Although the problems occurred due to the world economy crisis of last year which influences the new orders of ships, we believe that Greek controlled shipping will remain on the first place in the world fleet, especially in Bulk shipping.

**TABLE 3: GREEK IMPORTED SHIPPING CURRENCY**

YEAR	MILLIONS \$US	YEAR	MILLIONS \$US
1975	845	1992	1993,1
1976	914,1	1993	1920
1977	1126,6	1994	1957,1
1978	1177,2	1995	2189,8
1979	1519	1996	2263,5
1980	1816	1997	2104,2
1981	1826	1998	2173,2
1982	1655	1999	5141
1983	1305	2000	7914,2
1984	1100	2001	8165,7
1985	1037	2002	11127,3
1986	1001	2003	12493,4
1987	1194	2004	13307 EUROS
1988	1379,6	2005	13871 EUROS
1989	1374,8	2006	14324,7 EUROS
1990	1761,9	2007	16939,3 EUROS
1991	1774		

SOURCE: HELLENIC CHAMBER OF SHIPPING

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# INTERNATIONAL FINANCIAL REPORTING STANDARDS IN GREECE REAL ESTATE SECTOR

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## Abstract

*The present paper compares the financial statements of all listed companies of the Real Estate Sector of Athens Stock Exchange for the year ended 31/12/2004, which were prepared both with Greek Accounting Standards and International Accounting Standards. More specifically, it analyses the financial figures from Balance-Sheets and Income Statement, which were published in the annual reports of the specific companies for the year 2005. The different accounting practices, which enforced by International Accounting Standards create remarkable differences, which have been investigated poorly. The paper tries to detect and to distinguish these differences. The data are presented via vertical analysis (common size statements) and financial statements analysis (ratios).*

*Key words: Accounting; Greece; International; Standards; Harmonization; Real Estate.*

## 1. Introduction

The Accounting Directives of the European Union which constitute its own Accounting Standards and which they have been adopted by all the countries – members differ from International Accounting Standards ([www.pwcglobal.com](http://www.pwcglobal.com)). The Directives aim mainly in the protection of enterprises as source of the social economy (producing goods and offering jobs), while International Accounting Standards aim mainly in the information of investors and in the functionality of stocks exchange (Grigorakos, 2004).

European Union in order to increase the comparability of the accounting practices not only on communal, but also on international level, it imposes the adoption of International Accounting Standards in its countries – members with the regulation 1606/2002.

As regards Greece, the Corporate Law 2190/1920 “Disclosures about Societe Anonyme”, which was modified with Law 3229/2004, forced all the listed companies to publish their financing statements from 1/1/2005 according to the International Accounting Standards.

The obligation of listed companies to publish for the first year of adoption comparative financial figures both with Greek Accounting Standards and International Accounting Standards forced with International Financial Reporting Standards 1. This fact provides a direct comparison of the adoption (Papadeas, 2005).

More specifically, listed companies were forced to publish information about reconciliation in Equity and reconciliation in Net Profit/(Loss) accounts. Fortunately, many of the companies presented also comparative figures for Balance-Sheet and for Income Statement. As a result there are adequate data to detect the implications.

In 2004 and 2005 the sector of Real Estate included nine companies. The effort to analyze all the listed companies of the specific sector conducted with the rationale to avoid as many errors as it was possible from predictions and estimations. Six of them published comparatives figures for Balance-Sheet and Income Statement, while the other three published only comparatives figures for reconciliation in Equity and in Net Profit/(Loss) accounts.

In this paper, the Greek Accounting Standards and the International Accounting Standards will be referred to as GAS and IAS respectively.

The remainder of the paper is organized as follows: the second section analyzes data which are referred to Total Assets, to Liabilities, to Equity and to Net Profit/(Loss) with the use of vertical analysis. The third section presents the financial statement analysis with the use of three ratios (debt ratio, debt-to-equity ratio and return on equity). Both techniques identify quite successful any irregularities, anomalies and areas of significant change (Elliott, 2006). The fourth section referred to the conclusion.

## 2. Results of the published Financial Statements

Table 1 presents all the financial figures (www.ase.gr), from the nine companies, both with GAS and IAS for the year ended 31/12/2004, which analyzed from the article.

It should be pointed out that three companies (“Alpha”, “Kekrops” and “Elviemek”) did not publish comparative figures for Total Assets and Total Liabilities.

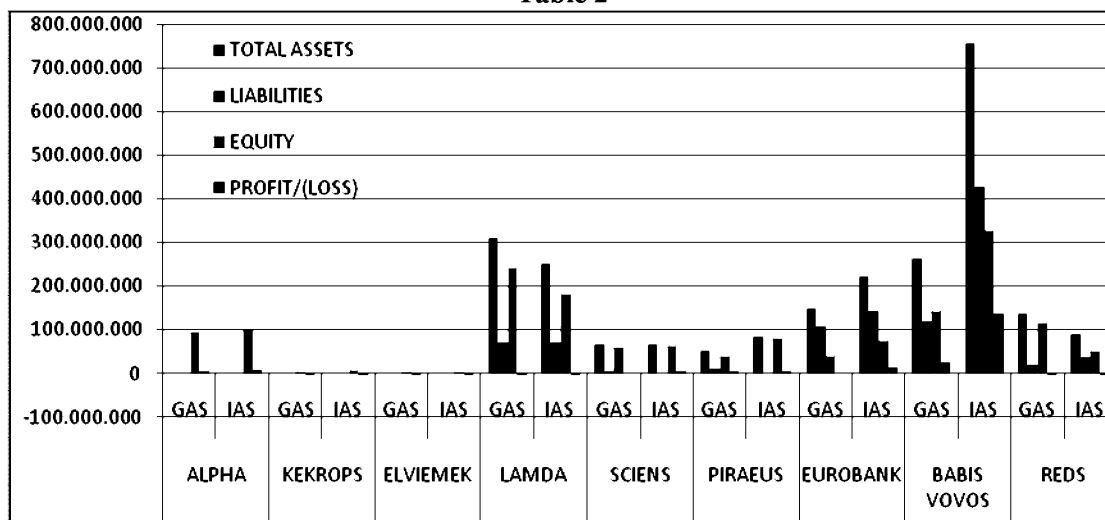
A quick observation distinguishes essential differences. For example six companies (“Alpha”, “Elviemek”, “Lamda”, “Sciens”, “Eurobank” and “Babis Vovos”,) presents substantial increases in Net Profit/(Loss) with IAS as regards GAS, while two companies (“Kekrops” and “Reds”) shows significant decrease. Moreover, substantial changes are revealed also in Total Assets such as in three companies (“Piraeus”, “Eurobank” and “Babis Vovos”), where figures increased with IAS, while in two other companies (“Lamda” and “Reds”) figures decrease with IAS.

These changes are presented diagrammatically in Table 2 (Frangos, 2002).

**Table 1**

PUBLISHED FINANCIAL FIGURES IN € - 31/12/2004 - REAL ESTATE SECTOR					
LISTED COMPANIES		TOTAL ASSETS	LIABILITIES	EQUITY	NET PROFIT/(LOSS)
<i>ALPHA ASTIKA AKINITA S.A.</i>	GAS			95.460.215	6.671.171
	IAS			99.109.118	7.217.280
<i>KEKROPS S.A.</i>	GAS			4.862.000	53.000
	IAS			8.662.000	1.000
<i>ELVIEMEK S.A.</i>	GAS			6.890.740	357.502
	IAS			6.492.029	422.941
<i>LAMDA DEVELOPMENT S.A.</i>	GAS	311.875.376	69.729.888	242.145.488	-584.813
	IAS	250.855.955	69.729.888	181.126.067	34.361
<i>SCIENS INTERNATIONAL INVESTMENT AND HOLDINGS S.A.</i>	GAS	65.942.000	4.376.000	61.566.000	2.421.000
	IAS	65.658.000	2.517.000	63.140.000	5.227.000
<i>PIRAEUS REAL ESTATE INVESMENT COMPANY</i>	GAS	51.794.000	11.155.000	40.639.000	6.805.000
	IAS	83.620.000	1.282.000	82.338.000	6.688.000
<i>EUROBANK PROPERTIES REIC</i>	GAS	149.259.000	108.278.000	40.981.000	3.765.000
	IAS	221.374.000	144.402.000	76.972.000	14.000.000
<i>BABIS VOVOS INTERNATIONAL TECHNICAL S.A.</i>	GAS	264.554.000	120.704.000	143.850.000	24.739.000
	IAS	757.084.000	428.864.000	328.220.000	137.786.000
<i>REDS S.A.</i>	GAS	136.397.728	18.921.624	117.476.104	277.603
	IAS	90.988.061	38.119.140	52.868.921	-511.210

**Table 2**

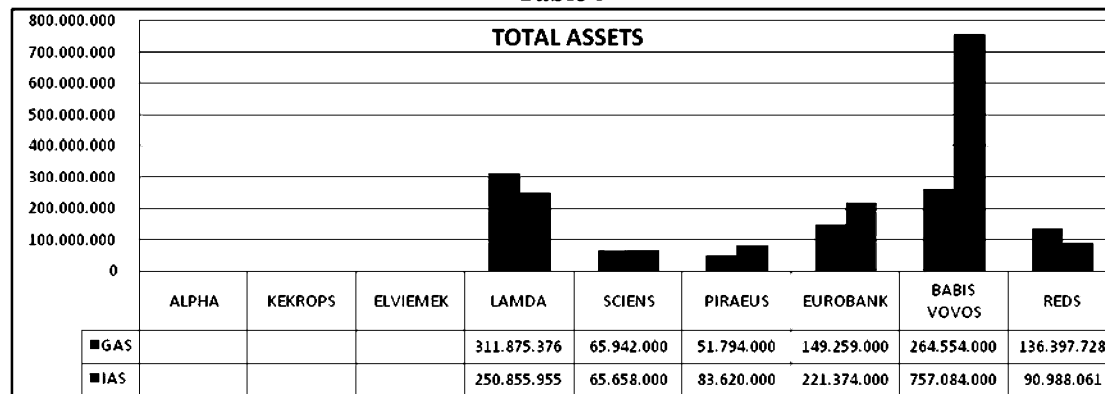


For better and more direct comparison the analysis involves separately reports to the changes according the four important categories of financial figures (Papailias, 2006):

- Total Assets, where derive also the changes in the Total Equity and Liabilities (Table 3 and 4)
- Liabilities (Table 5 and 6)
- Equity (Table 7 and 8)
- Net Profits/(Loss) (Table 9 and 10)

Table 3 reflects the figures of Total Assets with the two accounting frameworks (GAS and IAS), as they were published in 31/12/2004.

**Table 3**



For better presentation table 4 was created. It shows the analogy of Total of Assets with IAS as regards GAS (figures of Total Assets with IAS divided by figures of Total Assets with GAS). The followings are observed:

- one (“Babis Vovos”) of the six companies present almost two times increase on Total Assets with IAS. This is owed mainly to the increase in “investments property”<sup>1</sup> and “tangible assets”<sup>2</sup> accounts, where

<sup>1</sup> Under IAS 40 property that is held for long-term rental yields or for capital appreciation or both, and that is not occupied by the companies in the consolidated Group, is classified as investment property. Investment property comprises freehold land, freehold buildings and property held under finance leases. Investment property is measured initially at its cost, including related transaction costs. Valuations are performed in accordance with the guidance issued by the International Valuation Standards Committee at periodic intervals not exceeding six months. According to GAS companies classified investment properties under fixed assets that were recorded at cost, adjusted by depreciation, so with GAS there is no discrimination for investment property

<sup>2</sup> Tangible assets according to GAS are evaluated with their acquisition value, while with IAS 16 they are evaluated either with their fair value (value of sale), which is determined by independent professionally valuers or with the revaluation method. Revaluation according to GAS is becoming in current value and if the difference with the

according to IAS 40 their values are revaluated with base the value which determined by independent professionally qualified valuers (Filios, 2003)

- “Sciens” did not present any changes
- two companies (“Piraeus” and “Eurobank”) presented an increase of almost half time with IAS, due to the increase in the value of “investments property” account
- while two enterprises (“Lamda” and “Reds”) presented reduction with IAS almost 0,3 times, because of the small increase in the “investments property” and greater reduction in the “tangible assets” and in the “investments in subsidiaries or affiliated entities”<sup>3</sup> account

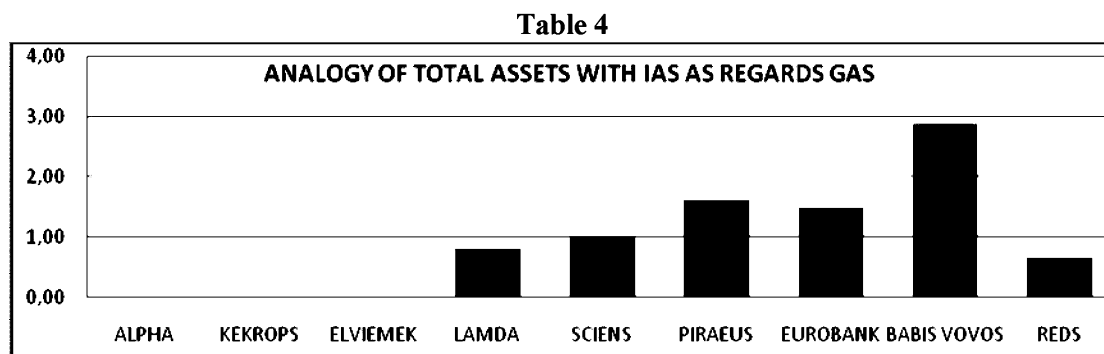


Table 5 presents Liabilities both with the two accounting framework (GAS and IAS), as they were published in 31/12/2004. Table 6 shows the analogy of Liabilities with IAS as regards GAS (figures of Liabilities with IAS divided by figures of Liabilities with GAS). It is worth mentioning that:

- figures of “Babis Vovos” increased more than two and a half times with IAS. This explained mainly from (IAS 17) recognition of 250.000.000€ “debts of finance leases” and from (IAS12) deferred tax liabilities” 58.000.000€, (Arthur Andersen, 2002)
- Liabilities of “Reds” increased one time, something that is explained mainly from 18.326.836€ “Provision-Liabilities”<sup>4</sup> (IAS 37) about for the cover of obligation of repurchase of action of subsidiary company ([www.iasb.org/standards/summaries.asp](http://www.iasb.org/standards/summaries.asp))
- figures of “Sciens” reduced half time of Liabilities with IAS due to appearance of “dividends payable”<sup>5</sup>, 1.874.000€ in the retained profits

accounting value is positive, it is registered in the revaluations, while if it is negative in retained earnings. Revaluation is allowed only every four years with specific percentages (law 2065/1992) and is limited only in land and buildings, while IAS 16 forecasts that revaluation could be conducted by the company in all the tangible assets when the company consider changes in the fair value and with base the value which determined by independent professionally qualified valuers

<sup>3</sup> Subsidiaries companies according to IAS 27 and IAS 28 are companies over which the Group, directly or indirectly, controls their financial policies, while associated (affiliated) companies are companies over which the Group exercises significant influence, but not control, that is holding percentage between 20% and 50% of the voting rights. GAS do not allow the total consolidation of subsidiaries with different objective of the parent company

<sup>4</sup> According to IAS 37 provisions for legal claims are recognized when: 1) the Group has a present legal or constructive obligation as a result of past events, 2) it is more likely than not that an outflow of resources will be acquired to settle the obligation 3) and the amount has been reliably estimated. Where there are a number of similar obligations, the likelihood that an outflow will be required in settlement is determined by considering the class of obligations as a whole. A provision is recognized even if the likelihood of an outflow with respect to any one item included in the same class of obligations may be small. Where the Group, as a lessee, is contractual required to restore a leased in property to an agreed condition, prior to release by a lessor, provision is made for such costs as they are identified. Provisions are measured at the present value of management’s best estimate of the expenditure required to settle the present obligation at the balance sheet date. The discount rate used to determine the present value reflects current market assessments of the time value of money and the risks specific to the liability. GAS specify that provisions must be recognized for every risk that should be located, except income and if the amount cannot be allocated, then it must be disclosed in the explanatory notes

<sup>5</sup> According to IAS 10 a provision is made for the estimated minimum statutory dividend expected to be payable to the Company’s shareholders for each period. Any dividends in excess of the minimum statutory dividend are recognized as a liability by the Company in the period when such dividends are approved for distribution by either the board of directors or the shareholders. With GAS dividends were recognized and registered as obligation without the final approval of board of directors or approvers

- and the reduction almost one time of Liabilities with IAS of “Piraeus” company, because deletion of “forecasts of - obligations” by 3.131.000€, which had become in previous uses for depreciation of real estates and because appearance of “dividends payable” by 6.736.000€, in the retained profit, that is to say in Total Equity and Liabilities

Table 5

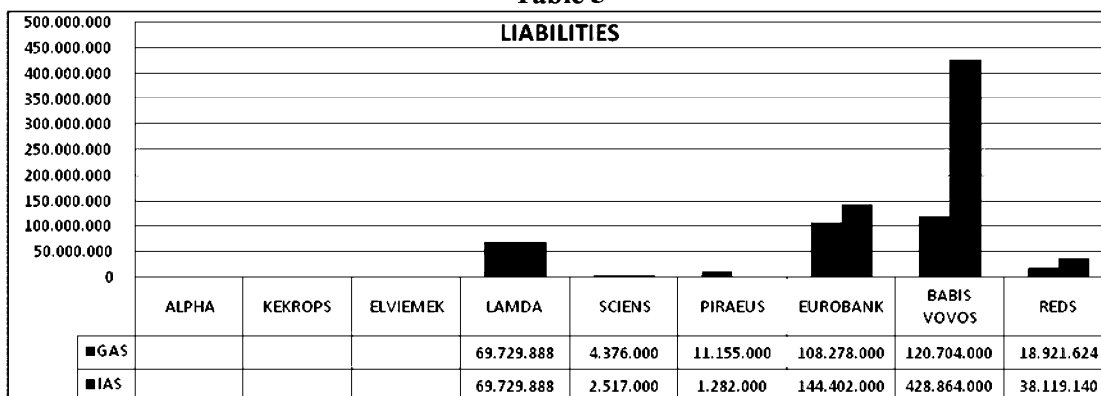


Table 6

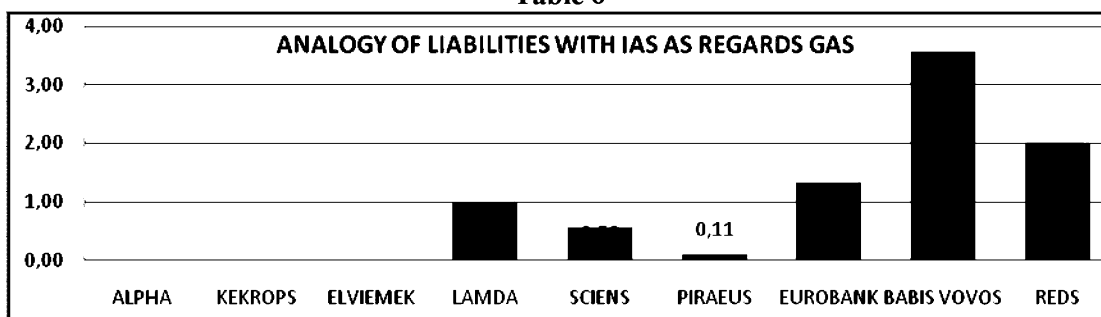
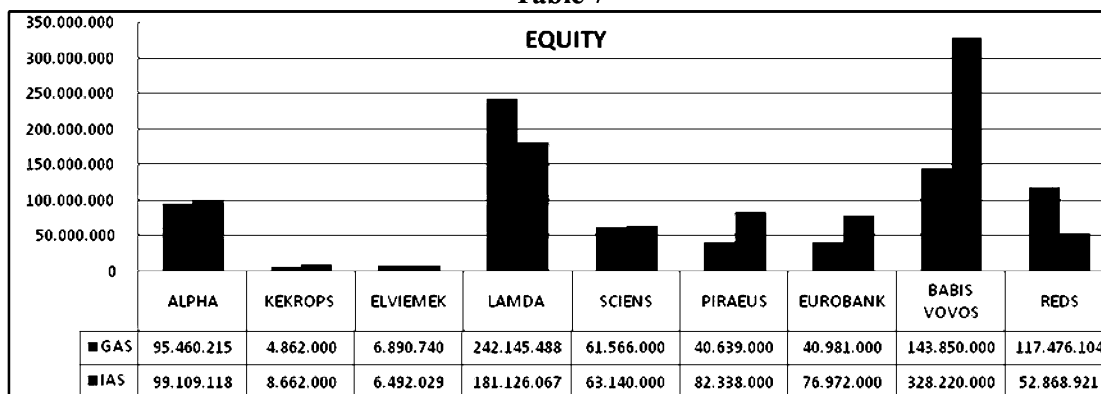


Table 7 describes figures of Equity both with two accountant framework (GAS and IAS), as they were published in 31/12/2004. Changes are presented more clearly in table 8, where is portrayed the analogy of Equity with IAS as regards GAS (figures of Equity with IAS divided by figures of Equity with GAS). The table shows that:

- three (“Alpha”, “Elviemek” and “Sciens”) out of six companies they do not present significantly changes (least from 0,04 times fluctuation)
- four companies present important increase of Equity with the IAS, from 0,8 until 1,3 times. More important reason was the increase by 5.165.000€ because of revaluation in the “restatement of participations” to their fair values as regards “Kekrops”, the increase (by 34.963.000€ and 37.315.000€) in figure “investments property” (“Piraeus” and “Eurobank”), as well as the increase of “tangible assets” for “Mpampis Vovos” (173.109.000€)
- two listed entities (“Lamda” and “Reds”) presented diminish (0,25 and 0,55 times respectively), because of reduction in “restatement of participations” to their fair value by 59.881.859€ as regards “Lamda” and reduction of “reserves” from previous restatement in the “recognition of fair value for bonus shares at the cost of acquisition” by 57.422.453€ as regards “Reds”

**Table 7**



**Table 8**

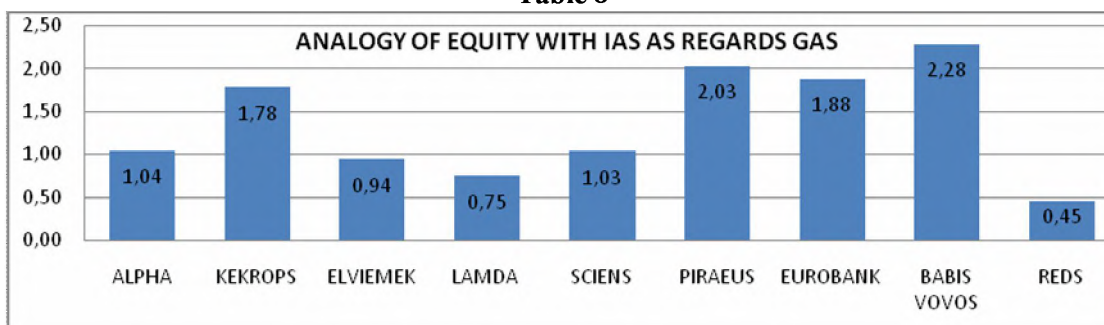


Table 9 portrays the total Net Profit/(Loss) both with IAS and GAS, as they were published in 31/12/2004 for all listed entities of the sector. Because of the reason that the companies have different size (share in the market) implications are not so clear.

**Table 9**

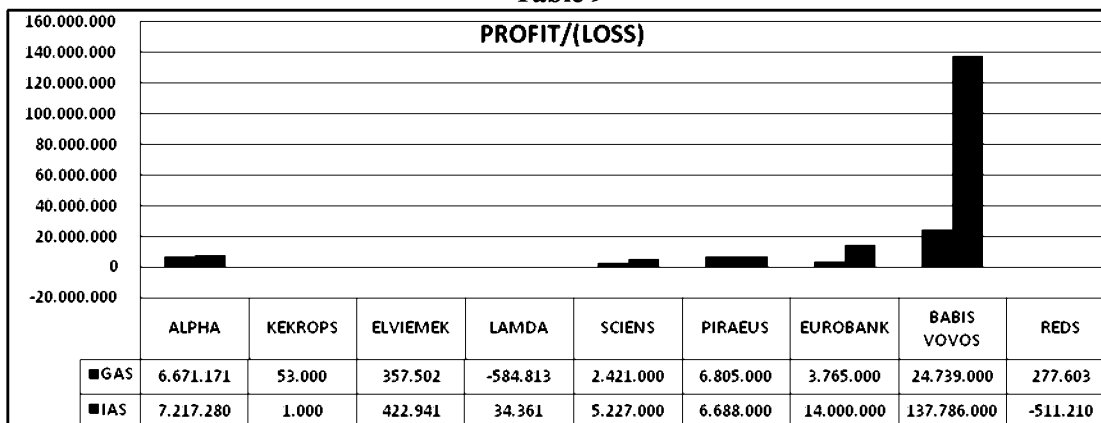


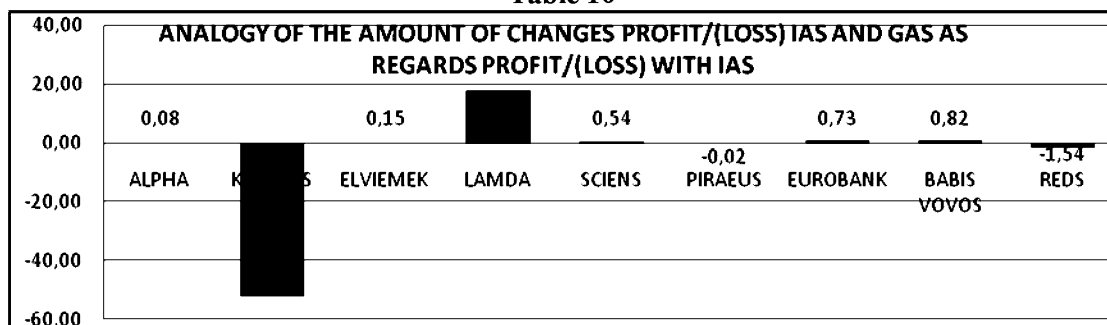
Table 10 presents the analogy of total amount of Net Profits/(Loss) with IAS minus the figure with GAS divided by the total amount of Net Profit/(Loss) with IAS, therefore:

- as regard companies with big “turnover”, three of them (“Babis Vovos”, “Eurobank” and “Sciens”) present important increases. The amount of the increase is more than the half amount of Net Profit/(Loss) with GAS of each company (0,54, 0,73 and 0,82 times respectively). More important causes were the “profits from restatements of tangible assets in the fair value”, “deferred tax adjustments” and from “depreciations”<sup>6</sup>. On the other hand, two companies (“Alpha” and “Piraeus”) do not present remarkable changes

<sup>6</sup> According to GAS depreciation of tangible assets is conducted by percentages which determined with Law, while with IAS 36 and IAS 40 there are not fixed percentage and depreciation is conducted with base their expected life. Depreciation of intangible assets with GAS is carried out in five years, while with IAS expenses of acquisition and construction are not depreciated

- as regard enterprises with low figures in their accounts, “Kekrops presents a total reduction of Net Profits/(Loss) by 52 times, while “Lamda” presents an increase of 18 times concerning the Profits/(Loss) that presents with IAS due to readjustments of “deferred tax”

Table 10



### 3. Results of research for important financial ratios

This section presents the financial ratio analysis. More specifically, is analyzed three significant ratios (Kioxos, 2003).

The table 11 portrays the debt ratio, which shows the percentage of Liabilities divided by the total Liabilities and Equity. It impresses the extent of dependence of the enterprise from foreign capitals. It is evident that a high ratio warns creditors for potential dangers from excessive financing of enterprise with foreign capitals. From the all changes it worth mentioning that from the adoption of IAS the debt ratio of “Piraeus” decreases from 21,54% to 1,53% (reduction of 14 times), while on the contrary the debt ratio for “Reds” increases by 3 times with the IAS (from 13,87% to 41,89%). Moreover, it should also be stated that the debt ratio with GAS of “Piraeus” was higher than Reds, while with the adoption of IAS led to be approximately 27,4 times lower. Furthermore, all the other companies distinguish notably changes. How much the adoption of IAS changes the financial image of the companies;

Table 11

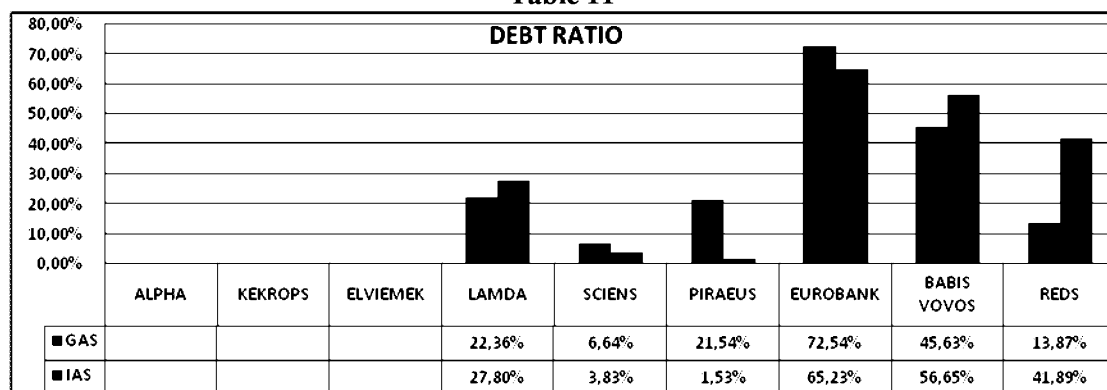


Table 12 presents the changes of the debt to equity ratio, where is examined the percentage of Liabilities concerning Equity (Liabilities divided by Equity). The specific ratio shows in which capitals the company is support its existence. It is evident that a lower ratio is more seductive to the investors, because it means that the company supports itself in “its own” money.

Great differences are observed. For example the debt to equity ratio of “Piraeus” was decreased with IAS by 18 times approximately (from 27,45% to 1,56%), while “Reds” ratio was increased 4,5 times approximately (from 16,11% to 72,10%). In addition, it should be also stated that the debt to equity ratio with GAS of “Reds” was two times lower as regards “Piraeus” (16,11% and 27,45% respectively), while with IAS ratio of “Reds” increased 46,3 times as regards “Piraeus” (72,10% and 1,56% respectively). To sum up also “Lamda”, “Sciens”, Eurobank” and “Babis Vovos” present significant changes.

Table 12

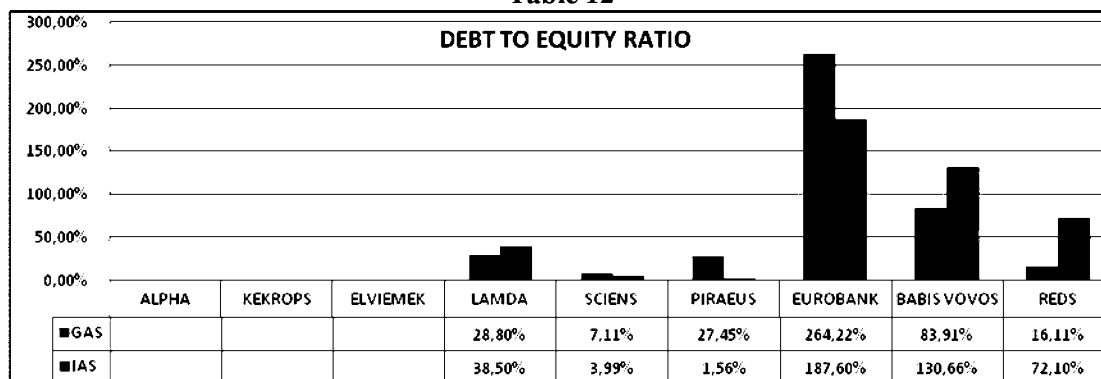
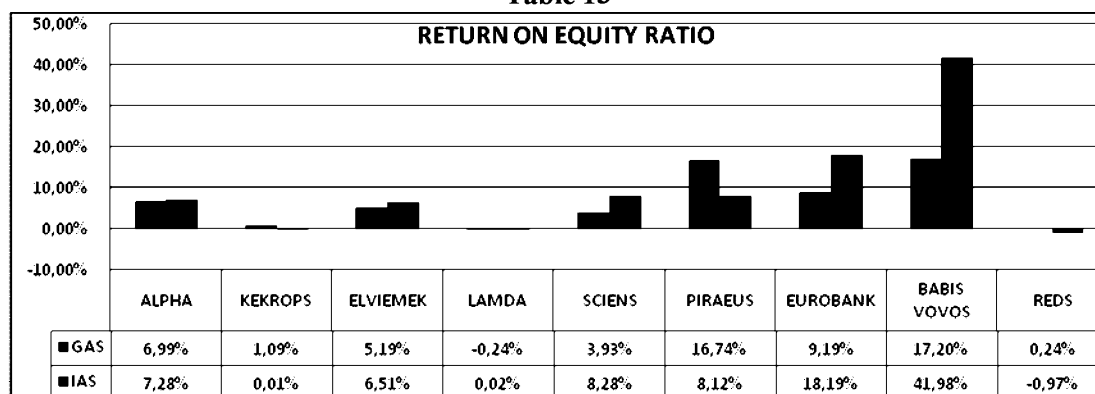


Table 13 presents the return on Equity ratio (Net Profit/(Loss) divided by Equity). It analyzes the degree of utilization of Equity and the efficiency of the businessman to achieve higher profit with specific financial elements. As bigger is the ratio so better for the owners and the picture of the company. Return on assets is also a very famous ratio for measuring the profitability, but not all companies published figures for assets. It is worth mentioning that the “Piraeus” and “Babis Vovos” had approximately the same ratio with GAS (16,74% and 17,20% respectively), while with the adoption of IAS ratio of “Piraeus” reduced by two times, but the ratio of “Babis Vovos” increased by 2,5 times. So their difference exceed the 5 times (8,12% and 41,98% respectively).

In addition is should be mentioned that with the GAS “Piraeus” presented almost twice the percentage of “Eurobank” (16,74% and 9,19% respectively), while with the adoption of IAS they presented the inverse percentages (8,12% and 18,19% respectively). To sum up, it should be also stated that “Elviemek”, “Sciens” and “Piraeus” presented approximately the same percentages with IAS, while figures with GAS are quite different and do not present any similar trends.

Table 13



#### 4. Conclusion

This paper tried to present the differences in the financial statements of all the listed companies in the Real Estate sector of Athens Stock Exchange from the adoption of International Accounting Standards as regards as Greek Accounting Standards. The paper argued the findings via vertical analysis and financial ratio analysis.

It should be pointed out again that figures of each company are reported for the same period (year ended 31/12/2004), therefore it is evident that any difference appeared could justified only by the adoption of the accounting framework (International Accounting Standards instead of Greek Accounting Standards) and from no one other external reason.

From the above analysis the paper led to the conclusion that the adoption of IAS has different effects even in companies which are listed in the same sector of Athens Stock Exchange. Normally, it might be expected that the specific companies should have shown similar trends in the implications, but the fact that entities even of the same sector had different structure in Balance-Sheet led to these differences. Some significant reasons, which transform the image of the companies related to the different treatment that IAS adopt about



“investment property”, “investments in subsidiaries and affiliated entities”, “dividends payable” and “depreciations”.

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## ROLE CONFLICT IN ORGANIZATIONS

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### Abstract

*This paper presents a study of a specific communication problem in organizations. The problem is "Role Conflict", also known as "Role Ambiguity". A person experiences Role Conflict when two or more role expectations occur at the same time, and compliance with the one make compliance with the other difficult. There are several types of role conflict and various ways to deal with each type. The five types of Role Conflict will be described for a better insight to this communication problem. Consequences of Role Conflict will then be analyzed, which indicate that high levels of Role Conflict have negative impacts on the organization. Role Conflict for the Paralegal position in a law firm setting in the USA will be examined. The author describes five positions which characterize an average-sized law firm. In order of authority, the positions are: Manager, Administrator, Attorney, Paralegal and Secretary. In the final part of the paper the author will propose several strategies for the reduction of role conflict in organizations. Although these strategies are designed for the law firm environment, they may be applied in other types of organizations as well.*

*Keywords: role conflict; paralegal; attorney; communication problem; conflicting expectations; strategies*

### PURPOSE OF THE PAPER

The intent of this paper is to bring to light a communication phenomenon, known as Role Conflict, which frequently exists in organizations so that the consequences can be minimized through adherence to proposed strategies. Although Role Conflict is examined for the Paralegal position in a law firm setting in the USA, it can be applied to any position in any organization worldwide.

### TYPES OF ROLE CONFLICT

Generally, role conflict is defined as the incompatibility of expectations or demands in an organizational setting (Kahn, et al, 1964). A person experiences role conflict when two or more role expectations occur at the same time, and compliance with the one make compliance with the other difficult. There are several types of role conflict. A discussion of the types of role conflict, supplemented with examples, will help clarify the concept of role conflict.

Five types of role conflict are described by Sell, et al. (1981): (1) intra-sender, (2) inter-sender, (3) person-role, (4) inter-role, and (5) role overload. These types of role conflict will be used as the basis for the discussion.

Intra-sender role conflict exists when the same person (source) sends incompatible messages to the role-taker (receiver). For example, in the relationship between supervisor (attorney) and subordinate (paralegal), conflict is created when the subordinate continuously receives conflicting expectations in relation to assignments communicated from his/her superior. In this case, role conflict is created when there is one message sender, who communicates or transmits incongruent messages to the role taker or receiver.

Inter-sender role conflict occurs when incompatible messages are being sent from more than one person. The paralegal may receive conflicting expectations from two message sources - the attorney and the administrator. The focus of this paper will be on inter-sender role conflict which the paralegal experiences in a law firm from two message sources.

Person-role conflict is a third type of role conflict which may exist in organizations. This occurs when there is incompatibility between the role and the person. An example of this would be when a person's values or internal standards are being violated as a result of fulfilling the expected job duties. For example, it may be expected to lie or not reveal the whole truth in carrying out one's role in an organization, and this may create conflict for the individual whose inner beliefs are different.

A fourth type of role conflict is inter-role conflict, which occurs when there is incompatibility between two roles a person holds in the same position. In a law firm, the manager may experience inter-role conflict in trying to fulfill the roles of boss and friend. In the one role he is expected to behave as the authority figure and is seen distant from other members, and in the other role he is expected to come down to everyone's level.

Finally, there is role overload, where one person is expected to engage in several role behaviors within a short time period. Role overload may occur to a secretary in a law firm when another secretary is out sick and the sick secretary's attorney needs work to be completed that day. The secretary in this case is considered to be overloaded with additional duties and expectations outside his/her role. This situation involves more than one message sender (the attorney from the role-set and the attorney outside the role-set), each communicating different expectations to the message receiver, and thus creating role conflict.

## CONSEQUENCES OF ROLE CONFLICT

Role conflict is a very important concept in the study of organizational communication. The existence of role conflict leads to many negative consequences for both the individual experiencing role conflict and the organization. Some consequences for the individual which have been empirically linked to role conflict are job satisfaction, organizational commitment, performance, and job involvement (Fry, et al, 1986; Lavan and Banner, 1985; Zahra, 1985; Stevens, et al, 1978). This section will focus on two of these consequences: satisfaction and commitment.

Job satisfaction is "the overall attitude (favorable or unfavorable) an individual has towards his/her job" (Dubinsky et al, 1988, p.135). If one has a favorable attitude about the job, he/she will be satisfied. On the other hand, if one has an unfavorable attitude about the job, he/she will not be satisfied. Locke (1976) defined job satisfaction as "**the positive emotional state resulting from the appraisal of one's job or job experiences**" (p. 1300).

Many studies have shown a negative correlation between role conflict and satisfaction (Fry et al, 1986; Hampton et al, 1986; Jackson and Schuler, 1985). For example, the study conducted by Jackson and Schuler (1985) found a correlation of  $-0.48$  ( $p < .10$ ) between role conflict and general satisfaction. One explanation for this finding is the presence of role conflict would create negative or unfavorable attitudes, which in turn would decrease the level of satisfaction with work.

As with satisfaction, a person's commitment to an organization has been frequently studied in relation to role conflict. Organizational commitment has been defined as "**a strong belief in the organization's goals and values, willingness to exert considerable effort on behalf of the organization and a strong desire to remain a member of the organization**" (Mowday et al, 1982, p.27). This situation could only be possible if one has a favorable attitude about the organization. Research indicates that commitment may be multidimensional, having both attitudinal and behavioral components (O'Reilly and Chatman, 1986; McGee and Ford, 1987). Thus, if one develops unfavorable attitudes about work, he/she will tend to become less committed.

Many studies have shown that role conflict leads to decreased commitment (Glisson and Durick, 1988; Jackson and Schuler, 1985; Lavan and Banner, 1985). For example, Glisson and Durick (1988) found a correlation of  $-0.43$  ( $p < .001$ ) between role conflict and commitment. One explanation for this finding is that role conflict creates negative attitudes, and since commitment is influenced by attitudes, it will tend to decrease as role conflict increases.

Research confirms that individual consequences such as decreased satisfaction and commitment inevitably lead to negative consequences for the organization. Some of these consequences are decreased effectiveness, decreased productivity, and increased turnover rate (Kemery, et al, 1985; Baroudi, 1985; Lee and Mowday, 1987; Good, et al, 1988). The organizational consequence which will be discussed to demonstrate the importance of role conflict is turnover rate.

It was previously described how unfavorable attitudes created from role conflict result in decreased satisfaction and commitment for the member. If other job opportunities are available to the member, he/she will make the decision to leave or stay with the organization. During the decision process the member may consult with other members in the organization and information will be exchanged. Information obtained by the member experiencing role conflict may assist him/her in making the decision to leave or stay in the organization.

A study conducted by Addae & Parboteeah (2008) demonstrates that public sector employees in St Lucia are less likely to develop affective or normative commitment to the service if they experience role conflict and ambiguity. Furthermore, those employees with continuance commitment will stay regardless of any role stressors if they perceive few job alternatives available to them. However, employees with greater

probabilities of finding alternative employment, employees with continuance commitment are more likely to leave if they experience role stressors.

The decision to leave affects the organization's turnover rate. Turnover is considered to be the frequency of change in personnel. High turnover rate implies that people are constantly entering and leaving the organization, and very few individuals remain for a long period of time. It is usually desirable for an organization to keep the turnover rate as low as possible so that the members will grow with the organization and thus feel a part of it. There are cases where high turnover rate is preferred, such as when the organization needs change, or when there's receptiveness to new ideas. For the purposes of this paper, it will be assumed that an increase in the organization's turnover rate is not a desirable outcome of role conflict.

Steers and Mowday's Model of Turnover includes many antecedents of organizational turnover, including satisfaction and commitment. Lee and Mowday (1987) tested this model and these two factors were linked on the one end to role conflict and on the other to turnover. In other words, it was confirmed that role conflict leads to decreased satisfaction and commitment (among other factors), which ultimately increases organizational turnover.

Three research hypotheses were tested in a study conducted by Acker, 2004:

1. Social workers experiencing higher levels of role conflict and ambiguity are more likely to have a reduced job satisfaction.
2. Social workers experiencing higher levels of social support at their job are more likely to have higher levels of job satisfaction.
3. Social workers experiencing higher levels of role conflict and ambiguity are more likely to intend to leave their job.

The results are consistent with other studies that demonstrate that organizational conditions play an important role in predicting job satisfaction and intention to leave (Mor-Barak, Nissly & Levin, 2001). It is important that agencies offer a supportive environment that mediates the stress contributed by factors such as Role Conflict, Role Ambiguity, and insufficient resources.

In another study conducted by Shen, 2005 the following hypothesis were analyzed:

**Hypothesis 1:** RA and job satisfaction will be negatively correlated among IS professionals.

**Hypothesis 2:** RC and job satisfaction will be negatively correlated among IS professionals.

**Hypothesis 3:** The correlation between RA and job satisfaction will differ from the correlation between RC and job satisfaction among IS professionals.

**Hypothesis 4a:** The strength of the relationship between RA and job satisfaction will be similar among IS professionals and other job types.

**Hypothesis 4b:** The strength of the relationship between RC and job satisfaction will be similar among IS professionals and other job types.

The analysis of the results indicates that Hypothesis 1 and 2 are supported, Hypothesis 3 is not supported, and Hypothesis 4 was supported.

## POSITIONS IN A LAW FIRM

To illustrate the importance of communication in organizations, the positions in a law firm will be described. The number of positions in a firm depends on its size, which in turn is determined by the number of employees. For example, the smallest law firm may consist of two members who occupy two positions, namely an attorney and a secretary. A larger firm includes additional positions since there are more employees. The following chart outlines five positions which characterize an average-sized law firm. In order of authority, the positions are: Manager, Administrator, Attorney, Paralegal, and Secretary. Each position involves certain duties, as well as one or more roles, which are listed below.

The duty of the paralegal position is to assist the lawyer in case preparation, specifically in legal and factual research. In order to be effective, the assignments must be clearly communicated and understood. The paralegal plays the role of a para-professional because his/her legal education is not as extensive as the attorney's, but more extensive than the secretary's. This situation creates a wide variety of tasks for the paralegal, which is a mixture of both the attorney's and secretary's. Another role of the paralegal is that of a subordinate, who receives instructions from the supervisor (attorney). The focus of this paper will be the communication processes related to the paralegal position in the context of role conflict.

## **ROLE CONFLICT FOR THE PARALEGAL**

The relationship between paralegal and attorney in a role set is classified as a supervisor/subordinate relationship. Since the communication between them occurs frequently on a daily basis, it is considered to be informal. In other words, the paralegal does not have to make an appointment to consult with his/her supervisor and vice-versa.

The attorney has certain expectations for the paralegal's role behavior. These expectations are usually verbally communicated or sent during their informal contacts.

### Expectations of the attorney

1. To carry out assignments completely and correctly.
2. To stay overtime when needed to meet a deadline.
3. Work independently and responsibly.
4. Work as a team member of the role-set and share its goals.
5. Be willing to take on additional responsibilities when a member of the role-set is out.

The paralegal's relationship to the administrator is not as familiar as it is with the attorney. Communication between the paralegal and the administrator occurs very rarely throughout the year. There are usually two formal meetings a year between these two members. During this time, the administrator informs the paralegal of his/her performance in the organization, and goals are set for the next six months. Besides these two contacts, other communication between the administrator and paralegal is very sporadic.

Just as the attorney has expectations for the paralegal, so does the administrator. These expectations are usually communicated in written form, i.e. employee handbook. The following list includes some expectations held by the administrator for the paralegal:

### Expectations of the administrator

1. To report to work on time, take the scheduled lunch hour, and leave work at the scheduled time.
2. Complete daily time records which show how the 8-hr. day was spent, so that the time spent on a particular file can be billed to the appropriate client.
3. If need to take any time off, must notify at least two days in advance, and must make up compensation time within one week
4. Must share goals of organization.
5. Aid in evaluation of attorney/supervisor.

### Conflicting expectations

Now that the expectations of both the attorney and administrator have been listed, problem areas can be detected which lead to role conflict for the paralegal. The first is that expectations are not clearly communicated and/or understood. The second is the goals of the role set are different from the organizational goals. The third is inconsistent feedback from the supervisor and administrator. And, the fourth is the subordinate's reluctance to evaluate his/her supervisor.

One of the reasons conflicting expectations occur is that they are poorly communicated to the paralegal. In other words, the message received is different than the message sent. For example, the paralegal might perceive a message sent from the supervisor as contradictory to what was contained in the employee handbook, when instead the problem is mis-communication. Thus, when expectations of the attorney and administrator are not clearly communicated, role conflict is created for the paralegal.

One of the expectations of the attorney for the paralegal is to share the goals of the role-set. At the same time, the administrator expects the paralegal to share the organizational goals. Role conflict is created when these goals are not the same. For example, a goal of the role-set might be to work faster than another role set, while an organizational goal might be to avoid such competition. When such a situation exists, role conflict is created for the paralegal.

A third way role conflict is created from conflicting expectations is when the paralegal receives inconsistent feedback from the supervisor and the administrator. Since feedback given from the supervisor is informal and occurs verbally, the administrator is unaware of the subordinate's progress. Thus, when it comes time for the six-month evaluation, the administrator may give feedback to the paralegal which conflicts with the supervisor's current feedback.

A final way role conflict is created is when the administrator expects the subordinate to evaluate the supervisor and the supervisor does not expect this. The paralegal is put in an uncomfortable situation. On the one hand, he/she does not want to harm the relationship with the supervisor, and on the other hand, he/she wants to be in good standing with the firm. As a result, the paralegal experiences role conflict.

## STRATEGIES TO REDUCE ROLE CONFLICT

This paper has shown how role conflict is a communication problem. This section will propose communication strategies to help reduce this problem. The first strategy is to train employees to communicate effectively. This can be done by weekly seminars explaining the different communication methods available, and suggesting which method is most effective for different situations. For example, when a problem is encountered during the pursuance of a task, a written memo to the supervisor is the most appropriate way to make him aware of the problem in order to receive the correct guidelines (in written form) to correct the problem. The second strategy is to set common goals for the supervisor and the administrator. If both supervisor and administrator share the same goals, there will be less role conflict for the employee. The third strategy is to train the supervisor to conduct formal monthly performance evaluations of the employee in order to avoid inconsistencies with the six-month evaluation conducted by the administrator. The last strategy is to train the subordinate to evaluate the supervisor so that he/she feels comfortable about this expectation. The employee must realize that evaluating his supervisor is just as important as being evaluated by him.

Specifically, in the effort to reduce role conflict for the paralegal, a monthly meeting between the administrator, supervisor and paralegal can be considered a "problem solving" meeting. The problem to be solved is conflicting expectations in an effort to create common goals. Jones (1981) sets forth some guidelines for conducting a problem solving meeting. They are: (1) state the problem and reason why it must be solved, (2) analyze the causes of the problem, (3) brainstorm possible solutions, (4) determine the best solution, (5) select the best solution, and (6) implement the solution. After the first few weeks it may be essential to meet monthly to reinforce the common goals. Then, after six months, the entire process of creating common goals should be repeated to minimize inter-sender role conflict experienced by paralegals.

Strategies for managing ambiguity were suggested by Merrell, 2000, in her study in well woman clinics. Organizations need to make explicit their motives and purpose of involving volunteers in service provision. Almond (1990) found in her study that the role and function of the volunteers was implicit within the hospice's organizational structure and that the volunteers, who numbered over 200, were unacknowledged within the charity's formal policy documents. **The formulation of written guidelines out-lining the role and scope of the volunteer's role may lessen the potential for role ambiguity and foster positive relationships between volunteer and paid workers.** The provision of a training program enables volunteer and paid workers to have a clearer understanding of the core components of each other roles and the opportunity for volunteers to demonstrate their talents. **Training is particularly important when volunteers work directly with clients, so that volunteers feel content in their role and issues such as the importance of confidentiality are clearly understood.** Additionally, the opportunity for regular up-dating or opportunities for volunteers to discuss issues or seek clarification with paid workers lessens misunderstanding and improves relationships between them. Appointing an individual, usually a volunteer coordinator, who links together the bureaucracy of the NHS with the associational world of the volunteer, can play a key role in managing ambiguity and enabling volunteer and paid workers to work together effectively. The coordinator is faced with the task of ensuring that the expectations of the Health Trust are achieved, namely that an efficient, quality well woman service is delivered, while at the same time ensuring that the expectations and needs of the volunteers are also met. As the changing nature of the workforce within the clinics increases the potential for ambiguity, misunderstanding and misinterpretation, the coordinator provides continuity, acts as a point of contact and a source of information for all workers.

## CONCLUSION

The author of this paper has attempted to analytically present the communication problem of Role Conflict which occurs in organizations. The negative outcomes of this problem have been described for increased awareness to this problem. Finally, strategies to reduce Role Conflict have been suggested in order to minimize this communication problem in organizations. Although the example used to demonstrate the problem was in a law firm environment, the strategies can be applied in any organizational setting.

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# THE IMPACT OF MERGERS AND ACQUISITIONS ON ECONOMIC PERFORMANCE OF GREEK FIRMS: AN ACCOUNTING PERSPECTIVE

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## Abstract

*This study examines the impact of mergers and acquisitions (M&As) on the economic performance of merger-involved firms in Greece. Using financial ratios, the post-merger performance of a sample of forty Greek companies, listed on the Athens Stock Exchange that executed at least one merger or acquisition in the period from 2003 to 2005 as acquirers, is investigated. For the purpose of the study, a set of four profitability ratios (ROE and ROA, before and after taxes, respectively) is employed, in order to measure firms' economic performance and to compare pre- and post-merger economic performance for two years before and after the M&A announcements. The results revealed that none of all the examined profitability ratios did not change significantly due to the M&A event. The final conclusion that conducted is that M&As have not had any impact on economic performance of merger-involved firms and they were finally investment actions of zero value.*

*Keywords: Mergers; Acquisitions; Financial Ratios; Economic Performance.*

## 1. Introduction

The strategy literature commonly argues that mergers and acquisitions (M&As) are one of the mechanisms by which firms gain access to new resources and, via resource redeployment, increase revenues and reduce cost. The main hypothesis in successful M&As activities is that potential economic benefits arising from them are changes that increase economic performance that would not have been made in the absence of a change in control (Pazarskis, 2008).

However, many researchers and business practitioners regard with scepticism this hypothesis, despite the fact that many others are confident and enthusiastic. In order to examine the economic performance of Greek firms after M&As activities, this study proceeds to an analysis of the post-merger performance of a sample of firms, listed at the Athens Stock Exchange (ASE) in Greece that executed at least one merger or acquisition in the period from 2003 to 2005, using accounting characteristics (financial ratios), and attempts to investigate the M&As effects on their economic performance.

The structure of the paper is as follows: section 2 analyse the research design of this study (related past researches with financial ratios, sample and data, selection of variables-financial ratios, research methodology and hypothesis). Section 3 presents and analyses the results, and section 4 concludes the paper.

## 4. Research design

### *Related past researches with financial ratios*

Several studies on economic performance after M&As that employed accounting ratios concluded on ambiguous results (Pazarskis, 2008). Many of them supported an improvement in the economic performance after the M&As action (Cosh et al., 1980; Parrino & Harris, 1999; and others), while other researchers



claimed that there was a deterioration in the post-merger firm performance (Meeks, 1977; Salter & Weinhold, 1979; Mueller, 1980; Kusewitt, 1985; Neely & Rochester, 1987; Ravenscraft & Scherer, 1987; Dickerson et al., 1997; Sharma & Ho, 2002; and others), and others researchers concluded a “zero” result from the M&As action (Kumar, 1984; Healy et al., 1992; Chatterjee & Meeks, 1996; Ghosh, 2001; and others).

### **Sample and data**

The final sample consists of forty acquiring firms, listed in the ASE that executed at least one M&As action as acquirers in Greece during the period from 2003 to 2005. The study proceeds to an analysis only of listed firms as their financial statements are published and it is easy to find them and evaluate from them firm economic performance.

The M&As activities of the listed Greek firms have been tracked from their announcements on the web sites of the ASE and the PricewaterhouseCoopers. The data of this study (financial ratios) are computed from the financial statements of the M&As-involved firms and the databank of the Library of the University of Macedonia (Greece).

### **Selection of variables (financial ratios)**

The economic performance of a firm is evaluated with its performance at some profitability ratios. For the purpose of this study, four financial ratios (profitability ratios) are employed, which are the following ratios:

- Return On total Assets (ROA) Before Taxes, that is equivalent with: (Earnings Before Taxes / Total Assets) and is symbolised with the code: V1.
- Return to Owner’s Equity (ROE) Before Taxes, that is equivalent with: (Earnings Before Taxes / Equity ) and is symbolised with the code: V2.
- Return On total Assets (ROA) After Taxes, that is equivalent with: (Earnings After Taxes / Total Assets ) and is symbolised with the code: V3.
- (Return to Owner’s Equity (ROE) After Taxes, that is equivalent with: (Earnings After Taxes / Equity ) and is symbolised with the code: V4.

### **Research methodology and hypothesis**

The M&As action of each company from the sample is considered as an investment that is evaluated by the NPV criterion (if  $NPV \geq 0$ , the investment is accepted). Based on this viewpoint, the study proceeds to its analysis and regards the impact of an M&A action similar to the impact of any other positive NPV investment of the firm to its ratios over a specific period of time (Healy et al., 1992; Pazarskis, 2008).

In order to evaluate the relative change with ratio analysis of the sample of the Greek firms that executed M&As actions, the general form of the hypothesis that is examined for each financial ratio separately (ratios from V1 to V4) is the following:

$H_{0i}$ : There is expected **no** relative change of the financial ratio  $i$  from the M&As event.

$H_{1i}$ : There is expected relative change of the financial ratio  $i$  from the M&As event.

where,

$$i = \{V1, V2, V3, V4\}$$

The crucial research question that is investigated by examining the above mentioned ratios is the following: “Economic performance in the post-merger period is greater than it is in the pre-merger period?” (Pazarskis, 2008).

The selected financial ratios for each company of the sample over a two-year period before (year T-2, T-1) or after (year T+1, T+2) the M&As event are calculated, and the mean from the sum of each financial ratio for the years T-2 and T-1 is compared with the equivalent mean from the years T+1 and T+2, respectively<sup>1</sup>.

The study does not include in the comparisons the year of M&A event (Year 0) because this usually includes a number of events which influence firm economic performance in this period (as one-time M&As transaction costs, necessary for the deal, etc.) (Healy et al., 1992; Pazarskis et al, 2008; Pazarskis, 2008).

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<sup>1</sup> In this study, the mean from the sum of each financial ratio is computed than the median, as this could lead to more accurate research results (Pazarskis, 2008). This argument is consistent with many other researchers diachronically (Philippatos et al., 1985; Neely & Rochester, 1987; Cornett & Tehnarian, 1992; Sharma & Ho, 2002; Pazarskis et al, 2008; Pramod Mantravadi & A. Vidyadhar Reddy, 2008; and others).

Last, to test this hypothesis two independent sample mean t-tests are applied. The results are presented in the next section.

## 5. Results

From a set of four profitability ratios (Return On total Assets / ROA before taxes, Return to Owner's Equity / ROE before taxes, Return On total Assets / ROA after taxes, Return to Owner's Equity / ROE after taxes) that is examined, the results revealed that none of all the examined profitability ratios did not change significantly due to the M&A event (see V1-V4, Table 1).

*Table 1. Results of sample firms*

<i>Variable</i>	<i>Pre- or post-merger performance</i>	<i>Mean</i>	<i>T-statistic (Two-tail)</i>	<i>P-Value</i>	<i>Confidence Interval 95%</i>
<i>V1</i>	pre-merger	0,087	-0,65	0,520	(-0,0643 , 0,0327)
	post-merger	0,071			
<i>V2</i>	pre-merger	0,242	-0,61	0,545	(-0,2362 , 0,1252)
	post-merger	0,186			
<i>V3</i>	pre-merger	0,064	-0,81	0,418	(-0,0519 , 0,0217)
	post-merger	0,049			
<i>V4</i>	pre-merger	0,173	-0,70	0,483	(-0,1877 , 0,0891)
	post-merger	0,123			

These results are not consistent with the results of some others studies that found a decline of the profitability ratios in the post-merger period: Meeks (1977), Salter & Weinhold (1979), Mueller (1980), Kusewitt (1985), Neely & Rochester (1987), Ravenscraft & Scherer (1987), Dickerson et al. (1997), Sharma & Ho (2002), and others.

Also, this result is consistent with the results of some other past studies that there is no relative change of economic performance from any examined profitability ratios due to M&As activities: Kumar (1984), Healy et al. (1992), Chatterjee & Meeks (1996), Ghosh (2001), and others.

Furthermore, the results of this study revealed that as M&As have not had any impact on economic performance of merger-involved firms, they were finally investment actions of zero value for the sample firms, even two years after the M&A transaction, and they do not lead to enhanced economic performance.

## 6. Conclusions

This study have been chosen the accounting studies in order to examine the impact of mergers and acquisitions (M&As) on the economic performance of merger-involved firms in Greece. Using four financial ratios (profitability ratios), the post-merger performance of a sample of forty Greek companies, listed on the Athens Stock Exchange that executed at least one merger or acquisition in the period from 2003 to 2005 as acquirers, is investigated. For the purpose of the study, a set of four profitability ratios (ROA before taxes, ROE before taxes, ROA after taxes, ROE after taxes) is employed, in order to measure firms' economic performance and to compare pre- and post-merger economic performance for two years before and after the M&A announcements. The results revealed that none of all the examined profitability ratios did not change significantly due to the M&A event. The final conclusion that conducted is that M&As have not had any impact on economic performance of merger-involved firms and they were finally investment actions of zero value, even two years after the M&A transaction.

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# RISK PREMIUM EFFECTS ON IMPLIED VOLATILITY REGRESSIONS

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## Abstract

*This article provides new insights into the sources of bias of option implied volatility to forecast its physical counterpart. We argue that this bias can be attributed to volatility risk premium effects. The latter are found to depend on high-order cumulants of the risk-neutral density. These cumulants capture the risk-averse behavior of investors in the stock and option markets for bearing the investment risk that is reflected in the deviations of the implied risk-neutral distribution from the normal distribution. We show that the bias of implied volatility to forecast its corresponding physical measure can be eliminated when the implied volatility regressions are adjusted for risk premium effects. The latter are captured mainly by the third-order risk-neutral cumulant. We also show that a substantial reduction of higher-order risk-neutral cumulants biases to predict their corresponding physical cumulants is supported when adjustments for risk premium effects are made.*

*JEL Classification: C10, G13, G14.*

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## I. Introduction

There is voluminous evidence that the volatility implied by option prices, referred to as risk-neutral volatility, constitutes a biased upward predictor of the future realized volatility of asset (stock) returns, known as physical volatility, over the remaining life of the relevant options (see, e.g., Canina and Figlewski 1993, Poon and Granger 2003, and Jiang and Tian 2005). This bias means that the slope coefficient of a linear regression of physical volatility on implied volatility will be biased downward from unity. This evidence is in contrast to the pure (without risk premium) version of the market efficiency hypothesis asserting that the preceding two measures of volatility should possess a one-to-one correspondence. As is shown in many recent studies, the implied volatility bias can be related to the market volatility risk premium (see Bates 2003, Bollerslev and Zhou 2006), creating a wedge between physical volatility and risk-neutral volatility. In particular, based on the stochastic volatility option pricing model, Bollerslev and Zhou (2006) show that the bias of the slope coefficient of the standard implied volatility regression is not zero and critically depends on the parameters of the underlying option pricing model.

The present article provides new insights into the sources of the volatility risk premium and the forecasting bias of the slope of the implied volatility regressions. We derive a theoretical relation between physical volatility and risk-neutral volatility, which shows that under a power utility pricing kernel, the difference between the two measures of volatility depends on higher than second-order risk-neutral cumulants. This relation is derived in a model-free manner, without imposing any structure on the underlying asset price process or adopting any specific parametric option pricing model (see Bakshi and Madan 2000). It can also be easily extended to analogous relations predicting the future level of higher-order cumulants based on their risk-neutral counterparts.

Expressing the difference between physical and risk-neutral volatilities in terms of cumulants rather than moments enables us to distinguish its generating sources more clearly. In particular, the cumulants greater than second-order quantify deviations from the normal distribution and therefore measure large risks beyond the variance (equal to the second-order cumulant). The third and higher odd-order cumulants capture asymmetric deviations, and the fourth and higher even-order cumulants reflect symmetric deviations. Because cumulants generally constitute adequate measures of risk (see Malevergne and Sornette 2006), the higher-order risk-neutral cumulants that enter the physical-risk-neutral volatility relation derived in this article can be given the interpretation of reflecting risk premium effects. These compensate investors in the asset markets for bearing the risk of deviations from the normal distribution of asset returns due, for instance, to asymmetric or extreme values of them. Among these effects, we provide strong evidence that the risk premium captured by the third-order risk-neutral cumulant, which is associated with the skewness of the risk-neutral density, can sufficiently explain the bias of the slope coefficient of the standard implied volatility regression. This is shown in a new regression framework adjusted for the risk premium effects and can be done for small estimates of the relative risk aversion coefficient. This framework can be easily extended to test for the information content of higher than second-order risk-neutral cumulants about their physical counterparts.

## II. On the Relation Between Risk-Neutral and Physical Volatility

### Theoretical Model

Consider an economy in the absence of arbitrage. Then, there will be a pricing kernel projected onto the asset (stock) log-return, denoted as  $\rho_T = \ln\left(\frac{S_T}{S_t}\right)$  where  $S_T$  (or  $S_t$ ) denotes the asset price at the future time  $T$  (or at the current time  $t$ ). Under this kernel, the physical probability density function of  $\rho_T$  conditional on time  $t$  information set (denoted as  $L_t$ ) is related to its risk-neutral counterpart through the following relation:

$$p_t(\rho_T) = \frac{q_t(\rho_T) / M_t(\rho_T)}{\int q_t(\rho_T) / M_t(\rho_T) d\rho_T}, \quad (1)$$

where  $p_t(\rho_T)$  and  $q_t(\rho_T)$  denote the conditional physical and risk-neutral probability densities of  $\rho_T$  and  $M_t(\rho_T)$  is the projected pricing kernel onto the payoff  $\rho_T$ . Under the power/logarithmic utility,  $M_t(\rho_T)$  is given as  $M_t(\rho_T) = e^{-\gamma\rho_T}$ , where  $\gamma$  is the relative risk aversion coefficient. Then, relation (1) can be written as:

$$p_t(\rho_T) = \frac{e^{\gamma\rho_T} q_t(\rho_T)}{\int e^{\gamma\rho_T} q_t(\rho_T) d\rho_T} \quad (2)$$

where the normalizing factor  $\int e^{\gamma\rho_T} q_t(\rho_T) d\rho_T$  integrates the values of  $p_t(\rho_T)$  to unity. Based on (2), in the next proposition we derive a theoretical relation linking the  $v^{\text{th}}$ -order physical cumulant of the log-return  $\rho_T$  conditional on the information set  $L_t$  to the risk-neutral cumulants<sup>1</sup>.

**Proposition 1** Let  $k_{\rho,n}^N$  and  $k_{\rho,n}^P$  be the  $v^{\text{th}}$ -order cumulants of the conditional on the current market information set  $L_t$  risk-neutral probability density function  $q_t(\rho_T)$  and the physical probability density function  $p_t(\rho_T)$  of the log-return  $\rho_T$ , respectively. Then, the following relation holds:

$$k_{\rho,n}^P = \sum_{m=0}^{\infty} \left( \frac{\gamma^m}{m!} \right) k_{\rho,n+m}^N \quad \forall v \in \mathbb{N} \quad (3)$$

where  $\frac{\gamma^0}{0!} = 1$ .

For  $v = 2$ , the theoretical relation given by Proposition 1 implies that the second-order cumulants  $k_{\rho,2}^P$  and  $k_{\rho,2}^N$ , which respectively represent physical volatility and risk-neutral volatility, are linked through the following relation:

$$k_{\rho,2}^P = k_{\rho,2}^N + \gamma k_{\rho,3}^N + \frac{\gamma^2}{2!} k_{\rho,4}^N + \frac{\gamma^3}{3!} k_{\rho,5}^N + \dots \quad (4)$$

implying that

$$k_{\rho,2}^P - k_{\rho,2}^N = \gamma k_{\rho,3}^N + \frac{\gamma^2}{2!} k_{\rho,4}^N + \frac{\gamma^3}{3!} k_{\rho,5}^N + \dots \quad (5)$$

From the last relation, it can be easily seen that there is no one-to-one correspondence between risk-neutral and physical volatilities captured by the second-order cumulants  $k_{\rho,2}^P$  and  $k_{\rho,2}^N$ , respectively. The two volatilities differ from each other, and their difference  $k_{\rho,2}^P - k_{\rho,2}^N$ , referred to as the volatility risk premium, critically depends on all higher than second-order cumulants of the risk-neutral density of the log-return  $\rho_T$ . Only when  $\gamma = 0$  (risk-neutrality) do the values of  $k_{\rho,2}^P$  correspond to those of  $k_{\rho,2}^N$  in a one-to-one

<sup>1</sup> Note that the first four cumulants,  $k_n$  for  $n = 1, 2, 3, 4$  of a probability density function are related to the central ( $\mu'_m$ ) and non-central ( $\mu_n$ ) moments through the following relationships:  $k_1 = \mu'_1 = \mu_1$ ,  $k_2 = \mu'_2 - (\mu_1^2)$ ,  $k_3 = \mu'_3 - (3\mu_2\mu_1 - 2\mu_1^3)$  and  $k_4 = \mu'_4 - 3\mu_2^2 - \mu_4 - 4\mu_3\mu_1 - 3\mu_2^2 + 12\mu_2\mu_1^2 - 2\mu_1^4$ , (see Stuart and Ord 1994). Based on the above definitions of cumulants, we can write the skewness and kurtosis coefficients as  $sk = \frac{k_3}{(k_2)^{3/2}}$  and  $Ku = 3 + \frac{k_4}{(k_2)^2}$

relationship. The latter can also take place when  $k_{\rho,2}^N = 0$ , for all  $\mu > 2$ , which holds under the assumptions of the Black and Scholes (BS) model.

In contrast to the moments, the cumulants of the risk neutral-density that feature in the right-hand side of relation (5) can directly measure deviations of this distribution from the normal one, with the third and higher odd-order cumulants to capturing asymmetric deviations, and the fourth and higher even-order cumulants to reflecting symmetric deviations. In fact, this relation enables us to separate the implied volatility risk premium effects caused by the above distinct sources of deviations from the Gaussian law: skewness and excess kurtosis. By their definitions (see footnote 3), the former is directly related to the third-order cumulant, and the latter to the fourth-order cumulant.

Risk-neutral skewness commands a volatility risk premium to compensate risk-averse investors for bearing the risk associated with asymmetric stock return distributions. A negative value of risk-neutral skewness often found in practice (implying  $k_{\rho,3}^N < 0$ ) should be taken to reflect the fact that risk-averse investors assign higher risk-neutral probabilities to negative stock returns (or, more generally, to stock returns with smaller values than their mean) than positive returns. In forecasting expected stock market physical volatility  $k_{\rho,2}^P$ , the previously described behavior of risk-averse investors will have the following consequences. To estimate  $k_{\rho,2}^P$ , an upward adjustment must be made to the risk-neutral probabilities of positive stock returns (which are smaller than the risk-neutral probabilities of negative returns) and a downward adjustment to the risk-neutral probabilities of negative returns (which are larger to the risk-neutral probabilities of positive returns). Due to the exponential nature of the pricing kernel implied by the power utility, the upward adjustment is approximately equal to the downward adjustment around the mean of the risk-neutral density and both of them are proportional to the risk aversion coefficient  $\Theta$ .

Thus, if risk-neutral skewness is negative, expected physical volatility will be smaller than risk-neutral volatility by a factor which equals  $\Theta$ -times the risk-neutral third-order cumulant,  $k_{\rho,3}^N$ , as is predicted by relation (5). In this case, the volatility risk premium  $k_{\rho,2}^P - k_{\rho,2}^N$  will be negative. Note that the higher the risk aversion coefficient  $\Theta$ , the higher the negative effect of  $k_{\rho,3}^N$  on  $k_{\rho,2}^P - k_{\rho,2}^N$  will be.

By analogous arguments as above, we can explain the effect of the fourth-order riskneutral cumulant  $k_{\rho,4}^N$  on  $k_{\rho,2}^P - k_{\rho,2}^N$ . This cumulant reflects a separate source of volatility risk premium. A positive value of  $k_{\rho,4}^N$ , implying that the risk-neutral density has fat tails (or excess kurtosis), can be attributed to the fact that risk-averse investors assign higher probabilities to extreme values of stock returns<sup>2</sup>. Thus, in calculating physical volatility an upward adjustment should be made to the risk-neutral probabilities of positive extreme values of stock returns distributions and a downward adjustment to the risk-neutral probabilities of negative returns. Since these probabilities concern stock returns whose values are not close to their mean, the exponential nature of the pricing kernel of the power utility function (see relation (2)) implies that the upward adjustment of the risk-neutral probabilities will be higher than the downward one. This can explain the positive relationship between the volatility risk premium  $k_{\rho,2}^P - k_{\rho,2}^N$  and the fourth-order risk-neutral cumulant  $k_{\rho,4}^N$ , implied by relation (5). Our theoretical relation (3) can be also employed to investigate the sources of the risk premium reflected into the difference between higher than second-order physical and riskneutral cumulants, i.e.  $k_{\rho,n}^P - k_{\rho,n}^N$ . In particular, for the third and fourth-order cumulants, which are related to skewness and excess kurtosis, respectively, relation (3) implies:

$$k_{\rho,n}^P - k_{\rho,n}^N = \gamma k_{\rho,n+1}^N + \frac{\gamma^2}{2!} k_{\rho,n+2}^N + \frac{\gamma^3}{3!} k_{\rho,n+3}^N + \dots, \text{ for } v = 3, 4. \quad (6)$$

The last relation is analogous to (5). It shows that the existence of the third-order cumulant risk premium,  $k_{\rho,3}^P - k_{\rho,3}^N$ , also referred to as the skewness premium, can be explained by higher than third-order risk-neutral cumulants<sup>3</sup>. According to this, a positive value of the

<sup>2</sup> The economic intuition of using the fourth-order cumulant as a measure of risk is given by Malevergne and Sornette (2006). In the context of the risk-neutral density, this can be obtained by writing the fourthorder cumulant  $k_{\rho,4}^N$  as  $k_{\rho,4}^N = \mu_{\rho,4}^N - 3(\mu_{\rho,2}^N)^2$ , where  $\mu_{\rho,4}^N$  and  $\mu_{\rho,2}^N$  are the fourth and second-order risk-neutral central moments, respectively. A positive value of  $k_{\rho,4}^N$  implies the following inequality  $\mu_{\rho,4}^N > 3\mu_{\rho,2}^N$ . This can be interpreted as expressing the fact that investors are more risk-averse to large risks associated with extreme values of stock returns measured by  $\mu_{\rho,4}^N$ , compared to smaller ones related to smaller variation of stock returns measured by  $\mu_{\rho,2}^N$ . Having  $k_{\rho,4}^N = 0$  (implied by the BS model) means that risk-averse investors are indifferent between large and small risks.

<sup>3</sup> Oakshi, Kapadia and Madan (2003) derived an approximating version of this relation based on the risk-neutral skewness and kurtosis coefficients.

skewness premium (implying that the physical distribution is more skewed towards the right compared to the risk-neutral distribution) can be attributed to the positive sign of the fourth-order risk-neutral cumulant  $k_{\rho,4}^N$  capturing the risk-averse behavior of investors to assign higher probabilities to extreme values of stock returns, as mentioned before. Analogously, we can explain a negative sign of the excess kurtosis premium reflected into the difference  $k_{\rho,4}^P - k_{\rho,4}^N$ .

*Explaining the Bias of the Standard Implied Volatility Regressions*

The results of Proposition 1 can be used to investigate the sources of documented biases in forecasting future levels of physical volatility based on currently observed levels of risk-neutral volatility. Relation (5) provides us with the theoretical underpinnings of the volatility risk premium and, thus, permits to specify a new econometric framework to measure the slope bias of the implied volatility regressions. This framework only requires estimates of the physical and risk-neutral cumulants of the log-return  $\rho_T$ , which can be easily obtained from the data. As mentioned before, the statistical framework which is often employed in practice to forecast the future level of physical volatility based on implied volatility is a single regression model employing the risk-neutral volatility  $k_{\rho,2}^N$  (say with a maturity interval  $T-\tau$ ) as a regressor and the future level of physical volatility  $k_{\rho,2}^P$ , over the future period  $T-\tau$ , as a regressand, i.e.

$$k_{\rho,2}^P = \alpha + \beta \cdot k_{\rho,2}^N + e, \quad (7)$$

where  $e$  stands for a zero mean forecast error conditional on the current market information set  $L_t$ . Estimation of this regression model can be performed using the least squares method with time series data on the second-order cumulants  $k_{\rho,2}^N$  and  $k_{\rho,2}^P$ . These estimates can then be used to test for the validity of the following two hypotheses. First, whether implied volatility contains some information about the future value of physical volatility, which is often measured by the future realized volatility. In this case, the estimate of the slope coefficient  $\beta$  should be different from zero. Second, whether implied volatility constitutes an unbiased forecast of physical volatility, which implies the following joint hypothesis:  $\alpha = 0$  and  $\beta = 1$ . Under the last hypothesis, deviations of the regression estimates of coefficients  $\alpha$  and  $\beta$  from their theoretical values  $\alpha = 0$  and  $\beta = 1$  are considered as evidence of bias and information inefficiency in option market forecasts. However, in the light of relation (5), one ought to interpret such a failure of option market forecasts with caution. A rejection of the joint hypothesis  $\alpha = 0$  and  $\beta = 1$  (or the hypothesis  $\beta = 1$ ) can be attributed to the risk premium effects omitted from the right-hand side of the implied volatility regression model (7). As equation (5) shows, the risk-neutral volatility  $k_{\rho,2}^N$  will fully reflect information about its physical counterpart only when  $\rho = 0$  (i.e. under risk neutrality) or when the BS model holds, implying that  $k_{\rho,n}^N = 0$  for all  $v > 2$ . In contrast, if  $\rho \neq 0$  and  $k_{\rho,n}^N \neq 0$ , for  $v > 2$ , then the least squares estimator of the slope coefficient  $\beta$  will be biased, while that of the intercept  $\alpha$  may give a value different from zero<sup>4</sup>.

The bias of the least squares estimator of the slope coefficient  $\beta$  will depend on the magnitude of the risk aversion coefficient  $\rho$ , the sign and size of the correlation coefficients between the second-order risk-neutral cumulant  $k_{\rho,2}^N$  and the higher-order cumulants  $k_{\rho,2+m}^N$ , for  $\mu=1,2,\dots$ , which are omitted from the regression model(7). Moreover, the bias will also depend on the standard deviation of  $k_{\rho,2+m}^N$  relative to that of  $k_{\rho,2}^N$ . Below, we present an analytic formula of the asymptotic bias of the estimator of  $\beta$ , denoted as  $\hat{\beta}$ , from unity:

$$AsyBias(\hat{\beta}) \equiv p \lim_{T \rightarrow \infty} \hat{\beta} - 1 = \sum_{m=0}^{\infty} \left( \frac{\gamma^m}{m!} \right) \phi_{2,2+m} \frac{SD(k_{\rho,2+m}^N)}{SD(k_{\rho,2}^N)} \hat{\beta} \quad (8)$$

where  $T$  denotes here the number of the time series observations of the sample,  $\phi_{2,2+m}$  stands for the correlation coefficient between the risk-neutral cumulants  $k_{\rho,2}^N$  and  $k_{\rho,2+m}^N$ , for all  $\mu \in 1$ , and  $\Sigma\Delta(\cdot)$  stands for standard deviation. Formula (8) implies that, under risk aversion (i.e.  $\rho \neq 0$ ), estimator  $\hat{\beta}$  will be biased downward from unity if some of the correlation coefficients  $\phi_{2,2+m}$  are negative. This source of bias can explain the upward bias of the implied volatility to forecast the future level of its physical counterpart documented in

<sup>4</sup> This will happen due to the omission of higher than second-order risk-neutral cumulants from the righthand side of (7). Alternative estimators, such as the instrumental variables (IV) or the generalized methods of moments (GMM) suggested in the literature to deal with the measurement errors in the risk-neutral volatility (see Christensen and Prabhala 1998) can not resolve this problem, as most of the instruments used for this purpose are correlated with the omitted risk-neutral cumulants from (7).

the literature. Note that, only when  $\lambda_{2,2+\mu} = 0$  or  $\frac{SD(k_{\rho,2+m}^N)}{SD(k_{\rho,2}^N)}$  is close to zero,  $\hat{\beta}$  will provide unbiased estimates of the slope

coefficient  $\beta$  of regression (7) under risk-averse behavior. To calculate the magnitude of the asymptotic bias of the estimator  $\hat{\beta}$  and, hence, measure the risk premium effects on  $\beta$ , formula (8) shows that an unbiased estimator of the risk aversion coefficient  $\beta$  is required.

### III. Empirical Analysis

The main goal of this section is to assess the ability of our theoretical relation (4) to explain the documented biases of implied volatility regressions to forecast future levels of physical volatility. To this end, we suggest a new implied volatility regression model allowing for risk premium effects. This model can be also used to provide estimates of the risk aversion coefficient implied by option and stock markets data. Our analysis is also extended to investigate whether relation (6) can consistently explain the biases of higher than second-order risk-neutral cumulants to forecast their corresponding physical cumulants.

#### Data

Our empirical analysis uses index returns and cross-section sets of monthly observations on option prices for three different indexes: Standard & Poor's 500 Index (henceforth denoted as S&P500) and Financial Times Stock Exchange 100 Index (henceforth denoted as FTSE100) from 1996:01 to 2007:12, as well as NASDAQ 100 Index (henceforth denoted as NASDAQ) from 2001:06 to 2007:12. These sets of option prices cover different strike prices and have maturity intervals of approximately one calendar month (i.e. twenty two trading days). By employing these data, we have obtained estimates of the risk-neutral cumulants  $k_{\rho,n}^N$  at any point in time  $\tau$  of our sample based on the formulas suggested by Bakshi, Kapadia and Madan (2003), and Rompolis and Tzavalis (2008). These formulas give estimates of non-central risk-neutral moments from out-of-the-money option prices in a model-free manner. Employing them we have derived values of the risk-neutral cumulants using Stuart's and Ord (1994) cumulant formulas (see footnote 3). As shown by Rompolis and Tzavalis (2008), this procedure of retrieving the risk-neutral cumulants  $k_{\rho,n}^N$  from option prices provides very precise estimates of them<sup>5</sup>.

As values of the physical volatility  $k_{\rho,2}^P$  or the higher-order cumulants  $k_{\rho,3}^P$  and  $k_{\rho,4}^P$ , our analysis uses unbiased cumulant estimates of them based on the future realized values of the three indexes daily returns, denoted as  $\rho_j$  for  $j = 1, 2, \dots, n_T$ , up to one-month head, i.e. for the time interval of  $n_T = 22$  approximately trading days for each month (see, e.g., Canina and Figlewski 1993). For instance,

the realized volatility is calculated as  $k_{\rho,2}^P = \frac{1}{n_T - 1} \sum_{j=1}^{n_T} (p_j - \bar{p})^2$ , where  $\bar{p} = \frac{1}{n_T} \sum_{j=1}^{n_T} \rho_j$ . Analogous relations to the above can be

employed to estimate the third and fourth-order physical cumulants (see Stuart and Ord 1994). The estimates of physical cumulants derived by the above method have the key feature that they result in nonoverlapping data, as time periods covered by successive options exhibit no overlap. The nonoverlapping nature of the data can yield more precise estimates of them relative to their historical estimates obtained from overlapping samples (see Christensen and Prabhala 1998).

#### Estimation of Implied Volatility and Higher-Order Risk-Neutral Cumulant Regressions With and Without Risk Premium Effects

In this section we introduce a new implied volatility regression framework adjusted for risk premium effects which provides unbiased forecasts of physical volatility. This framework can be also extended to examine the information content of higher than second-order riskneutral cumulants.

*Implied Volatility Regressions Without Risk Premium Effects.* We commence our analysis with presenting estimates of the standard implied volatility regression model (7), without adjusting for risk premium effects. We also present estimates of other two implied volatility regression models often used in practice to forecast functions of the realized volatility  $k_{\rho,2}^P$ . These models employ the square root

transformation of  $k_{\rho,2}^P$  and  $k_{\rho,2}^N$  (i.e.  $(k_{\rho,2}^P)^{1/2}$  and  $(k_{\rho,2}^N)^{1/2}$ , or alternatively their logarithmic values  $\ln \left[ (k_{\rho,2}^P)^{1/2} \right]$  and

$\ln \left[ (k_{\rho,2}^N)^{1/2} \right]$  as regression variables (see, e.g., Andersen et al 2001, Corrado and Miller 2005, Giot and Laurent 2007). Under the risk-

<sup>5</sup> For instance, the authors show that the percentage error of the risk-neutral kurtosis coefficient is, on average, less than 1.5%. This error is even smaller for the risk-neutral skewness coefficient.



neutrality hypothesis (i.e.  $\alpha = 0$ ), note that the last two implied volatility regression models mentioned above can be thought of as direct transformations of our theoretical relation (5), underlying regression model (7).

Least squares (LS) estimates of all implied volatility regression models specified above are reported in Table 1. In particular, the table reports estimates of the coefficients  $\alpha$  and  $\beta$ , the Wald test statistic of the joint hypothesis  $\alpha = 0$  and  $\beta = 1$ , denoted as  $W(\alpha = 0, \beta = 1)$ , the adjusted coefficient of determination  $\bar{R}^2$  and the Durbin-Watson ( $\Delta\Omega$ ) statistic, as well as of two measures assessing the in- and out-of-sample forecasting performance of the models: the *RMSE* (root mean square error) and the *MAE* (mean absolute error). These measures are denoted as  $RMSE^{(i)}$  and  $MAE^{(i)}$  for the in-sample forecasts and as  $RMSE^{(o)}$  and  $MAE^{(o)}$  for the out-of-sample forecasts. They can be used to assess which one of the three implied volatility regression models considered in our analysis can provide better fit of our data, given that the coefficient  $\bar{R}^2$  can not be used for this purpose when regression models are not nested (see Davidson and MacKinnon 1993). To examine this, the table also reports the values of the  $P_E$  statistic testing whether the standard regression model (7) or that based on the square-root variables  $(k_{\rho,2}^P)^{1/2}$  and  $(k_{\rho,2}^N)^{1/2}$  constitute better specifications of the data than the log-linear model. To calculate the out-of-sample forecasting performance measures  $RMSE^{(o)}$  and  $MAE^{(o)}$ , we have estimated the alternative implied volatility models recursively starting from date 2004:01 and adding one observation at a time until the end of the sample. The out-of-sample forecasts are then calculated as the one-period ahead predictions of the models at each point of the recursive estimation.

The results of Table 1 are consistent with those provided in the literature. They indicate that, although the slope coefficient  $\beta$  of the standard implied volatility regression model (7) is of the right direction, its estimate is substantially less than unity, thus implying that the risk-neutral cumulant  $k_{\rho,2}^N$  is a biased upward predictor of the future level of its physical counterpart  $k_{\rho,2}^P$ . Furthermore, the values of the Wald test statistic  $W(\alpha = 0, \beta = 1)$  reported in the table clearly reject the joint hypothesis  $\alpha = 0$  and  $\beta = 1$  at 5% significance level. These results are stronger for the S&P500 and FTSE100 indexes. However, for NASDAQ the joint hypothesis  $\alpha = 0$  and  $\beta = 1$  is marginally rejected at the 5% significance level. Regarding the two other functional forms of the implied volatility regressions examined, the results of the table indicate that the estimates of the slope coefficient  $\beta$  are closer to unity, especially for the log-linear model. However, the estimates of these two models reject the joint hypothesis  $\alpha = 0$  and  $\beta = 1$ . They also indicate that the forecasting performance of these two models is poorer than that of the standard implied volatility regression model, given by relation (7). Note that, among the three models, the highest prediction errors are observed for the log-linear model. Further evidence that this specification of the implied volatility regression model does not constitute a better specification of the data than the standard model is provided by the values of the  $P_E$  test statistic reported in the table. These can not reject the null hypothesis that the standard implied volatility regression model (or its square transformation) constitutes a correct specification of the data series, when compared to the log-linear model. One explanation that may be given to the above results and, in particular, to the evidence that the slope coefficient  $\beta$  tends to unity for the log-linear model is that, by taking the logarithmic transformation of the regression series, the risk premium effects are smoothed out. Of course, this is not without cost. As our results show, the estimates of the constant of the log-linear model become significantly different than zero and take negative values. The latter may explain the less than satisfactory performance of the log-linear model of implied volatility to forecast future levels of physical volatility, as demonstrated by the *PMSE* and *MAE* measures.

Finally, before closing this section we examine whether higher than second-order riskneutral cumulants provide unbiased predictions of their physical counterparts. To this end, we have estimated the following regressions:

$$k_{\rho,n}^P = \alpha + \beta k_{\rho,n}^N + u_n, \text{ for } n = 3, 4. \quad (9)$$

Least squares estimates of these regressions are reported in Table 3. These show that the bias of the slope coefficient  $\beta$  is worse than in the case of the standard implied volatility regression model (7). The estimates of the slope coefficient  $\beta$  of these models are not different than zero for all indexes considered, and thus the joint hypothesis  $\alpha = 0$  and  $\beta = 1$  is clearly rejected at 5% significance level. These results clearly indicate that the higherorder cumulants  $k_{\rho,3}^N$  and  $k_{\rho,4}^N$  contain no information about their physical counterparts. In the light of our theoretical relation (3) and the results of Table 1 (see Panels A and B), these biased estimates of  $\beta$  can be explained by the much higher correlation which exists among the higher-order risk-neutral cumulants  $k_{\rho,3}^N, k_{\rho,4}^N$  and  $k_{\rho,5}^N$ , as well as

their relative 13 levels of standard deviations  $\frac{SD(k_{\rho,4}^N)}{SD(k_{\rho,3}^N)}$  and  $\frac{SD(k_{\rho,5}^N)}{SD(k_{\rho,4}^N)}$ .

*Implied volatility regressions allowing for risk premium effects.* To investigate whether the risk premium effects can remove the bias of implied volatility regressions to forecast physical volatility, in this section we suggest a new statistical framework which, in light of our theoretical relation (5), includes higher-order risk-neutral cumulants in the standard regression model (7) as additional regressors. In particular, we have estimated the following regression model:

$$k_{\rho,2}^P = \alpha + \beta k_{\rho,2}^N + \gamma k_{\rho,3}^N + \varepsilon_2 \quad (10)$$

This model assumes that the third-order risk-neutral cumulant  $k_{\rho,3}^N$ , which captures the skewness effects on volatility premium, can account for the risk premium effects on the slope coefficient of the risk-neutral cumulant  $k_{\rho,2}^P$ . Note that, in addition to  $k_{\rho,3}^N$ , higher than second-order risk-neutral cumulants (e.g.  $k_{\rho,3}^N, k_{\rho,4}^N \dots$ ) can be also included in the standard regression model (7), but as our initial estimates have shown the results of our analysis do not change. The inclusion of higher-order risk-neutral cumulants in regression (10) does not provide a better fit for our data. As mentioned before, estimation of the multiple regression model (10) should be performed with caution due to the multicollinearity problem that may appear in practice. This is due to the high correlation which exists between the two regressors  $k_{\rho,2}^N$  and  $k_{\rho,3}^N$ . When this problem arises, the estimates of the slope coefficients of model (10) and/or their standard errors become very large (see Greene 2004). To see if this problem is present in our case, we have also estimated a restricted version of model (10) assuming that  $\beta = 1$ , i.e.

$$k_{\rho,2}^P - k_{\rho,2}^N = \alpha + \gamma k_{\rho,3}^N + \varepsilon_2^* \quad (11)$$

Comparison of the least squares estimates of coefficient  $\gamma$  between the above two models (10) and (11) can reveal whether any serious problem of multicollinearity is present in the unrestricted estimation of model (10). If this happens, then the estimates of  $\gamma$  should considerably differ between models (10) and (11).

The estimation results of models (10) and (11) are reported in Table 2. As can be seen from them, the inclusion of the third-order cumulant  $k_{\rho,3}^N$  in the implied volatility regression model removes the bias of the least squares estimates of the slope coefficient  $\beta$ . The estimates of this coefficient now become close to unity and the joint hypothesis  $\alpha = 0$  and  $\beta = 1$  can no longer be rejected by the Wald test statistic  $W(\alpha = 0, \beta = 1)$  at the 5% significance level. This is true for all indexes examined. Further support for the validity of hypothesis  $\beta = 1$  and model (10) can be obtained by the values of the likelihood test statistic,  $\Delta P$ , reported in the table. This test examines the validity of the restricted model (11), under the restriction  $\beta = 1$ , against its unrestricted version given by equation (10). As the results of the table show, this statistic can not reject the restricted model.

Another interesting result of Table 2 concerns the small values of the estimates of the risk aversion coefficient  $\gamma$  implied by our data sets. These values are very close for both the restricted and the unrestricted least squares estimates of models (11) and (10), respectively. They are also consistent with those found in other studies in the literature based on stock and/or option price data (see, e.g., Hansen and Singleton 1984, and Bliss and Panigirtzoglou 2004). They suggest that the risk aversion coefficient of the representative agent implied by option prices is not as extreme, as those found in studies based on consumption data (see, e.g. Mehra and Prescott 1985). The fact that the estimates of  $\gamma$  remain almost the same across the restricted and unrestricted regression models (10) and (11) can be taken as evidence of no presence of multicollinearity in the estimates of the coefficients  $\beta$  and  $\gamma$  of model (10).

To examine if the above estimates of  $\gamma$  are also consistent with those implied by our data for higher than second-order risk-neutral cumulants, in Table 3 we present least squares estimates of the restricted model (11) estimated as a system of the following equations:

$$k_{\rho,n}^P - k_{\rho,n}^N = \alpha + \gamma k_{\rho,n+1}^N + e_n, \quad n = 2,3,4. \quad (12)$$

These estimates are then used to calculate the values of the Wald statistic testing the hypothesis that the risk aversion coefficients  $\gamma$ , denoted as  $\gamma_n$  for each equation of system (12), are equal per pair of equations (i.e.  $\gamma_2 = \gamma_3$  or  $\gamma_3 = \gamma_4$ ) or across all of them (i.e.  $\gamma_2 = \gamma_3 = \gamma_4$ ). The results of the table clearly indicate that the estimates of  $\gamma$  are very close for all equations of system (12) and the three stock indexes considered. The estimates of  $\gamma$  vary between the values 1.78 and 3.15, which are very close to those found in the augmented implied volatility regression (10). These results can be more formally confirmed by the Wald test statistics reported in the table which can not reject the above hypotheses examined. The only exemption is the joint hypothesis  $\gamma_2 = \gamma_3 = \gamma_4$  for the FTSE100 index, which is rejected at the 5% significance level. But, even for this case the estimates of  $\gamma$  are very close to each other for all equations of the system. Note also that for this index, the pairs of hypotheses  $\gamma_2 = \gamma_3$  and  $\gamma_3 = \gamma_4$  can not be rejected when they are tested, separately.

Summing up, the results of this subsection clearly indicate that a relatively small degree of risk aversion in the options and stock markets can explain the biases of implied volatility to forecast its physical counterpart documented in the literature.

## IV. Conclusions

In this article we provide a new framework of explaining the sources of bias of the implied by option prices volatility regressions to forecast future levels of physical volatility. This is done in a model-free manner, without imposing any structure on the stochastic process driving asset prices, or relying on any specific parametric option pricing model. The paper 17 derives a theoretical relation between physical and risk-neutral volatilities which shows that, under risk aversion, these two different measures of market volatility do not possess one-to-one correspondence. This relation can explain the biases of implied volatility regressions documented in the literature. According to this, the discrepancy between physical and riskneutral volatilities originates from the volatility risk premium effects which can be captured by higher than second-order risk-neutral cumulants. These effects, which are priced in option markets, compensate investors for extreme negative shifts in asset markets due to, for instance, crashes or other extreme events.

Based on this theoretical relation, we suggest new regression models to investigate the information content of implied volatility or any other higher-order risk-neutral cumulant about their corresponding physical measures. These models adjust standard implied volatility regression models used in practice to account for risk premium effects. Using these models and option price data on the S&P500, FTSE100 and NASDAQ indexes, we provide strong evidence that the volatility premium can adequately capture the bias of the standard implied volatility regression to predict physical volatility. Our results indicate that this risk premium generated bias can be mainly attributed to the negative skewness of the log-return risk-neutral distributions. This can be done for relatively small values of the risk aversion coefficient. Analogous values of this coefficient are also found that can explain the risk premium biases embedded in higher than second-order risk-neutral cumulant regressions used to predict their physical counterparts.

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## Appendix

Table I. Implied Volatility Regressions

	SBSP500	FTSE100	NASDAQ			
Model: $k_{\rho,2}^P = \alpha + \beta k_{\rho,2}^N + e$						
$\alpha$	0.00021	(0.4E-4)	0.5E-4	(0.0003)	0.0005	(0.4E-4)
$\beta$	0.68	(0.14)	0.52	(0.09)	0.77	(0.08)
$W_{(\alpha=0, \beta=1)}$	29.52	[ $pv = 0.00$ ]	50.63	[ $pv = 0.00$ ]	3.13	[ $pv = 0.04$ ]
$\bar{R}^2$	0.41		0.48		0.77	
$DW$	1.78		1.40		1.61	
$RMSE^{(i)}$	0.0021		0.0022		0.0033	
$MAE^{(i)}$	0.0012		0.0013		0.0021	
$P_E$	0.32	[ $pv = 0.72$ ]	1.40	[ $pv = 0.16$ ]	0.35	[ $pv = 0.73$ ]
$RMSE^{(o)}$	0.9E-4		0.0014		0.0013	
$MAE^{(o)}$	0.8E-4		0.0007		0.0008	
Model: $(k_{\rho,2}^P)^{1/2} = \alpha + \beta (k_{\rho,2}^N)^{1/2} + e_1$						
$\alpha$	0.0037	(0.0048)	0.0051	(0.0037)	0.0027	(0.0035)
$\beta$	0.77	(0.096)	0.69	(0.0740)	0.87	(0.05)
$W_{(\alpha=0, \beta=1)}$	58.58	[ $pv = 0.00$ ]	87.67	[ $pv = 0.00$ ]	8.91	[ $pv = 0.00$ ]
$\bar{R}^2$	0.49		0.58		0.83	
$DW$	1.81		1.47		1.70	
$RMSE^{(i)}$	0.015		0.015		0.014	
$MAE^{(i)}$	0.010		0.010		0.010	
$P_E$	0.22	[ $pv = 0.83$ ]	1.21		0.72	[ $pv = 0.47$ ]
$RMSE^{(o)}$	0.0089		0.012		0.010	
$MAE^{(o)}$	0.0061		0.008		0.007	

(continued)

**Table 2. Implied Volatility Regressions (continued)**

	S&P500	FTSE100	NASDAQ			
	Model: $\ln(k_{\rho,2}^P)^{1/2} = \alpha + \beta \ln(k_{\rho,2}^N)^{1/2} + e_2$					
$\alpha$	-0.45	(0.23)	-0.49	(0.18)	-0.20	(0.11)
$\beta$	0.92	(0.08)	0.92	(0.06)	0.95	(0.06)
$W_{(\alpha=0,\beta=1)}$	82.64	[ $pv = 0.00$ ]	68.99	[ $pv = 0.00$ ]	13.33	[ $pv = 0.00$ ]
$\bar{R}^2$	0.55		0.65		0.80	
$DW$	1.87		1.68		1.90	
$RMSE^{(i)}$	0.27		0.20		0.18	
$MAE^{(i)}$	0.20		0.20		0.14	
$RMSE^{(o)}$	0.24		0.27		0.20	
$MAE^{(o)}$	0.18		0.19		0.14	

**Notes:** Table 1 presents the least squares estimates of all implied volatility regression models for the Standard & Poor's 500 (S&P500), Financial Times Stock Exchange 100 (FTSE100) and NASDAQ 100 (NASDAQ) indexes.  $k_{\rho,2}^P$  is the second-order physical cumulant standing for physical volatility and  $k_{\rho,2}^N$  is the second-order risk-neutral cumulant standing for risk-neutral volatility.  $W_{(\alpha=0,\beta=1)}$  is the Wald test statistic of the joint hypothesis:  $\alpha = 0$  and  $\beta = 1$ . This is distributed as  $\chi^2$  with two degrees of freedom.  $\bar{R}^2$  is the adjusted coefficient of determination,  $\Delta\Omega$  is the Durbin-Watson statistic for serial correlation,  $RMSE^{(i)}$  and  $MAE^{(i)}$  are the in-sample values of the root mean square and mean absolute prediction errors, respectively, while  $RMSE^{(o)}$  and  $MAE^{(o)}$  are the out-of-sample ones, covering the sample interval 2004:01-2007:12.  $P_E$  is the MacKinnon, White and Davidson test for log-linearity (see footnote 11). Standard deviations are in parentheses and p-values in brackets. The standard deviations are corrected for White heteroscedasticity and Newey-West serial correlation using four lags back.

**Table 3. Implied Volatility Regressions Allowing for Risk Premium Effects**

	S&P500	FTSE100	NASDAQ			
	Unrestricted Model: $k_{\rho,2}^P = \alpha + \beta k_{\rho,2}^N + \gamma k_{\rho,3}^N + e_2$					
$\alpha$	-0.8E-4	(0.0005)	-0.0002	(0.0003)	0.9E-4	(0.0006)
$\beta$	0.89	(0.25)	0.92	(0.16)	0.97	(0.15)
$\gamma$	1.28	(0.89)	2.03	(0.71)	1.48	(1.10)
$W_{(\alpha=0,\beta=1)}$	1.47	[ $pv = 0.47$ ]	5.33	[ $pv = 0.07$ ]	0.026	[ $pv = 0.97$ ]
$\bar{R}^2$	0.40		0.52		0.77	

<i>DW</i>	1.81		1.40		1.63	
<i>RMSE</i> <sup>(i)</sup>	0.0020		0.0021		0.0032	
<i>MAE</i> <sup>(i)</sup>	0.0011		0.0017		0.0025	
<i>RMSE</i> <sup>(o)</sup>	0.0008		0.0014		0.0013	
<i>MAE</i> <sup>(o)</sup>	0.0004		0.0007		0.0008	
Restricted Model ( $\otimes = 1$ ): $k_{\rho,2}^P - k_{\rho,2}^N = \alpha + \gamma k_{\rho,3}^N + e_2^*$						
$\alpha$	-0.0003	(0.0002)	-0.0004	(0.0002)	-0.3E-5	(0.0011)
$\gamma$	1.68	(0.74)	2.39	(0.34)	1.63	(0.70)
$\bar{R}^2$	0.15		0.48		0.21	
<i>DW</i>	1.82		1.41		1.63	
<i>RMSE</i> <sup>(i)</sup>	0.0020		0.0021		0.0032	
<i>MAE</i> <sup>(i)</sup>	0.0016		0.0013		0.0020	
<i>RMSE</i> <sup>(o)</sup>	0.0004		0.0014		0.0012	
<i>MAE</i> <sup>(o)</sup>	0.0005		0.0006		0.0008	
<i>LR</i>	0.35	[ <i>pv</i> = 0.54]	0.44	[ <i>pv</i> = 0.50]	0.052	[ <i>pv</i> = 0.82]

Notes: Table 2 presents least squares estimates of both the unrestricted and restricted implied volatility regression models allowing for risk premium effects for the three indexes: Standard & Poor's 500 (S&P500), Financial Times Stock Exchange 100 (FTSE100) and NASDAQ 100 (NASDAQ).  $k_{\rho,2}^P$  and  $k_{\rho,3}^P$  denote the second and third-order physical cumulants, respectively, while  $k_{\rho,2}^N$  and  $k_{\rho,3}^N$  denote the second and third-order risk-neutral cumulants, respectively.  $\Omega(\otimes=0, \otimes=1)$  is the Wald test statistic of the joint hypothesis:  $\alpha = 0$  and  $\beta = 1$ . This is distributed as  $\chi^2$  with two degrees of freedom.  $\bar{R}^2$  is the adjusted coefficient of determination, *DW* is the Durbin-Watson statistic for serial correlation, *RMSE*<sup>(i)</sup> and *MAE*<sup>(i)</sup> are the in-sample values of the root mean square and mean absolute prediction errors, respectively, while *RMSE*<sup>(o)</sup> and *MAE*<sup>(o)</sup> are the out-of-sample ones, covering the sample interval 2004:01-2007:12. *LR* is the likelihood ratio test of the restricted (under hypothesis  $\beta = 1$ ) model against the unrestricted model, where  $\beta$  is estimated freely. This is distributed as  $\chi^2$  with one degree of freedom. Standard errors are in parentheses and p-values are in brackets. These are corrected for White heteroscedasticity and Newey-West serial correlation using four lags back.

**Table 4. System Estimation of the Risk Aversion Coefficient**

	S&P500	FTSE100	NASDAQ			
	Model: $k_{\rho,n}^P - k_{\rho,n}^N = \alpha_n + \gamma_n k_{\rho,n+1}^N + e_n^*$			$v = 2, 3, 4$		
$\alpha_2$	-0.0002	(0.0002)	-0.0003	(0.0002)	0.0003	(0.0002)
$\alpha_3$	0.0001	(0.2E-0)	0.0002	(0.2E-0)	0.0003	(0.0002)
$\alpha_4$	-0.2E-4	(0.2E-0)	-0.4E-4	(0.2E-0)	-0.8E-4	(0.2E-0)
$\gamma_2$	1.78	(0.71)	2.57	(0.28)	2.10	(0.77)
$\gamma_3$	2.83	(0.15)	2.58	(0.19)	2.68	(0.29)

$\gamma_4$	2.86	(0.16)	3.03	(0.20)	3.15	0.45
$W_{(\gamma_2=\gamma_3)}$	1.75	[ $pv = 0.18$ ]	0.0006	[ $pv = 0.98$ ]	0.29	[ $pv = 0.58$ ]
$W_{(\gamma_2=\gamma_4)}$	1.89	[ $pv = 0.17$ ]	1.14	[ $pv = 0.28$ ]	0.67	[ $pv = 0.41$ ]
$W_{(\gamma_2=\gamma_3=\gamma_4)}$	2.33	[ $pv = 0.31$ ]	26.99	[ $pv = 0.00$ ]	0.29	[ $pv = 0.90$ ]

Notes: Table 3 presents estimates of the equation system containing the second, third and fourth-order cumulant restricted regressions. The system is estimated based on the SUR method for the following three indexes: Standard & Poor's 500 (S&P500), Financial Times Stock Exchange 100 (FTSE100) and NASDAQ 100 (NASDAQ).  $k_{\rho,n}^P$  denotes the  $\nu\tau\eta$ -order physical cumulant and  $k_{\rho,n}^N$  denotes the  $n^{\text{th}}$ -order risk-neutral cumulant.  $W_{(\gamma_2=\gamma_3)}$  and  $W_{(\gamma_2=\gamma_4)}$  are the Wald test statistics of the joint hypotheses  $\gamma_2=\gamma_3$  and  $\gamma_2 = \gamma_4$ , respectively. These are distributed as  $\chi^2$  with two degrees of freedom.  $W_{(\gamma_2=\gamma_3=\gamma_4)}$  is the Wald test statistic for the joint hypothesis  $\gamma_2=\gamma_3=\gamma_4$ . This is distributed as  $\chi^2$  with two degrees of freedom. Standard errors are in parentheses and p-values in brackets. These are corrected for White heteroscedasticity and Newey-West serial correlation using four lags back.

## GREECE IN THE “NEW” ERA OF GLOBALIZATION

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### Abstract

*This paper is an attempt to assess the effects of the integration of the global economy, on a unique country, Greece. While some countries were clearly affected in a positive or a negative way by globalization, Greece appears to have experienced both gains and losses in this economic integration path. Greek businesses have taken advantage of the opening of the borders and made a massive incursion in the neighboring Balkan countries, expanding their markets fivefold or more. Shipping, the flagship industry of the country, has taken advantage of the huge relocation of manufacturing to South-East Asia, transporting raw materials and finished goods into the region and away from it. Tourism picked up steam also, capitalizing on the gains realized by the Athens Olympic Games in 2004. While some of the Greek industries were beneficiaries of the globalized economy, some others have been on a steady decline path. Manufacturing and agriculture have been diminishing, for several years, as a percentage of the country's GDP. The onset of the global economic crisis, in 2008, alarmed the economists in Greece and abroad, seeking to determine the root causes of the crisis and the extent of the expected repercussions. While during the normal economic cycles there have been some winners and losers from globalization, at this time of disruption, it is hard to tell if there will be any winners at all, who they will be and what needs to be done to be one of them.*

### Περίληψη

*Με την παρούσα εργασία επιχειρείται μια αξιολόγηση των επιπτώσεων της παγκοσμιοποίησης στην Ελλάδα. Παρά το ότι, για πολλές χώρες είναι εύκολη η διαπίστωση, ως προς το θετικό ή αρνητικό αντίκτυπο της ενοποίησης της παγκόσμιας αγοράς σε αυτές, η Ελλάδα φαίνεται να απεκόμισε τόσο οφέλη, όσο και ζημίες, καθιστώντας το δύσκολο να αποφανθεί κάποιος με βεβαιότητα ως προς το επικερδές της παγκοσμιοποίησης για τη χώρα. Οι Ελληνικές επιχειρήσεις έσπευσαν να καλύψουν το κενό που δημιουργήθηκε με το άνοιγμα των βορείων συνόρων της χώρας, επενδύοντας τεράστια ποσά, και διευρύνοντας την αγορά τους κατά πέντε ή περισσότερες φορές σε σχέση με την υπάρχουσα. Οι θαλάσσιες μεταφορές, η πλέον δυναμική βιομηχανία της χώρας εκμεταλλεύτηκε τη μαζική μετεγκατάσταση της παγκόσμιας παραγωγής βιομηχανικών και άλλων αγαθών στην Κίνα και τη Νοτιοανατολική Ασία, μεταφέροντας πρώτες ύλες και έτοιμα αγαθά από και προς την περιοχή. Η τουριστική βιομηχανία, επίσης αναπτύχθηκε δραστικά, εκμεταλλευόμενη τα οφέλη που προέκυψαν από τους Ολυμπιακούς Αγώνες της Αθήνας το 2004. Ενώ κάποιοι από τους κλάδους της Ελληνικής βιομηχανίας ευνοήθηκαν από την παγκοσμιοποίηση της αγοράς, άλλοι κλάδοι όπως η γεωργία και η βιομηχανική παραγωγή συρρικνώνονται χρόνο με το χρόνο. Η έναρξη της παγκόσμιας οικονομικής κρίσης του 2008 σήμανε συναγερμό για τους οικονομολόγους και τους μανάτζερ στην Ελλάδα όπως και στις υπόλοιπες χώρες, οδηγώντας τους στην αναζήτηση τόσο του εδρους της κρίσης όσο και των επιπτώσεων της. Κατά τη διάρκεια των οικονομικών κύκλων, κατά κανόνα, παρατηρούνται χώρες που ωφελούνται, αλλά και άλλες που υφίστανται απώλειες. Κατά την διάρκεια της πρωτοφανούς οικονομικής κρίσης, δύσκολα μπορεί να προβλέψει κάποιος αν θα υπάρξουν ωφελημένοι, ποιοι θα είναι αυτοί και τι απαιτείται για να συμπεριληφθεί κάποιος στην ομάδα των κρατών αυτών.*

JEL CODE: A10, A11, F01, F21, G01

Key Words: Globalization, Greece, Balkans.

### GREECE IN THE ERA OF GLOBALIZATION

It has been almost two decades since globalization unleashed its forces on the planet and has become the dominant socioeconomic, cultural, political and technological discussion subject. All of a sudden, it became apparent that the world is an open system, where tampering with one part affected the whole global society and the economy. The interconnectedness of the world economy is so strong, that the repercussions of the failure of the US banks are threatening the functioning and economic health of countries as diverse as Iceland, U.K., Japan and the BRIC group (Brazil, Russia, India and China).

Globalization has been defined in a variety of ways, the common denominator of which has been the “..widening, deepening and speeding up the interconnectedness in all aspects of contemporary social life”, according to Held and McGrew (2001).



Due to the wide variations of the effects of different aspects of globalization, one must make clear distinctions as to which dimension of the concept he or she is referring to. Economic globalization refers to the integration of the global economic activities through trade, capital flows and migration. Environmental globalization includes the global effects of human activity on the environment. Cultural globalization addresses the convergence of nations in their ways of living, their interests, hobbies and so on. Political globalization finally, deals with the wider acceptance of global political standards such as democracy, human rights, environmental standards and the functioning of global institutions such as the U. N., the World Bank, the World Trade Organization and the I. M. F. All of the above globalization aspects affect every single nation on earth, in every conceivable way.

The effects of globalization on individual nations, as well as groups of nations vary, with some having benefited more than others, while every nation has suffered in some respect undesired consequences beside the beneficial ones. Although assertions are being made by leading thinkers such as Anthony Giddens (2003), that isolationism is worse than becoming integrated in the global economy, not much has been said about the optimal degree of integration in the global community (Legrain, P. 2009). Additionally, Nobel laureate Joseph Stiglitz (2002), member of International Labor Organization's Commission on the social dimensions of globalization, proposes that the "destructive effects of it ( globalization)" by far outweigh its benefits to society. He claims that up to this day, the economic integration has served mainly the interests of the large multinational corporations, rather than the people, effectively reducing the role of governments in their national economies ( Stiglitz, 2002). The ILO Commission feared the diminished role of the governments, as a result of the global trend of "freeing up the markets". Ironically, today, we are becoming witness to the Commission's fear coming true. It was only few months ago, when the Governments of the European Union, the United States and other Developed Countries decided that the threat of the collapse of the free market system was imminent and the government intervention is imperative. The implosion of the global economy has undermined the faith in free markets.

### **Is Globalization good for the people?**

Many influential people believe that the benefits of an integrated world economy clearly surpass the costs of it. Ideally, in a well-functioning globalized economy:

- There is a worldwide market for the companies and for the people there is more access to products of different countries.
- There is a steady cash flow into the developing countries.
- Due to the presence of a worldwide market, there is an increase in the production sector and there are lots of options for the companies to locate.
- There is greater exchange of information between two countries, which do not have anything in common.
- There is cultural intermingling and each one is trying to know about the other's cultural preferences and in the process of doing so, people are actually coming across things that they might like and in the course of time adopt them.
- Socially we have become more open and tolerant towards each other and they who live in the other part of the world are not aliens as we always thought. There are examples like, now Indian girls work in call centers and work nights, which was a taboo even two years back.
- There is a lot of technological development that we have undergone over the years. There are fewer brain drains since Asians are working in their own country though for a foreign company but are earning foreign exchange for their country (Hart 2006).

### **There are as many cons as pros to globalization some of which are listed below:**

- It is true that Europeans and Americans are losing jobs and that is posing a problem for them, since the companies are outsourcing work to the Asian countries where the cost of labor is low and profits the company considerably (Slaughter & Swagel, 1997).
- There is immense pressure on the employed Europeans who are always under the threat of the business being outsourced.
- Corporations are building up units in other countries equally well equipped as they have done at their own country, thus transferring the product and process quality to other countries.
- There are some experts who think that globalization, along with the positive aspects is also leading to the importing of problems like communicable diseases such as SARS and recently the Swine Flu and social degeneration.

- There is also a threat of corporations ruling the world because there is a lot of power, which is given to them due to their global influence (Stiglitz, 2002)
- Streeten (2001), in his study of winners and losers of globalization, presented a concise, yet complete picture of globalization effects indicated in the table below.

**Table 1. Winners and losers of globalization**

Winners	Losers
The North (Japan, The U.S., Europe) and parts of Asia	Many developing countries (including most of Africa and Latin America)
Output	Employment
People with Assets	People without Assets
Profits	Wages
The highly skilled and educated	People without skills
Professional, managerial, and technical people	The uneducated
People able to adjust to new situations quickly and easily	Workers
Creditors	People unable to adjust to new situations easily
Those independent of public services	Debtors
Large firms	Those dependent on public services
Men	Small Firms
The strong	women and children
Risk Takers	Human Security
Global Markets	Local communities
Sellers of technologically advanced equipment	Sellers of primary and manufactured products
Global Culture	Local Cultures
Global Peace	Local troubles (here referring to Russia, Mexico and Turkey)
Proponents	Opponents
Businessmen and Economists	Environmentalists, Working People, Consumer Rights Groups, Family Organizations, Farmers, Religious Organizations, Advocates of democracy

*As adapted from Globalization: Threat or Opportunity? by Paul Streeten.  
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We could go on identifying the pluses and the minuses of globalization in greater length, but what is certain is that the integrated economy has not treated all countries equally. Truth is that in the last ten years we saw the greatest redistribution of the world wealth ever, to the benefit of the developing nations, or at least some of them. China for one, which averaged a 9,7% growth over the past 30 years, surpassed Germany and became the third largest economy behind the USA and Japan (Stiglitz, 2006). India is following China's lead, although still far behind, with an increasing foreign trade every year and becoming the hotbed of new software development companies, making a leap from an agricultural economy to a post – industrial one. Other countries are following China's and India's lead such as Vietnam, Mexico, Singapore, Thailand and so on.

It is also true however, that hundreds of thousands of jobs have been off-shored, causing a major problem in developed countries, where governments see the discontent of the workforces, nervously waiting for the next layoff announcement by their employer and the outsourcing of their job to some country abroad with a tiny fraction of labor cost.

## **The globalization effects on Greece**

Every country experiences globalization in a unique way. Some obtain greater benefits incurring less costs, others lose more than they gain, while a third category is somewhere in the middle. Greece is in our view, in the latter group. While it has benefited from the opening of the market, the free capital flow and the other positive aspects of globalization, she has also gone through the painful experience of losing large numbers of jobs and capital which, in part at least, could have been invested at home rather than the neighboring countries.

The Greek economy has always been intertwined with the European economy, following the trends of the latter, usually with certain lag. Traditionally the E.U. countries have been the main trade partners of Greece. In spite of the close bonds Greece has with its economic partners in the European Union, the country has developed in the last decade a dynamic relationship with her neighboring countries from the north and the east, namely, Turkey, Bulgaria, Romania, Serbia, FYROM and Albania. Greek exports to South Eastern European countries reached 22,1% of the total exports of the country in 2007, up from 7,5% in 1997. The Imports were also up to 6,2% of total imports in 2007, compared to 1,9% in 1997. The Greek Foreign Direct Investment in SEE (cumulative) was \$2,2bn in 2007 compared to \$1,1bn in 1997. (Source: Ministry of Economics and Trade Affairs).

The integration of Greece's economy to that of the SEE countries is estimated to have added about 0,6 of a percentage point to the country's annual economic growth during the past ten years.

The opening up of a market of 100 million consumers provided a thrust to the Greek Exports offering a heaven to the country's entrepreneurs and leading to skyrocketing export levels.

Greek business expansion to SE Europe has also helped the competitiveness of the Greek products in the EU market. Using inexpensive resources and with low labor cost Greek businesses managed to increase their exports to the EU-15.

The influx of 1 million immigrants from the SEE in the country, boosted the flexibility in the Greek labor market, making it into an employer's paradise with a great excess in labor supply. The immigrants of course became also consumers once integrated in the economy supporting thus local consumption.

The annual profitability of the 12 billion € FDI in SEE is expected to bring back in Greece € 2 billion by the end of 2009, which will add 0,2 of 1% to annual GDP growth. (Source: Bank of Greece).

All of the above represent the positive aspect of the integration of Greece with the SEE economies, however, there have been some problem areas as well. With the opening of the northern borders of Greece hundreds of entrepreneurs closed shop, to rush into the neighboring countries taking advantage of the low labor, raw material, plant and equipment costs. The Northern Greece economic activity has slowed dramatically and social problems exacerbated.

The relocation of several Greek businesses cost the country close to 180.000 jobs, according to some estimates.

Another problem created by the opening of the SEE countries borders is the offering of a new alternative to FDI previously directed towards Greece. Statistics show how large amounts of FDI have been directed into the newly created free markets.

Moreover, the demand by EU-15 countries for Greek products has shifted to the lower cost SEE-produced products services, with the most pronounced effect on tourism moving to Turkey. However, it isn't only Turkey that is challenging Greece's position in the tourism market of the Southeastern and Mediterranean Europe. Bulgaria, Romania and Albania are becoming increasingly potent competitors, offering low prices and improving the quality of their services.

Greek Financial Services have a strong presence in the SEE region. The large Greek banks have large networks in virtually of the regions countries, expanding either by opening new branches or through Mergers and Acquisitions.

Finally, the most important Greek industry, shipping, is making huge gains establishing its prowess in the global market, being the biggest in the world, makes Greece a real global player. Shipping, which contributed by 4,5% to the country's GDP in 2006 and employs 4% of the country's workforce, generates significant foreign exchange, enough to cover 30,2% of the trade deficit in 2005, compared to tourism receipts of 26,2% and to EU net transfers of 11,6%. (Economic Bulletin Alfabank, No. 108, 2009). Given that 95% of the global trade is undertaken by ship, with Greece controlling 21% of the world's tankers and dry cargo fleet and 16% of the sea going fleet, the country becomes a heavyweight champion in the industry and a really global power.

Greece is therefore fully integrated in the global economy in which it plays a vital role. The country has benefited in several respects from globalization both through its bilateral relationships with other countries

and through its EU membership. It is hard to say, what would happen if Greece would not have participated in the transformation of the Balkans, or if she opted out of the EU, however most indicators point to the direction that the country gained more, by her engaging in the EU and the SEE, than she lost.

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# SERVICE QUALITY: A CRITICAL REVIEW OF SERVICE QUALITY MODELS

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## Abstract

*Service quality is a particularly important factor for companies since it is strongly connected with customer satisfaction, and strongly influences competitive advantage. Therefore, the measurement of quality and customer satisfaction are important factors in the success of a company. In recent decades companies have begun to understand the importance of quality and customer satisfaction, and consider their measurement as the most reliable system of feedback since, in this way they derive all the information necessary for the assessment of their performance. For this reason, companies are increasingly orientating themselves in this direction.*

*In this article, there is an analysis of more than twenty models of service quality, which have at some time been suggested by researchers, and in their most essential elements, cover a spectrum from conventional services to internet services, including organizational and behavioural aspects. The main goal is the assessment of these service models, offering a practical aid to prospective researchers and professionals. In this way, there is a basis on which to expand knowledge and use in everyday practice. In conclusion, research is conducted using the Servqual model, showing how this model functions in analyzing service quality.*

## Περίληψη

*Η ποιότητα των υπηρεσιών έχει ιδιαίτερη σημασία για τις επιχειρήσεις καθώς συνδέεται άρρηκτα με την ικανοποίηση του πελάτη. Πρόκειται για ένα σημαντικό παράγοντα από τον οποίο προκύπτει βασικό ανταγωνιστικό πλεονέκτημα. Επομένως η μέτρηση της ποιότητας και της ικανοποίησης των πελατών αποτελούν βασικούς παράγοντες που καθορίζουν την επιτυχή πορεία μίας επιχείρησης. Τις τελευταίες δεκαετίες οι επιχειρήσεις έχοντας κατανοήσει τη σπουδαιότητα της ποιότητας και της ικανοποίησης των πελατών, θεωρούν τη μέτρησή τους ως το πλέον αξιόπιστο σύστημα ανάδρασης καθώς με τον τρόπο αυτό αντλούν όλη την απαραίτητη πληροφόρηση που έχουν ανάγκη για την αξιολόγηση της απόδοσης και της λειτουργίας τους. Για το λόγο αυτό κινούνται όλο και περισσότερο προς την κατεύθυνση αυτή.*

*Στο άρθρο αυτό γίνεται μια κριτική αναφορά σε περισσότερα από είκοσι μοντέλα ποιότητας υπηρεσιών που κατά καιρούς έχουν προταθεί από ερευνητές και στα βασικότερα στοιχεία αυτών. Καλύπτοντας ένα φάσμα μεταξύ συμβατικών εξατομικευμένων υπηρεσιών και υπηρεσιών διαδικτύου, ενώ συμπεριλαμβάνονται τόσο οργανωσιακές όσο και συμπεριφορικές (behavioural) πτυχές. Ο κύριος στόχος του είναι να αξιολογηθούν αυστηρά αυτά τα μοντέλα υπηρεσιών προσφέροντας έτσι μια πρακτική βοήθεια στους μελλοντικούς ερευνητές και επαγγελματίες αυτής της κατεύθυνσης, αφού έτσι τους δίνεται μια βάση πάνω στην οποία θα μπορούν να στηριχτούν είτε για να επεκτείνουν την γνώση είτε για να την χρησιμοποιήσουν στην καθημερινή πρακτική, αντίστοιχα. Τέλος πραγματοποιείται μία ερευνητική εφαρμογή του μοντέλου Servqual, δείχνοντας με τον τρόπο αυτό τη λειτουργία του για την μέτρηση και ανάλυση της ποιότητας υπηρεσιών.*

**Keywords:** *quality, satisfaction, customer, model*

## 1. Introduction

The competition between enterprises is increasingly intensifying as strict limits begin to disappear whilst customer requirements for quality, fast correspondence, etc, are increased. These factors, in combination with the excessive supply of goods and services, lead enterprises to search for ways that will allow them to survive in the modern business environment. Their objective is to provide the best possible customer service and satisfy customers' needs and expectations. In this framework, the measurement of quality and customer satisfaction constitute basic factors that determine the successful course of enterprises.

Through research on how customers conceive the quality of product or services, an enterprise is in the position of knowing its customers' opinions and determining the degree to which it can satisfy their needs and expectations. Using the measurement of these factors, any changes in the customers' needs become immediately apparent to the enterprise, allowing it to adapt the level of service to these changes. Knowing the requirements of its customers and by insuring the satisfaction of these, the enterprise manages to survive in the face of competition, not only in the present but also in the future, since it is in a position to ascertain

the critical elements of quality that require improvement and to seek methods with which to achieve this improvement.

## **2. Measurement of service quality**

The question of measurement of service quality has always been of great importance. For this reason, researchers have sought methods for the definition, the modelling and the measurement of quality, and various models have been developed, many of which result from each other. The various models proposed by researchers are described below:

### **Model 1. Technical and Functional quality model (Grönroos, 1984)**

The Grönroos model supports that quality depends on two variables - the conception and expectation of quality of service - and that the enterprise should achieve the matching of these two in order for customer satisfaction to be achieved. Specifically, quality of service is comprised of the following three elements: technical quality, functional quality and the image of the enterprise. Technical quality is the quality that the customer receives through his contact with the enterprise which provides the service and can be measured objectively, such as for example the technical dimensions of the product. While technical quality applies to what the customer receives, functional quality applies to how he receives it. Finally a third dimension of quality is the enterprises' image, that is to say, the image of an office or a company which significantly influences customers' expectations.

### **Model 2. GAP model-Servqual (Parasuraman et al., 1985)**

This is one of the best-known models of measurement of quality of service. The quality of service here is measured by the difference between the expectations of consumers and what they actually receive. If the quality of what customers receive is lower than their expectations, then they consider the quality to be low. On the contrary if what they receive is higher than their expectations, then they consider the quality to be high. The Servqual model uses these two components - output and expectations - in order to calculate the gap that exists between them. Specifically, there are five gaps which explain why enterprises are unable to offer qualitative services according to the models of quality that the customers expect.

### **Model 3. Attribute service quality model (Haywood-Farmer, 1988)**

The Haywood-Farmer model supports that an enterprise provides service of high quality when it satisfies on time the preferences and expectations of customers and for this reason enterprises need to discover what customers expect from service. Generally, in the Haywood-Farmer model, services have attributes that can be categorized into the following three groups: 1) physical facilities and processes, 2) employees' behaviour and 3) professional criticism. The first group includes characteristics that have to do with natural installations whilst in the second are characteristics such as oral or non-oral communication, politeness and friendliness. Finally, professional criticism is related to competitiveness, guidance, innovation, flexibility, knowledge, discretion and to all those elements that confer professionalism on the enterprise. The selection of elements from each group constitutes an important strategic decision on behalf of the enterprise in order to achieve the appropriate balance.

### **Model 4. Synthesised model of service quality (Brogowicz et al, 1990)**

The model of Brogowicz et al supports that customers determine the quality of service by comparing their expectations with their perception of service received. Customer satisfaction is achieved when the perception of the service corresponds to expectations. Specifically, the expectations of customers are determined by various factors, which are categorized in three groups: exterior influences, traditional marketing activities and the enterprises' image. Included in the exterior influences factors are elements such as culture, social structure, WOM, media exposure, competition and the personal needs and previous experiences of each individual. Traditional marketing activities, such as publicity, public relations, sales promotion and pricing also influence expectations and usually promise to the customers better quality than what is actually provided, thus creating a gap. Finally, traditional marketing activities interact with the various exterior influences and define the image of the enterprise which later influences expectations. The enterprise should determine first of all its mission and its objectives and subsequently materialise its strategy by applying certain service specifications and by selecting suitable marketing activities.

**Model 5. Performance only model (Cronin and Taylor, 1992)**

The model also known as ServPerf supports that output should be used in order to measure quality of service, in contradiction to the Servqual model which takes into consideration output as well as the expectations of customers. The model investigates the relationship between the quality of service, customer satisfaction and purchase intentions. Specifically, it supports that this output determines the quality of service rather than output-expectation as proposed by ServQual and considers that quality of service is a condition for customer satisfaction which has a significant affect on purchase intentions

**Model 6. Ideal value model of service quality (Mattsson, 1992)**

Mattsson supported that factors such as ideals and experience shape the value received by the customer, which has a direct relation to his satisfaction. In the majority of studies on the quality of services, expectation is defined as the conviction for desirable attributes. Nevertheless, this question is further examined by Mattsson taking into consideration factors such as experience, the ideal, the minimal desirable and tolerable level. This model proposes the use of perceptible ideals which are compared with experience. The comparison with the ideal determines to a great degree customer satisfaction. For this reason, more attention should be given to the processes through which customers' perceptions of service are shaped and altered.

**Model 7. Evaluated performance and normed quality model (Teas, 1993)**

Teas criticised the Servqual model by claiming that it had certain theoretical, conceptual and functional weaknesses, such as the fact that the conceptual determination is ambiguous, it has theoretical documentation of expectations and connection between the quality of service and the satisfaction of customer, etc. Thus the following model is proposed, according to which the appreciated output results from the following relation:

$$Q_i = -1 \left[ \sum_{j=1}^m w_j \sum P_{ij} |A_{jk} - I_j| \right]$$

$Q_i$  is the conceived quality of the object  $i$

$W_j$  is the importance of attribute  $j$  that determines the conceived quality.

$P_{ij}$  is the probability that the object  $i$  has quantity  $k$  of the attribute  $j$

$A_{jk}$  is quantity of  $k$  of the attribute  $j$  that exists in object  $i$

$I_j$  is the ideal quantity of attribute  $j$

$m$  is the number of attributes.

The model supports that individual perception of the quality of attribution of object  $i$  is positively connected with the weighted probability that the attribution of object  $i$  in the  $m$  dimensions is close to the perceptions of each one for the most optimal output for the  $m$  dimensions. Thus the model considers that the conceived quality of object  $i$  can be increased by decreasing the gap between the attribution of object and the ideal perceptions about it for one or more  $m$  attributes.

**Model 8. Model of perceived quality and satisfaction (Spreng and Mackoy, 1996)**

This model examines the relation, and apparent connection, between conceived quality and customer satisfaction. However, according to Spreng and Mackoy, certain conflict exists between them since an enterprise should know if its objective is to have satisfied customers or to maximize the perceived quality of service. This model focuses on the effect which expectations have on the quality of services and on customer satisfaction, as well as on wishes and conformation to them. It supports that the dissatisfaction of customers' expectations indirectly effects the quality of service since satisfaction is decreased and so the quality of service.

**Model 9. PCP attribute model (Philip and Hazlett, 1997)**

The model of Philip and Hazlett takes the form of a hierarchical structure based on three categories of attributes which compose the quality of services: the basic, central and regional. The basic attributes are considered to have an important influence on the decision of the consumer to prefer a certain enterprise, as well as on his level of satisfaction. The central attributes include people, procedure and the enterprise structure through which the consumers receive the basic attributes. The regional attributes can be defined as supplements which complete the service and make it an enjoyable experience for the consumer. When a customer uses a service for the first time, if the service ensures the basic attributes to a certain extent and the others to a smaller extent, the customer remains satisfied. As long as the customer uses the service more often, central and regional attributes begin to acquire particular importance.

**Model 10. Internal service quality model (Frost and Kumar, 2000)**

The model of Frost and Kumar is based on the model of Parasuraman et al (1985), the difference being that it evaluates dimensions and relations which determine the quality of services between the internal customers and the internal suppliers of an enterprise supporting services. The first line personnel are characterized as internal customers who serve the customers while the support personnel are characterized as internal suppliers who serve the first line personnel. Specifically, three gaps are found: the first gap presents the difference between the perception of support personnel (internal supplier) about the expectations of first line personnel (internal customers) and their real expectations. The second internal gap results from the difference between the specifications of quality of service and the service itself which has as a result a gap in output of service. Finally, the third internal gap results from the comparison of expectations of first line personnel with the service received.

**Model 11. The interactivity model (Svensson, 2003)**

The quality of service depends on the enterprise that provides the service but also on the customer. For this reason it is essential that a model takes into consideration the expectations and perceptions of the supplier and also of the customer. According to Svensson, the achievement of quality in service is determined by the interaction between the enterprise that provides the service and the customer, and specifically is made up of the following four elements: the expectations and perceptions of the supplier and the expectations and perceptions of the customer. As a consequence these elements comprise the four gaps 1) the gap between the expectations and the perceptions of the supplier; 2) the gap between the expectations and the perceptions of the customer; 3) the gap between expectations of supplier and expectation of customer; and 4) the gap between the perception of the supplier and of the customer.

**Model 12. The importance - satisfaction model (Yang, 2003)**

The objective of this model is to determine precisely the requirements of customers and the real level of their satisfaction and in this way to find out which attributes require improvement. This model represents in the horizontal dimension the level of importance of a certain attribute of service while in the vertical dimension the level of satisfaction of this particular attribute. Thus the following four areas exist: The most excellent area presents the attributes of quality that the customers consider important and where the output is also satisfactory. The to-be-improved area includes attributes that are considered important by the customers but currently the output does not satisfy the expectations of customers and for this reason the output requires improvement. The surplus area includes attributes what are not considered important by the customers but the output of the enterprise in relation to them is satisfactory. If an enterprise needs to decrease its costs, it can make certain reductions in this area without harming the quality of its service. The care-free area includes attributes for which the customers has a low level of satisfaction but which they do not consider very important. So the enterprise does not need to worry about these attributes since they have little influence on the quality the customers conceive.

**Model 13. A general systems approach to services (Johnson et al, 1995)**

The theory of this system explains how an enterprise acquires input and through the productive process converts this into products. This theory finds also application in services, and in the measurement of quality of services. Because of the unique characteristics of services, customers are influenced not only by the result of service but also by the input and the service process. For this reason the measurement of total quality of service should consist of all the dimensions of service: the input, the process and the output. This first dimension of input includes physical elements such as modern equipment and others, tangible or not (such as whether the premises are suitably decorated, clean etc.) The second dimension of process of quality is reported on the quality of interaction between the person who provides the service and the consumer and it includes elements such as friendliness, politeness, eagerness to please, etc. The third dimension is the measurement of result of service provided. It includes non-tangible gains and usually is related to the change in the physical or intellectual state of the customer.

**Model 14. Structural equation model of antecedents affecting repurchase and positive word of mouth (Molinari et al, 2008)**

Molinari et al examined the different influences of satisfaction, quality and value on customers' behaviour in B2B services. They support that the achievement of expectations of customers is positively related to customer satisfaction, quality and value. The precedents result in the purchase intention of service from the customer and the WOM of service and enterprise. The most important relation between these factors is found



between quality and WOM. For this reason it is very important for the enterprise to determine what customers expect in order to provide service which satisfies these expectations. The policy of over-promising causes customers to have higher expectations of service and results in their dissatisfaction when their expectations are not met.

**Model 15. Model of customer satisfaction and future intentions (McDougall and Levesque, 2000)**

McDougall and Levesque had investigated the relation between three elements: the quality of service and conceived value, customer satisfaction and future intentions. They supported that the quality of service and the conceived value are the most important factors in satisfying customers while satisfaction has a significant effect on the intentions of the customer. Specifically, the quality of service has two dimensions, the first one includes the basic service which is provided and the second includes the way the service is provided. Satisfaction, as well as the quality of service, positively influence customer satisfaction, which determines the intention to reuse the service. Satisfaction causes the customer to remain faithful to the enterprise while dissatisfaction leads him to seek service elsewhere.

**Model 16. Two Approaches to Service Quality Dimensions (Lehtinen and Lehtinen, 1991)**

Lehtinen and Lehtinen proposed two approaches concerning the analysis of quality of service and its dimensions. The first approach uses three dimensions of quality: the physical quality, the quality of interaction and the enterprises' quality. Physical quality is determined by the realistic elements of service while its basic elements are the products that are used in the provided service, the support (which includes the environment, such as decoration) and the equipment used. The above dimensions correspond to technical quality which was mentioned by Gronroos (1984). The quality in the interaction is reported as the relation between the enterprise and the customer and is distinguished between the interaction with individuals and the interaction with the equipment. The third dimension of quality concerns how the customers see the enterprise, the image or the profile it has created.

In the dimensions approach the discrimination of quality is between the quality of process and the quality of result. The quality of process is the qualitative estimate of the customer for his expectations of the service process. It is supported by how the customer sees the process of production and how he feels about this process. The element which determines the process quality is the comparison between the customers' expectation of the process and the way in which service is provided. The dimension of quality of result includes the evaluation of result of service process by the customer. Finally Lehtinen and Lehtinen point out that there is strong relation between the two dimensions since an enterprise, by checking the process, determines its quality and the quality of the result.

**Model 17. Model of disclaimer of expectations (Woodruff and Gardial, 1996)**

The confirmation or denial of expectations is realised by taking into account the product output that is conceived by the customer in comparison with the models. It is worth noting that the conceived output can be considerably different from the real product output, mainly when the service is complex or the customer is not familiar with it. Ideals can emanate from various sources depending on the customer, the situation and the type of service. The confirmation or denial of expectations creates a positive or negative feeling of satisfaction, which is responsible for the final result of this process (degree of satisfaction or dissatisfaction of customer). The result of satisfaction determines the purchase intention and creates the WOM while, on the contrary, dissatisfaction creates complaints.

**Model 18. IT alignment model (Berkley and Gupta, 1994)**

Berkley and Gupta's model describes how information technology can be used in order to improve the quality of service through the study of various cases such as banks, construction industries, service enterprises. Specifically, seven dimensions of quality have been found: reliability, correspondence, competitiveness, accessibility, communication, safety and customers' understanding. Information systems are generally used for the control of quality but also for the improvement of certain dimensions of it. Improvement can exist in many areas, it is however important that investment in information technology be in those areas that will lead to the improvement of competitive position of the enterprise. For this reason it is very important that information systems are aligned with strategy. The enterprise must understand its information systems needs and develop a suitable strategy.

**Model 19. Kano model (Kano et al, 1984)**

Kano's model investigates the product attributes which customers conceive as important. Kano has found the following elements of quality: the expected quality, the desirable quality and the attractive quality. In the expected quality the characteristics of product or service which the customers evaluate as particularly important are included. The high output of product to particular characteristics involves high customer satisfaction while on the contrary low output creates serious dissatisfaction. The characteristics of desirable quality constitute the basic desires and needs of customers. It includes elements of quality that give satisfaction when they exist and the opposite if they do not exist. Finally, attractive quality characteristics are those which the product or service allocates but which customers do not expect to be so. For this reason the high output of product concerning particular characteristics involves high customer satisfaction, while on the contrary the low output does not create dissatisfaction.

**Model 20. Model of e-service quality (Santos, 2003)**

The quality of service is one of the basic factors in the determination of success or failure in the electronic trade. This model examines the quality of service provided by the electronic trade. The basic dimensions that are examined are on the one side the facility of use, the appearance, structure, the linkage, the layout and the content, and on the other side reliability, sufficiency, support, communication, safety and motives for the use of the electronic trade. The last element is particularly important since this is the one that will attract customers and will keep them as customers.

**Model 21. Measuring Service Quality in e-retailing (Collier and Bienstock, 2006)**

For enterprises that operate via the internet it is of great importance to know how customers perceive the quality of service that is offered. This type of service presents unique characteristics that determine the quality of service in comparison with the traditional service that is offered outside of the internet. According to Collier and Bienstock (2006), quality of service is made up of three dimensions: the quality of process, the quality of result and the addressing of problems. Customers evaluate elements such as the precision of information, functionalism, the safety and the ease of using a web page. The process quality influences the customer's perception of the service result and this in its turn determines customer satisfaction. Satisfaction and purchase intention are also determined by the existence or not of problems and the confrontation of these.

**Model 22. Service quality and customer satisfaction (Iacobucci et al, 1995)**

Service quality and customer satisfaction are important elements which are often used in bibliography. Iacobucci et al examined the question of whether quality and satisfaction are determined by different factors and had different results. Researchers concluded that factors such as price, the backstages of an enterprise, and the ability to provide service, determine the opinion of customers about the quality of service, and the addressing of problems, the natural environment in which the service is provided, are all elements which make up customer satisfaction.

### **3. An application of the Servqual model**

The Servqual model (Parasuraman et al, 1988) measures the quality of service as the difference between the expectations of the customer and his perception about the service he receives. In this framework, an application of the Servqual model is made in enterprises ABC and XYZ using a sample of 60 individuals.

The main methodological tool of the research constitutes the SERVQUAL questionnaire which measures quality through 49 questions, making discrimination in the following five dimensions: tangibles, reliability, responsiveness, assurance and empathy.

Table 1 summarises the average degree that the company ABC has in each dimension concerning the perception and the expectations of its customers. In the second column the gap in each dimension is presented which is calculated through the relation Perceptions-Expectations, while in the third column the factor of importance of each dimension is presented. In the last column the gap of each dimension is presented and finally the calculation of the gap is made. The same analysis is organised for the enterprise XYZ, the data of which are presented in Table 2.

**Table 1: Enterprise ABC**

Quality Dimensions	Perceptions-expectations	Importance of dimension	Weighted result
Tangibles,	-0,18	0,38	-0,067
Reliability	-0,21	0,28	-0,058
Responsiveness	-0,18	0,18	-0,032
Assurance	-0,18	0,09	-0,016
Empathy	-0,18	0,07	-0,013
			-0,18

**Table 2: Enterprise XYZ**

Quality dimensions	Perceptions-expectations	Importance of dimension	Weighted result
Tangibles,	-0,20	0,35	-0,070
Reliability	-0,19	0,25	-0,047
Responsiveness	-0,18	0,23	-0,039
Assurance	-0,15	0,11	-0,016
Empathy	-0,28	0,06	-0,017
			-0,19

The basic conclusions, to which the gap analysis for enterprises ABC and XYZ leads, are summarised as follows:

- The gap for both enterprises is negative because the expectations of the customers exceed their perceptions.
- The gap which is found between conceived and expected quality for the enterprises ABC and XYZ is small. The expectation of the customers of both enterprises appear to be particularly high. Meanwhile at the same time both enterprises currently appear to satisfy these expectations to an important degree but not absolutely.
- There are important margins of improvement for both companies concerning their realistic characteristics (installations, equipment).
- Particular importance should be given by the companies to their reliability and correspondence, elements which have particular importance for their customers.
- The customers are more satisfied, however, with the level of safety they feel during their transactions with the companies but also from the general image which the companies and their employees present to the customers.

#### 4. Conclusions

In the modern competitive market, quality acquires particular importance for enterprises and consumers. The determination of significance of quality is an essential condition for its measurement. For this reason models have been formulated by researchers in order to provide the most reliable methods of measurement of quality and to offer to enterprises useful tools for the decision-making procedure. In the present article 22 models were reported on the measurement of quality of service, covering a spectrum from traditional services to services via internet, thus offering a useful handbook which can be used for instructive and inquiring aims. Interest was focused on the Servqual model, the application of which in two enterprises shows the way in which this particular model can be used to make useful conclusions. The report on the models shows that the subject of measurement of quality of service can be perceived from a different point of view each time, depending on the type of service and its characteristics.

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# GLOBALISATION AND ALIMENTARY CONSUMPTION: AN ECONOMIC ANALYSIS OF ECONOMIC CRITERIA IN THE CASE OF GREECE (1957-2005)

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## Abstract

*In this paper we examine the alimentary consumption in Greece, from a socio-economic perspective. The reference years discussed span the period from 1957 to 2005. Emphasis is given on the recent years of globalisation, and the radical changes that have almost brought about an alimentary crisis. Our study tries to contribute to the understanding of the causes behind those changes of the alimentary patterns and their consequences. This takes place through the analysis of economic aspects of the consumption patterns of different economic-vocational layers of the population. We also try to understand the relevance of other social processes.*

*JEL Classification: E21, Q11, M31*

**Key words:** economic variables, «globalisation», consumption, dietary patterns.

## Introduction

There are not any existing academic studies investigating the post-war alimentary consumption of different economic layers of the Greek population from an economic perspective per se. However mention is made on this topic from studies examining consumer behavior and economic demand of a specific product or a category of products (Kevork 1962, Drakatos 1963, Eksarhos 1977, Karapostolis 1979, 1983, Katsouyanni et al. 1989, Michalopoulos and, Demoussis 2001, Lazaridis 2003). A major data source on the subject matter is the annual Household Budget Surveys conducted by the National Statistical Service of Greece (H.B.S. 1957/58, 1963/64, 1974, 1981/82, 1987/88, 1993/94, 1998/99, 2004/05).

**Table 1. Alimentary Consumption Patterns in Greece, 1957-2005, (%).**

	<b>Alimentary Categories</b>	<b>H.B.S.</b> <b>'57/58</b>	<b>H.B.S.</b> <b>'63/64</b>	<b>H.B.S.</b> <b>1974</b>	<b>H.B.S.</b> <b>'81/82</b>	<b>H.B.S.</b> <b>'87/88</b>	<b>H.B.S.</b> <b>'93/94</b>	<b>H.B.S.</b> <b>'98/99</b>	<b>H.B.S.</b> <b>'04/05</b>
1	<i>Cereal</i>	15,6	16,9	9,7	8,6	8,8	10,0	8,7	8,6
2	<i>Meat</i>	16,1	14,6	25,9	26,7	23,2	20,2	15,1	14,4
3	<i>Fish</i>	5,3	6,5	4,5	5,0	4,7	5,0	5,1	5,4
4	<i>Oils and fat</i>	11,1	10,2	8,5	6,6	4,8	4,2	3,5	3,6
5	<i>Dairy</i>	12,1	8,1	11,6	11,9	12,6	13,0	12,0	12,0
6	<i>Vegetable</i>	10,0	8,8	9,9	8,8	8,2	8,4	8,1	7,5
7	<i>Fruit</i>	8,0	5,1	7,9	7,1	7,6	6,3	5,4	4,9
8	<i>Sugar-based, pastries.</i>	6,4	8,3	6,8	4,8	5,3	4,7	4,0	4,2
9	<i>Other food</i>	0,9	1,1	1,3	0,6	0,9	0,9	0,6	0,9
10	<i>Expenditure on food away from home</i>	12,3	12,8	8,9	17,4	21,1	24,4	33,7	34,7

	<b>Alimentary Categories</b>	<b>H.B.S.</b> <b>'57/58</b>	<b>H.B.S.</b> <b>'63/64</b>	<b>H.B.S.</b> <b>1974</b>	<b>H.B.S.</b> <b>'81/82</b>	<b>H.B.S.</b> <b>'87/88</b>	<b>H.B.S.</b> <b>'93/94</b>	<b>H.B.S.</b> <b>'98/99</b>	<b>H.B.S.</b> <b>'04/05</b>
11	<i>Non-alcoholic drinks*</i>	2,1	7,6	5,0	2,3	2,8	3,0	3,7	3,7
	<i>Total</i>	100	100	100	100	100	100	100	100

\*(including ice-creams in H.B.S. 1957/58).

Data Source: ESYE, H.B.S. 1957/58, 1963/64, 1974, 1981/82, 1987/88, 1993/94, 1998/99, 2004/05.

The qualitative description and analysis of the alimentary consumption of each demographic category that takes place here highlights the similarities, differences, convergence and divergence existing among these socio-economic classes both in the same time period and diachronically. In that manner we manage a more complete description of the examined alimentation patterns by stressing: existing particularities; the extent and intensity of observed behaviours; and the demographic classes that lead and/or follow the introduction of those alimentary consumption changes. By doing so we set the socio-economic grounds for understanding, explaining, and interpreting the causes that formulated the specific consumption patterns and their redevelopment in the examined period (see table 1).

In contemporary societies food is not a simple utilitarian product but “goods...are inputs and in which the output is a collection of characteristics” (Lancaster 1966: 133, Georgakopoulos and Thomson 2005, Georgakopoulos et al. 2006, Georgakopoulos et al. 2008). In addition alimentation patterns evolve within a fluid and constantly changing socio-economic environment that affects their development (Deaton 1992: 104).

### The alimentary consumption of different economic layers of the population

The description and analysis of the alimentation of the different economic layers of the Greek population highlight the differences existing in the respective consuming behaviour; differences between: a) specific income categories of the population for the same time period; b) within the same income classes for different time frames; but mainly between c) the population classes that instigate and lead those changes and d) the directions towards those changes lead to.

During the traditional alimentary era of the 50s and 60s (Sotiropoulos et al. 2008) there was a predominance of the higher income earning layers of the population in the consumption of the recently introduced meat-based food products, and away from home expenditure. Despite this, however, changes in the structure of traditional alimentation were not as radical as they have been in the 90s and 00s.

In the last two decades expenditure away from home consists of half of the total alimentary expenditure of the high earning layers of the population. Only meat-based and dairy products maintain a 10% participation approximately in the total alimentary expenditure; all other food categories have shrunk to very small percentages of participation (see table 2).

**Table 2. Alimentary Expenditure of the Higher Income Earning Layers of the Greek Population, 1957 – 2005, (%)**

	<b>Alimentary Categories</b>	<b>H.B.S.</b> <b>'57/58</b>	<b>H.B.S.</b> <b>'63/64</b>	<b>H.B.S.</b> <b>1974</b>	<b>H.B.S.</b> <b>'81/82</b>	<b>H.B.S.</b> <b>'87/88</b>	<b>H.B.S.</b> <b>'93/94</b>	<b>H.B.S.</b> <b>'98/99</b>	<b>H.B.S.</b> <b>'04/05</b>
1	<i>Cereal</i>	9,8	19,5	5,4	6,3	6,6	8,4	5,9	6,5
2	<i>Meat</i>	19,9	18,7	22,2	24,4	21,8	19,1	11,6	12,6
3	<i>Fish</i>	5,8	3,9	3,3	4,4	4,2	4,9	4,7	5,2
4	<i>Oils</i>	8,7	13,2	16,4	8,8	3,5	3,8	2,3	3,2
5	<i>Dairy</i>	11,5	7,6	9,8	11,7	11,2	12,0	9,2	9,8
6	<i>Vegetable</i>	12,1	5,7	5,8	6,7	6,3	7,0	5,4	5,5
7	<i>Fruit</i>	5,6	5,4	6,7	7,2	7,0	6,0	4,2	4,1
8	<i>Sugar-based, pastries.</i>	6,6	9,2	7,4	5,1	5,7	5,1	3,9	3,9
9	<i>Expenditure on food away from home</i>	16,9	14,9	17,7	22,5	29,8	29,6	49,1	45,9
10	<i>Non-alcoholic drinks</i>	0,7	1,1	1,6	1,1	1,8	2,1	2,0	3,4

	<i>Alimentary Categories</i>	<i>H.B.S. '57/58</i>	<i>H.B.S. '63/64</i>	<i>H.B.S. 1974</i>	<i>H.B.S. '81/82</i>	<i>H.B.S. '87/88</i>	<i>H.B.S. '93/94</i>	<i>H.B.S. '98/99</i>	<i>H.B.S. '04/05</i>
11	<i>Other food</i>	2,4	0,7	3,6	1,7	2,1	1,9	1,6	0,8
	<i>Total</i>	100	100	100	100	100	100	100	100

*Data Source: ESYE, H.B.S. 1957/58, 1963/64, 1974, 1981/82, 1987/88, 1993/94, 1998/99, 2004/05*

In contrast, alimentary consumption patterns of the lower income-earning layers of the population (see table 3) have changed very little in the last fifty years (there has been a small increase on meat-based products, dairy, and away from home expenditure with a corresponding small decrease on the plant-based food categories of the traditional alimentation). Food expenses away from home absorb less than 10% of total alimentary costs, whereas expenditure on bread, cereal-based food, meat, and dairy products are at much higher levels (greater than 14%).

Thus it appears that higher-earners tend to adopt the international alimentary behaviour patterns (Herpin and Verger 2000: 47, Sotiropoulos et al. 2008), whereas lower earners only slightly change their food consuming behaviour during these years.

**Table 3. Alimentary Expenditure of the Lower Income Earning Layers of the Greek Population, 1957 – 2005, (%)**

	<i>Alimentary Categories</i>	<i>H.B.S. '57/58</i>	<i>H.B.S. '63/64</i>	<i>H.B.S. 1974</i>	<i>H.B.S. '81/82</i>	<i>H.B.S. '87/88</i>	<i>H.B.S. '93/94</i>	<i>H.B.S. '98/99</i>	<i>H.B.S. '04/05</i>
1	<i>Cereal</i>	21,9	19,6	23,7	15,5	14,6	17,5	16,3	14,3
2	<i>Meat</i>	13,1	9,1	18,9	27,3	21,9	20,2	17,6	16,5
3	<i>Fish</i>	4,7	11,7	6,4	8,7	6,7	5,3	7,7	6,6
4	<i>Oil</i>	13,3	11,0	4,7	3,4	6,4	7,3	6,2	6,8
5	<i>Dairy</i>	10,9	4,6	8,1	10,4	13,9	17,2	16,9	17,1
6	<i>Vegetable</i>	14,2	14,8	13,9	9,7	10,7	11,5	11,8	12,4
7	<i>Fruit</i>	4,0	4,4	6,7	7,0	9,3	7,2	7,0	7,3
8	<i>Sugar-based, pastries</i>	7,2	11,1	6,7	4,2	3,9	3,3	3,1	4,7
9	<i>Expenditure on food away from home</i>	7,1	8,7	5,8	10,0	9,9	7,0	9,4	9,9
10	<i>Non-alcoholic drinks</i>	0,1	2,6	1,4	0,6	0,8	1,3	1,2	3,7
11	<i>Other food</i>	3,4	2,4	3,6	3,1	1,9	2,1	2,9	0,8
	<i>Total</i>	100	100	100	100	100	100	100	100

*Data Source: ESYE, H.B.S. 1957/58, 1963/64, 1974, 1981/82, 1987/88, 1993/94, 1998/99, 2004/05*

The above argument is of particular importance if linked with an examination of the undergone level of treatment of different alimentary categories through an analysis of the technical features of that processing (Sotiropoulos and Ntemousis 2002: 463). If technical criteria (agricultural/industrial – see Sotiropoulos et al. 2008) are considered (see table 1.3), the alimentary consumption of higher income earning layers of the population could be characterised as based on «the processing of animal based ingredients» in the 70s, as «tertiarised» after the 80s (H.B.S. 1987/88), and as consumption «away from home» after the end of the 90s. On the contrary, the alimentary habits of the lower income-earning layers of the population never truly left their rural features behind, even though there has been a weakening in the dietary participation of the plant-based in favour of animal-based food ingredients over the years.

**Table 4. Consumption Structure of Cereal, Meat, and Legume-Vegetable Based Products in Higher and Lower Income Earners, 1957 – 2005, (%)**

	<i>Lower Income Layers</i>		<i>Higher Income Layers</i>	
	<i>H.B.S. '57/58</i>	<i>H.B.S. '04/05</i>	<i>H.B.S. '57/58</i>	<i>H.B.S. '04/05</i>
<i>Cereal</i>				
<i>Bread</i>	66,1	57,6	63,5	42,9

	<i>Lower Income Layers</i>		<i>Higher Income Layers</i>	
	<i>H.B.S. '57/58</i>	<i>H.B.S. '04/05</i>	<i>H.B.S. '57/58</i>	<i>H.B.S. '04/05</i>
<i>Flour - based</i>	10,8	4,1	5,9	3,5
<i>Processed Cereal</i>	15,2	31,6	23,2	47,7
<i>Rice</i>	7,9	6,7	7,4	5,9
<b><i>Meat</i></b>				
<i>Beef</i>	10,3	0,6	4,9	0,8
<i>Veal</i>	32,8	39,3	42,6	39,7
<i>Total (Beef + Veal)</i>	43,1	39,9	47,5	40,5
<i>Sheep and Goat meat</i>	11,8	2,0	0,8	0,8
<i>Lamb and Kid meat</i>	25,0	12,8	30,3	15,4
<i>Total (Sheep + Lamb)</i>	36,8	14,8	31,1	16,4
<i>Pork</i>	2,9	14,2	1,1	14,6
<i>Poultry</i>	8,3	23,3	11,3	13,6
<i>Frozen Meat</i>	4,4	0,8	1,5	0,8
<i>Processed Meat</i>	2,5	6,7	4,4	12,9
<i>Other Meat, (organs, intestines, etc.)</i>	2,0	1,7	2,9	2,3
<b><i>Legumes-Vegetables</i></b>				
<i>Legumes</i>	17,2	9,4	7,4	4,9
<i>Potatoes</i>	17,2	17,6	14,7	14,5
<i>Fresh Vegetables*</i>	66,1	57,7	77,9	59,5
<i>Processed Vegetables, (tomato paste)</i>		11,1		17,5

\* including tomato paste in H.B.S. 1957/58.

*Data Source: ESYE, H.B.S. 1957/58, 1963/64, 1974, 1981/82, 1987/88, 1993/94, 1998/99, 2004/05*

Consumption structure of cereal, meat, legumes, vegetables and away from home expenditure is indicative. In the cereal category, rural products decrease their participation in the total consumption with a corresponding increase of industrialised-processed products. Flour and rice have a decreased participation in all different income earning layers of the population. A similar trend is noted for bread (a traditional rural-based processed product), especially for the higher earning layers, whereas processed neo-industrialised products (rusks, biscuits, etc.) significantly increase their appearance in the alimentation of all income earning classes by more than doubling their participation. The same alimentary behaviour is observed for processed meat-based products and vegetables. Higher earners (this includes average income levels and above and it applies as a general rule for all industrialised-processed products consumption) appear to have the highest preference levels of neo-industrialised products.

Traditional food categories (legumes, lamb-kid, other meat products such as animal organs, intestines, etc.) and fresh vegetables have a diachronic decrease in all income classes. Older animal meat products (beef, sheep, goat) and frozen meat are almost not consumed anymore especially by higher income categories of the population. In contrast some non-traditional (for the Greek context) alimentation based on potatoes, pork, and poultry («the poor's' meat» according to the popular French tradition) increase its participation in the dietary patterns of lower income earners.

On the basis of this information we argue in this paper that the alimentary environment constantly changes. There are strong differences in the alimentation of the same economic layers/classes of the population over time but also between different economic layers for the same time period. It is indicative for example the case of expenditure away from home (table 5). In the case of lower earnings layers, traditional cafes (kafenias) have always absorbed most of the costs associated with this expenditure. This is in total contrast with the behaviour of the higher income layers. Major proportions of the latter population spend more in restaurants for example and not in traditional cafes. However this picture is being altered (decreasing) in later years even though expenditure of the lower income layers in kafenia tends to increase. The above differences indicate particularities existing in the alimentary micro-environments of the respective economic layers of the population.



**Table 5. Cost Structure of Expenditure Away From Home For Lower And Higher Income Classes, 1957/58 and 2004/05, (%).**

<i>H.B.S. 1957/58</i>	<i>All Households</i>	<i>Lower Income Classes</i>	<i>Higher Income Classes</i>
<i>Expenditure on food away from home</i>	100	100	100
<i>Restaurants</i>	56,4	42,8	64,8
<i>Cafes (kafenía)</i>	43,6	57,2	35,2
<b><i>H.B.S. 2004/05</i></b>			
<i>Expenditure on food away from home</i>	100	100	100
<i>Restaurants</i>	47,8	27,6	57,8
<i>Cafes (kafenía)</i>	52,2	72,4	42,2

*Data Source: ESYE, H.B.S. 1957/58, 1963/64, 1974, 1981/82, 1987/88, 1993/94, 1998/99, 2004/05.*

These alimentary environments can be described both by quantitative measures (the part of the income spent on alimentation away from home) and qualitative indicators. In the latter case for example the cost of a meal in a restaurant is much higher than the cost of a cup of coffee or a drink in a traditional cafe (kafenio). That (in accordance to data from the H.B.S. surveys) would mean many more visits in a cafe than in a restaurant in order to equalise those two cost categories. This would have implications for the amount of time spent in the premises, related activities and associations in the restaurant or in the cafe. These different dimensions are significant when examining the alimentary environments away from home and additional research is required for their description. Existing differences could have a widespread character highlighting significant divergences in the inter-layer features of the population's alimentation (and food consumption in general) in Greece on the basis of income earning characteristics (see table 6.α, β). The associated proportionate relationships (for example 1 to 5 approximately or greater, between higher and lower earners) may also be indicative of the existence of special features of these alimentary environments.

**Table 6a.b. Consumption and Alimentation (in Drachmas - 1957/58 and in Euro - 2004/05) and Percentages per H.B.S.. Economic Criteria.**

<b>H.B.S. '57/58*</b>	<b>All Households</b>	<b>Up to 249</b>	<b>250-449</b>	<b>450-799</b>	<b>800-1.099</b>	<b>1.100-1.599</b>	<b>1.600 &amp; above</b>
Total Purchasing Expenditure (in Drachmas)	860,9	304,2	519,9	761,3	1.082,60	1.337,90	2.275,80
Alimentation (in Drachmas)	349,8	156,2	247,6	340,8	435,9	499,8	694,5
Alimentation/Total Purchasing Expenditure (%)	40,6	51,3	47,6	44,8	40,3	37,4	30,5

*\*In H.B.S. of 1957/58 and 1963/64 the data refer to «Weekly Revenues in Drachmas», whereas from 1974 - 1999 mention is made on «Total Monthly Purchasing Expenditure of Households».*

<b>H.B.S. '04/05</b>	<b>All Households</b>	<b>Up to €750</b>	<b>€751-€1100</b>	<b>€1101-€1450</b>	<b>€1451-€1800</b>	<b>€1801-€2200</b>	<b>€2201-€2800</b>	<b>€2801-€3500</b>	<b>€3501 &amp; above</b>
Total Purchasing Expenditure (€)	1792,28	380,65	689,19	1011,33	1308,61	1632,78	2072,51	2582,95	4237,08
Alimentation (€)	469,35	139,63	234,67	320,6	392,34	470,08	564,5	667,91	890,9
Alimentation/Total Purchasing Expenditure (%)	26,2	36,7	34,1	31,7	30,0	28,8	27,2	25,9	21,0

*Data Source: ESYE, H.B.S. 1957/58, 1963/64, 1974, 1981/82, 1987/88, 1993/94, 1998/99, 2004/05*

## Conclusions

The examination of alimentary consumption in post-war Greece using economic criteria demonstrates the changeable character of dietary behaviour both: a) over time; and b) within the identified different economic layers of the population:

a) During the 50s and 60s food consumption was taking place in the household with traditional, plant-based, rural products. Past the 70s and after the 80s alimentation is based on industrialised-processed, «away from home», meat-based food. b) Since the 50s several economic layers of the population start differentiating their dietary patterns (directors, self-employed professionals, employers, and higher income earning layers in general) and they are followed from other layers adopting at a greater or lesser extent and at different rates and priorities, the formers' behavior.

Alimentation has a different weighting in the consumption patterns of different economic classes of the population over time. The former has a smaller proportionate participation in the consumption expenditure of higher economic/social-status layers in contrast to what is observed for lower-earning classes. The diachronic character of this alimentary behaviour insinuates a greater significance on the impact economic-vocational attributes can have in affecting dietary patterns of consumption and for this reason a more systematic and specialized examination of this phenomenon is needed.

There is an observed gradual increase in the consumption of processed meat-based products both inside the household and «away from home» with a simultaneous decrease in the consumption of traditional, plant-based, localized, rural products. These generalized (western-origin) tendencies have been noted in the international literature since the 1980s and are widely known as «uniformisation» or «globalisation» of the dietary consumption patterns (see for example Galibert 1988, Fischler 1990). Similar reflections/problematisations are being made in the economic (Malassis 1986: 323) and biomedical science (Renaud 1995: 21, Trichopoulou 1989, 1997, 2000) literature.

The convergence of the traditional/local alimentary consumption patterns of postwar Greece to the international/western-origin ones and the «uniformisation» tendencies observed, involve all the different social-status layers of the population. This convergence takes place at different rates and forms. However this observation does not seem to apply if revenue criteria are examined since lower earners seem to maintain the traditional alimentary characteristics of the 50s.

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# A NEW APPROACH TO THE DESCRIPTION OF ALIMENTARY CONSUMPTION PATTERNS: THE CASE OF GREECE

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## Abstract

*The understanding of the formation and the evolution of alimentary consumption patterns requires a broad and multidimensional approach. Foods are either of plant or animal, agricultural or industrial origin, and in these forms they play their biological role; the consumption of foods has consequences (social, economical, health, etc.) on an individual level as well as on a wider collective level. In this essay we attempt to describe alimentary patterns in Greece (1957-2005) from three different dimensions: Natural (animal or plant origin), technical (agricultural or industrial origin) and biological (nutritional properties). The description – which is the base of interpretation – is done through charts and tables, based on numerical indicators that are deduced from simple functions-illustrations. The tables are simple or double-entry and we present spreading diagrams.*

## Περίληψη

*Η κατανόηση της διαμόρφωσης και εξέλιξης των διατροφικών προτύπων αναγκαστεί πολύπλευρης αντιμετώπισης. Τα τρόφιμα επιτελώντας το ζωτικό βιολογικό τους ρόλο είναι φυτικής ή ζωικής προέλευσης, αγροτικά ή βιομηχανικά, με συνέπειες και σε ατομικό αλλά και ευρύτερα συλλογικό επίπεδο (οικονομικό, κοινωνικό, υγείας κ.ο.κ.). Η εργασία αυτή επιχειρεί να περιγράψει τα διατροφικά πρότυπα στην Ελλάδα (1957-2005) από τρεις διαφορετικές διαστάσεις: Φυσική (ζωικής ή φυτικής προέλευσης), τεχνική (αγροτικής ή βιομηχανικής προέλευσης) και βιολογική (θεραπευτικές ιδιότητες). Η περιγραφή, που αποτελεί τη βάση της ερμηνείας, γίνεται με πίνακες και διαγράμματα, που βασίζονται σε αριθμοδείκτες οι οποίοι εξάγονται με απλές απεικονίσεις-συναρτήσεις. Οι πίνακες είναι απλής-διπλής εισόδου και τα διαγράμματα είναι διασποράς.*

*JEL Classification: E21, M31, Q11*

*Keywords: alimentary consumption patterns, physical, technical, biological characteristics*

## 1. Introduction

The original feature of this paper is the decomposition and reconstruction of statistical data from the National Statistical Service of Greece (ESYE). These allow the description by a physical aspect (grain, meat, fish, oil-fat, dairy, vegetables, fruit, sugar confectionery, non-alcoholic beverages, expenditure on food away from home away from home, other foods) without making reclassifications through technical and biological characteristics. This methodology is followed and accepted by other scientific studies, in available literature. As a result, industrial and biological characteristics of dietary standards cannot be distinguished, but only their physical properties (plant and animal) can be estimated.

In this study, instead, we process the data of the Household Budget Surveys (H.B.S.) and reclassified them with criteria according to agricultural and industrial features, and added also biological characteristics in to our consideration. The results are presented in tables and graphs, and describe the alimentary consumption patterns of the 1950's (traditional-«Mediterranean») and those of the early 2000-2010 (industrial-internationalized-«Western origin»).

This paper is divided into three parts. The first attempts to explain the importance of division and reclassification of data in order to describe the alimentary consumption patterns from a physical, biological and technical perspective. The second part describes the method (functions, indicators, tables and charts) that can describe comprehensively the alimentary consumption patterns. The third part presents the empirical results of our paper.

We conclude that this new method is possible a) to describe comprehensively alimentary consumption patterns and b) to allow the qualitative description and characterization, for instance, of agricultural or industrial, «Mediterranean», and «Western origin» alimentary consumption patterns.

## 2. Data: Processing and Reclassification

### 2a. Natural Features

Under this criterion (natural features) alimentary consumption patterns are characterized as either plant or animal origin. If the costs for products of plant origin surpass those of animal (at rates above 50%, see also L. Malassis 1979 pp. 188 & 198, and 1986 p. 187), as, for example, happens with the traditional Mediterranean alimentary consumption patterns, then alimentary patterns are indicated – from a natural point of view – as natural. If however, the cost of animal foods is more, as in the 1980's, then the alimentary patterns are indicated of an animal origin.

In the 1950s (H.B.S. 1957-58, see I. Sotiropoulos-M. Ntemousis, 2002, p. 458) rates (%) of participation in two major categories of total expenditure for food were 60.2% (plant ingredients) and 39.8% (animal ingredients). At current prices this means: 210.6 drachmae for plant ingredients, 139.1 drachmae for animal ingredients, and 349.7 total drachmas. On the contrary, during the 1980s, (H.B.S. 1981/82) the animal food ingredients were more (52.1% animal vs. 47.9% plant ingredients), while at the beginning of the first decade of 2000 (H.B.S. 2004/05) plant ingredients exceed again over animal ingredients in food (53.0% plant vs. 47.0% animal ingredients).

### 2.b Technical Features

Under this criterion, alimentary patterns are described either as agricultural or industrial origin. If the costs for agricultural products exceed those of industrial products, like in traditional «Mediterranean» alimentary patterns, then these dietary patterns are indicated as of agricultural origin. If, however, industrial food products exceed agricultural, then alimentary patterns are designated as of industrial origin.

According to data from H.B.S. 1957/58, alimentary patterns in Greece can be not considered as agricultural anymore, and are in a process of industrialization, which is intensified over time. The agricultural ingredients were 43.5% of the total in the data of H.B.S. 1957/58 but 29.9% in the H.B.S. 2004/05. In contrast, industrial ingredients, were 56.5% in the data of H.B.S. 1957/58 but 70.1% in the recent H.B.S. 2004/05.

### 2.c Biological features

Nutrition sciences investigate data such as the concentration of alimentary patterns in nutrients, with a commonly accepted indicator for measuring overall efficiency, energy points (=calories). The data used in this case result from the respective findings of nutrition science (biology, food chemistry, medicine, etc.), which use specific indicators each time for proteins, fats, sugars, vitamins, minerals and a few trace elements, etc. (see also L. Malassis, 1986, pp. 28-52). The World Health Organization (WHO) uses the following standards:

A = Less than 2.200 calories per capita per day (malnutrition)

B = 2.200 – 2.600 calories per capita per day (poor feeding)

C = 2.600 – 3.200 calories per capita per day (enough food)

D = more than 3.200 calories per capita per day (overfeeding)

In the early 1960s, Greece (at a general population level) was just moving from the poor feeding category (2.820 calories) – according to WHO – while at the end of the study period (2005), is characterized by overfeeding (3.680 calories).

## 3. Methods

### Functions and indicators used to describe alimentary consumption patterns

If, however, we must describe alimentary patterns from all aspects (as «feature packets»: K. Lankaster 1966, p. 133), it is necessary to create a common index. A simple and applicable index in all three cases (natural, technical, biological features) could be created as follows:

$$Q_{\text{index of plant ingredients}} = \frac{\text{rate \% of plant ingredients}}{50} \quad (1)$$

$$Q_{\text{index of animal ingredients}} = \frac{\text{rate \% of animal ingredients}}{50} \quad (2)$$

Where: «plant %» or «animal %» the percentage % of plant or animal ingredients that make up the respective diets.

Applying the data of H.B.S. 1957/58, our indices receive the following values:

$$Q_{\text{index of plant ingredients}} = \frac{\text{rate \% of plant ingredients}}{50} = \frac{60.2}{50} = 1.20 \text{ for plant origin foods, and}$$

$$Q_{\text{index of animal ingredients}} = \frac{\text{rate \% of animal ingredients}}{50} = \frac{39.8}{50} = 0.80 \text{ for animal origin food, with: } 50 = \text{the } 50\% \text{ rate when working on data rates.}$$

The logic behind using the 50% rate is as follows: it is a marginal point ( $\geq 50$ ) of characterization of patterns from a natural (animal or plant products) and a technical aspect (industrial or agricultural products) and, given that percentages of each category do not vary anywhere but only between 0% and 100%, the values of the index range between  $\geq 0$  to  $\leq 2$ .

When formulas (1) or (2) are applied for agricultural ingredients of alimentary patterns, we get:

$$Q_{\text{index of agricultural ingredients}} = \frac{\text{rate \% of agricultural ingredients}}{50} \tag{3}$$

When applied to industrial ingredients we get:

$$Q_{\text{index of industrial ingredients}} = \frac{\text{rate \% of industrial ingredients}}{50} \tag{4}$$

Hence, the general form of the index is:

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{rate \% of alimentary ingredients X}}{50} \tag{5}$$

where: X = plant, animal, agricultural or industrial ingredients.

When processing data concerning values (e.g. costs), quantities (eg kg or pieces), indices of food biological composition (eg kcal for calories, etc.), the formula takes the following form:

a) In the case of expenditure (costs):

$$Q_{\text{index of plant ingredients}} = \frac{\text{Cost of plant ingredients}}{\left( \frac{\text{Total category cost}}{2} \right)} \tag{6}$$

$$Q_{\text{index of animal ingredients}} = \frac{\text{Cost of animal ingredients}}{\left( \frac{\text{Total category cost}}{2} \right)} \tag{7}$$

$$Q_{\text{index of agricultural ingredients}} = \frac{\text{Cost of agricultural ingredients}}{\left( \frac{\text{Total category cost}}{2} \right)} \tag{8}$$

$$Q_{\text{index of industrial ingredients}} = \frac{\text{Cost of industrial ingredients}}{\left( \frac{\text{Total category cost}}{2} \right)} \tag{9}$$

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{Cost of alimentary ingredients X}}{\left( \frac{\text{Total category cost}}{2} \right)} \quad (10)$$

b) In the case of quantities (where instead of expenditure data we use data quantities):

$$Q_{\text{index of plant ingredients}} = \frac{\text{Quantity of plant origin ingredients}}{\left( \frac{\text{Total category quantity}}{2} \right)} \quad (11)$$

$$Q_{\text{index of animal ingredients}} = \frac{\text{Quantity of animal origin ingredients}}{\left( \frac{\text{Total category quantity}}{2} \right)} \quad (12)$$

$$Q_{\text{index of agricultural ingredients}} = \frac{\text{Quantity of agricultural origin ingredients}}{\left( \frac{\text{Total category quantity}}{2} \right)} \quad (13)$$

$$Q_{\text{index of industrial ingredients}} = \frac{\text{Quantity of industrial origin ingredients}}{\left( \frac{\text{Total category quantity}}{2} \right)} \quad (14)$$

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{Quantity of alimentary ingredients X}}{\left( \frac{\text{Total category quantity}}{2} \right)} \quad (15)$$

c) In the case of biological features (eg calories):

$$Q_{\text{index of biological ingredients}} = \frac{\text{Calories}}{\text{WHO's standard (e.g. 2200, 2600, 3200)}} \quad (16)$$

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{Quantity of biological ingredients X}}{\text{Standard base of biomedical sciences}} \quad (17)$$

Examples (with cost data):

$$Q_{\text{index of plant ingredients}} = \frac{210.6}{\left( \frac{349.7}{2} \right)} = 1.20 \quad (\text{applying formula (6) to data from H.B.S. 1957/58}) \quad (\text{see also results from formula (1) above}).$$

$$Q_{\text{index of animal ingredients}} = \frac{139.1}{\left( \frac{349.7}{2} \right)} = 0.80 \quad (\text{applying formula (7) to data from H.B.S. 1957/58}) \quad (\text{see also results from formula (2) above}).$$

$$Q_{\text{index of biological ingredients}} = \frac{\text{Calories}}{\text{WHO's standard (e.g. 2200, 2600, 3200)}}$$

$$Q_{\text{index of biological ingredients}} = \frac{2820}{2600} = 1.08 \quad (\text{applying formula (16) to WHO data})$$

Thus, we manage to create a common index, as shown by the results of formulas (1), (2) or (5) and (6), (7) or (10) for plant and animal ingredients, and (16) or (17) for biological.

#### 4. Results: Tables and Charts

In order to describe all features (natural, technical, biological) of an alimentary consumption pattern, a simple function can be generated.

$$Q_{\text{alimentary pattern}} = (Q_{\text{natural}}, Q_{\text{technical}}, Q_{\text{biological ingr.}}) \quad (18)$$

or more precisely

$$Q_{\text{alimentary pattern}} = (Q_{\text{nat.}}, Q_{\text{animal}}, Q_{\text{agric.}}, Q_{\text{indust.}}, Q_{\text{biological ingr.}}) \quad (19)$$

According to data from H.B.S. 1957/58 (see I. Sotiropoulos – M. Demousis, 2002, p. 456), the above relationship (19) receives the following values:

$$Q_{\text{alimentary pattern}} = (Q_{1.20}, Q_{0.80}, Q_{0.87}, Q_{1.13}, Q_{1.08}).$$

With data from H.B.S. 2004/05, the same relation (19) takes the values:

$$Q_{\text{alimentary pattern}} = (Q_{1.06}, Q_{0.94}, Q_{0.60}, Q_{1.40}, Q_{1.42}).$$

Thus, alimentary patterns can be described by tables and diagrams as shown in Table 1 and Figure 1, which depict in summary, that the alimentary pattern of 1957/58 consists of the following characteristics

- a) Plant features
  - b) It begins to become more industrialized and
  - c) It is just above the minimum levels of biological (energy) efficiency.
- However, the alimentary pattern of H.B.S. 2004/05 is:
- a) Plant-based also (but significantly reduced after a period of preponderance of animal ingredients over the past two decades)
  - b) Presenting growing industrial features and
  - c) Has significantly exceeded the levels of energy efficiency (see Table 2 and Figure 2).

**Table 1: Description of the alimentary consumption pattern of 1957/58 based on natural, technical, and biological features.**

<i>NATURAL FEATURES</i>		<i>TECHNICAL FEATURES</i>		<i>BIOLOGICAL FEATURES</i>	
<i>Plant ingredients</i>	1.20	<i>Agricultural ingredients</i>	0.87	<i>Energy efficiency</i>	1.08
<i>Animal ingredients</i>	0.80	<i>Industrial ingredients</i>	1.13		

**Figure 1: Description of the alimentary consumption pattern of 1957/58 based on natural, technical, and biological features.**

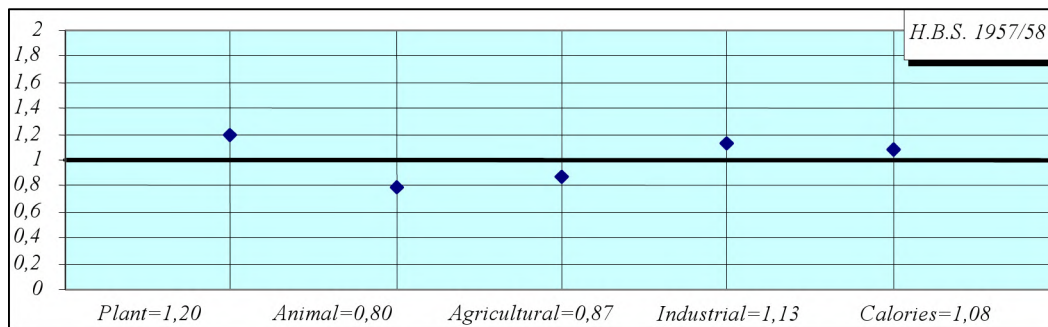
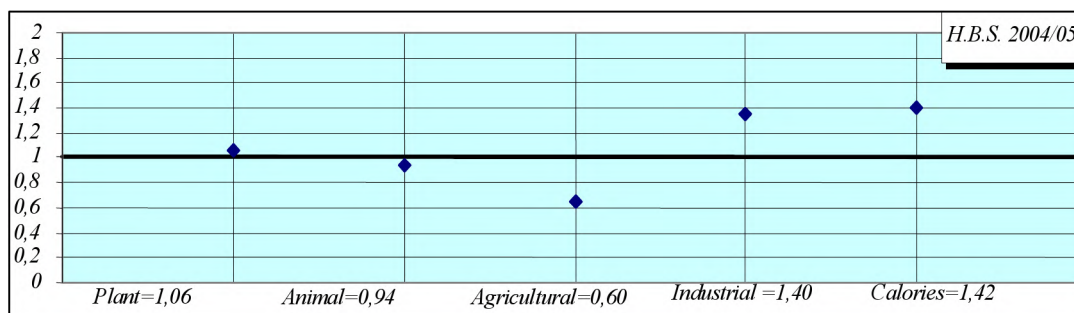




Table 2: Description of the alimentary consumption pattern of 2004/05 based on natural, technical, and biological features.

NATURAL FEATURES		TECHNICAL FEATURES		BIOLOGICAL FEATURES	
Plant ingredients	1.06	Agricultural ingredients	0.60	Energy efficiency	1.42
Animal ingredients	0.94	Industrial ingredients	1.40		

Figure 2: Description of the alimentary consumption pattern of 2004/05 based on natural, technical, and biological features.



### 5. Conclusions

Using the formulas:

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{rate \% of alimentary ingredients X}}{50} \quad (5)$$

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{Cost of alimentary ingredients X}}{\left( \frac{\text{Total category cost}}{2} \right)} \quad (10)$$

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{Quantity of alimentary ingredients X}}{\left( \frac{\text{Total category quantity}}{2} \right)} \quad (15)$$

$$Q_{\text{index of alimentary ingredients X}} = \frac{\text{Quantity of biological ingredients X}}{\text{Standard base of biomedical sciences}} \quad (17)$$

it is possible to formulate a common basis for characterizing alimentary patterns from a natural, technical and biological aspect:

$$Q_{\text{alimentary pattern}} = (Q_{\text{natural}}, Q_{\text{technical}}, Q_{\text{biological ingr.}}) \quad (18)$$

or more precisely

$$Q_{\text{alimentary pattern}} = (Q_{\text{nat}}, Q_{\text{animal}}, Q_{\text{rural}}, Q_{\text{indust.}}, Q_{\text{biological ingr.}}) \quad (19)$$

Thus, we have achieved giving a fuller description of alimentary consumption patterns, since using these indices, respective tables and charts can be constructed (see Tables 1, 2, and Figures 1, 2). Finally, it is easier understanding, classifying (eg, «agricultural», «industrial», «Mediterranean», etc.), analyzing their properties and evolution, and creating the conditions under which specific processing techniques can be employed. Finally, the method of creating these indicators, tables and diagrams can be applied as well within each category (eg meat, cereals, etc.), in other categories of consumption (eg clothing, housing, etc.) but also for the interpretation of their patterns and evolution.

In its general form, the basic formula may receive the form (when describing consumption patterns):

a)  $CM_d = (Ch_n, Ch_t)$

where:

$CM_d$  = Description of the consumption pattern

$Ch_n$  = natural features

$Ch_t$  = technical features

In the case of alimentary patterns the biological variable has been added, while in each different category of consumption corresponding variables are added.

Regarding the interpretation of consumption patterns, the formula may receive the form:

b)  $CM_e = (Ch_e, Ch_s)$

where:

$CM_e$  = Interpretation of the consumption pattern

$Ch_e$  = economic features

$Ch_s$  = social features

Each variable can be broken down into parts, such as  $Ch_e = P \cdot I$  (where  $P$  = price, and  $I$  = income) and a third variable may be added as well, according to formulas (18) or (19). This was applied with alimentary consumption, where we added the variable of biological ingredients in foods.

It would be interesting to study these data considering more features and processing them with a more complex methodology, in association with other indices (eg. GDP), a field of research which we are currently examining.

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# FINANCIAL ACCOUNTING REFORM IN GREEK PUBLIC HOSPITALS: AN EMPIRICAL STUDY OF THE IMPLEMENTATION

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## Abstract

*During the last decades, many countries worldwide have introduced financial accounting reforms at one or more levels of government by replacing or transforming their traditional budgetary cash accounting systems into an accrual based accounting system in order to increase accountability and financial transparency. This paper presents an overview of the current financial accounting reform towards a new accounting system, which combines cash and accrual accounting information, in the Greek public health sector. The focus is on the concept of the reformed financial accounting legislation and on the cross-sectional differences in the level of adoption and implementation of the new accounting system in Greek public hospitals. Our analysis is based on an empirical survey that was conducted via questionnaires during 2008 on a sample of 132 Greek public hospitals. The empirical examination revealed the perceived usefulness of the accrual accounting system in producing and presenting adequate accounting information to users for decision-making purposes as well as a lot of implementation problems in the early stage of hospital financial accounting reform.*

*JEL classification: M4, M48.*

*Key words: Accrual Accounting, Public Sector Accounting, Public Hospitals, New Public Management.*

## INTRODUCTION

During the last decades the public demand for radical changes towards the improvement of public sector activities resulted in a massive wave of organizational, managerial and accounting reform in the public sector and jurisdictions worldwide (Christiaens, 2008). Many of these reforms show a number of characteristics often summarized in terms of New Public Management (NPM). The NPM is a management philosophy used by governments to transform and modernize their public sector in order to enhance the efficiency, effectiveness and accountability of public services delivery by transplanting private sector management practices and techniques to the public sector (Lapsley, 1988; Potter, 2002; Van Helden, 2005). Within the context of NPM, several countries have adopted financial accounting reforms at one or more levels of government by replacing or transforming their traditional budgetary cash accounting systems to systems that support accruals, an accounting basis that is widely used by businesslike organizations, in order to increase financial accountability and transparency (Pessina and Steccolini, 2007, Blidisel, and Tudor, 2007; Aljarde, 1997; Christiaens, 1999 and 2001; Christiaens and Rommel, 2008; Christiaens and Peteghem, 2004; Hoque and Moll, 2001; Johnsen, 1999; Lapsley, 1994; Montesinos and Vela, 2000; Paulsson, 2006; Pallot, 1997 and 2001; Pettersen, 1999; Richardson and Cullen, 2000; and Venieris and Choen, 2004).

This change of public accounting systems towards accrual accounting seems necessary as the traditional budgetary cash accounting system is perceived nowadays as no longer satisfactory mainly due to the lack of a general financial picture and of adequate management information (Koen, 2007; Lapsley, 1999).

According to Christiaens et al. (2004, 2007) the governmental accounting reform was often the first phase of reforming governments and that is why it can be considered as an important condition and prerequisite for the success of the other consequent governmental reforms of NPM transformation international wave, such as organizational and managerial reforms. Therefore, an effective and successful implementation of the accounting reform plays an important and significant role in the success of implementing other NPM practises and techniques within public organizations. (Christiaens and VanPeteghem, 2007).

The Greek public sector, within the context of NPM and following the example of numerous other countries in Europe and worldwide, has encountered a number of financial accounting changes and reforms over the last ten years. As a result, in 1997 the Greek government started introducing the accrual based accounting

system and double-entry bookkeeping method to several public sector organizations. The most important examples of Greek public sector entities that an accounting reform took place towards accrual accounting are: Social securities funds (1997), Public law entities (1998), local government institutions, municipalities, (1999) and finally public owned hospitals (2003).

In the public sector accounting international literature, the transition to the accrual basis of accounting initiative is claimed to have a number of benefits, which can be grouped and summarised as follows : (i) identification of costs of services and political programmes; better measurement of costs and revenues; enhancement of control process and transparency (ii) greater focus on outputs; focus on the long-term impact of decisions (iii) more efficient and effective use and management of resources; greater accountability on the use of resources (iv) reduction of public expenditure; depiction of the true and accurate financial position (v) better financial management and greater comparability and evaluation of managerial and organizational performance ; greater attention to asset management; and more complete information on public organisations' liabilities. (Mellett, 2002; and Olsen et al., 2001; Barrett, 1993; Evans, 1995; Pallot, 2000; Mellor, 1996; Alijarde, 1997; Barzelay, 1992; Moe, 1994; Venieris and Choen, 2004; Choen et al., 2007; Aucoin, 1995; Pessina and Steccolini, 2007; OECD, 2005; and IFAC PSC, 2000, pp. 7–10).

However, it should be stressed that an increasing body of researchers are sceptical about the adoption of accruals accounting by public organisations and believe that the above accounting framework is often accompanied by difficulties and implementation problems. These problems may arise due to vague accounting objectives, standards and treatments that usually derive from unclear aspects of accounting legislation, such as the valuation and recognition of assets, the measurement of depreciation of physical assets and amortization of intangible assets and the recognition of income and expenses. (Christiaens, 2001; and Hepworth, 2003; Christiaens and Rommel, 2008; Jones and Pendlebury, 1991; Choen, Kaimenaki and Zoraios 2007).

As Cohen (2007) mentions, a second group of problems, when altering accounting systems from cash to accrual basis accounting, is related to organizational parameters. Examples of these parameters comprise the inadequacy of software and personnel resources and experience to implement accrual accounting, the lack of accounting training with shortage of skills and expertise, the absence of motivation and incentives for accrual accounting adoption and the insufficient political and Top Management Support and commitment, (Choen et al., 2007; Pallot, 1997; Pendlebury and Karbhari, 1998; Guthrie, 1998; Stanton and Stanton, 1998; Newberry, 2002; Carlin and Guthrie, 2003; Hodges and Mellett, 2003; and Alijarde, 1997) .

In order to reap the full benefits of switching to accrual accounting it is important to take into account the above frequently cited problems and shortcomings of public accounting reform and trying to control and resolve them, otherwise, the adoption of the accrual based accounting system may be delayed or impeded.

The purpose of this paper is to present experiences from Greek attempt to introduce accrual and management accounting practices and techniques into public entities and especially into public owned hospitals that are part of the Greek National Health System (NHS) and examine the finance directors' perceptions about the benefits derived from the reform but also, problems encountered.

This objective derives from the fact that little evidence has been presented about the views of practicing accountants and finance officers regarding this initiative. The empirical examination revealed a lot of implementation problems in the early stage of the hospital financial accounting reform.

The remainder of the paper proceeds as follows. The next section presents a short description of the Greek National Health System (NHS) and the financial accounting reforms that took place during the last ten years. The third section describes the methodology applied in this study. The presentation of the research results is found in section four. The paper conclusions drawn from the research are set out in the final section.

## **THE GREEK NATIONAL HEALTH SYSTEM HOSPITAL SECTOR**

Greek public hospitals have been confronted with a plethora of organizational, administrative and financial reforms since the mid of the 1980s in the name of improved efficiency, effectiveness, and accountability.

The Greek health care system can be characterised as a mixed System in which the National Health System (NHS), a compulsory social insurance, and the voluntary private health insurance system co-exist. The Greek NHS was established in

1983 under the Law 1397/83 which declared that health is a "social good" and all citizens should have the right to be offered high quality health care. Therefore, the objective of NHS was to provide free, equitable and universal health care coverage to citizens based on the principles of equity, equal access to health services and solidarity.

At a central governmental level, the Ministry of Health and Social Cohesion (MHSC) is responsible for the provision of health care and the development of a national strategy for health. More specifically, the MHSC sets strategic priorities at national level, defines the extent of funding for proposed activities and finally, allocates the necessary resources.

In 2001 a new organizational and administrative NHS reform (Law 2889/01) was enacted. The reform includes several structural changes such as the operation of 17 Regional Health Authorities (D.Y.Pe) and the establishment of new managerial structures and businesslike (private-sector) efficiency tools and techniques in public hospitals like cost-improvement programmes, performance indicators, financial management information systems and Global and departmental Budgets (WHO, 2005). Under the spirit of decentralisation the 17 D.Y.Pe are responsible for implementing national health priorities at regional level, coordinating regional activities and organizing and managing the delivery of health care and welfare services within their geographical area through the health care units (Hospitals, Health Centres, social care units, etc) .

Health care expenditures in Greece are funded mainly through the central annual government budget (general taxation), the numerous state insurance funds (compulsory employer and insured people contributions) and private insurance schemes (voluntary payments). Hence, the Greek NHS can be characterised as a “dual” system, in which elements from both the Bismarck and the Beveridge model co-exist. In 2006, Greece’s total spending on health accounted for 9.1% of GDP, slightly above the average of 8.9% in OECD countries, of which an extremely high 4.1% accounted for private health spending.

Health care services, in the public sector, (mainly Secondary and tertiary health care) are provided in 132 general and specialized public hospitals operate within the NHS. The public owned hospitals of NHS have a total capacity of 34.134 beds, according to data presented in Table 1.

**Table 1. Number of NHS Hospitals per Health Region**

Health Regions / Regional Health authorities	No of Beds	%	No of Hospitals	%	No of Health centers	%	No of social care units	%	No of Employees	%
1 <sup>n</sup>	9.291	27,22%	27	20,45%	8	4,10%	6	6,52%	27.567	28,07%
2 <sup>n</sup>	5.421	15,88%	20	15,15%	23	11,79%	14	15,22%	13.977	14,23%
3 <sup>n</sup>	4.044	11,85%	17	12,88%	17	8,72%	8	8,70%	10.340	10,53%
4 <sup>n</sup>	4.919	14,41%	15	11,36%	34	17,44%	16	17,39%	13.806	14,06%
5 <sup>n</sup>	2.420	7,09%	13	9,85%	32	16,41%	13	14,13%	9.032	9,20%
6 <sup>n</sup>	5.725	16,77%	31	23,48%	67	34,36%	26	28,26%	16.749	17,05%
7 <sup>n</sup>	2.314	6,78%	9	6,82%	14	7,18%	9	9,78%	6.747	6,87%
<b>Total</b>	<b>34.134</b>	<b>100%</b>	<b>132</b>	<b>100%</b>	<b>195</b>	<b>100%</b>	<b>92</b>	<b>100%</b>	<b>98.218</b>	<b>100%</b>

## ACCOUNTING REFORM IN THE GREEK HEALTH SECTOR

Traditionally, Greek governmental budgeting and accounting at all three levels of government, central, regional and local, is regulated by law and not by any external standard-setting professional body and is still based upon a cash principle and accounting basis. During the last years, efforts have been made from the government to change these budgetary principles towards accrual basis of accounting to central, regional and local government public entities.

The accounting regulations for Greek public hospitals, dated back to 1974 with the legislative decree 496/74, were based on a budgetary and single-entry bookkeeping accounting system and had a primarily cash basis accounting approach. The main purpose and concern of the hospitals budgetary cash accounting system was to register transactions and use the authorised budgets, driven by budgetary principles, and to control the execution of the budget approved by the governmental decision makers. On the other hand, little attention was given to providing a complete picture of the financial position and financial performance of public health organizations.

That is why, the Greek management literature has long pointed out the need for the reform of the accounting system in the health public sector and encouraged the switch to accruals accounting<sup>4</sup> (Ballas and Tsoukas, 2000; Venieris and Koen, 2003) as nowadays, the traditional budgetary accounting is viewed as ‘outdated’, no longer satisfactory and making a significant contribution to the inefficiency and ineffectiveness of the Greek public sector.

The initial efforts of introducing the accrual basis of accounting in public hospitals commenced in 1997 with the Law 2519/97. This Law presented for the first time the government’s attempt and intention to introduce double-entry bookkeeping and cost management methodologies in public hospitals.

The development and preparation of an Official Health Sector Accounting Plan (HSAP), aimed at developing the conceptual framework for accrual accounting in public hospitals, was assigned by the Ministry of Economy and Finance to the national Council of Accounting (ESYL) and to the Chamber of Finance (OEE).

The HSAP mainly included broad guidelines regarding principles for accrual basis accounting implementation, similar to those applied to the private sector, the charts of accounts, asset classification, examples of journal entries, templates of the layout and the content of the published financial statements (i.e. balance sheet, income statement, cash flow statement, The Statement of Income Distribution, Budget report and Actual report, ) and suggested financial ratios ( Venieris and Koen, 2004).

Furthermore, a pilot implementation project, under the experimentation clauses of the HSAP, commenced in 1999 in order to test the suitability of the new accounting system and its readiness for full implementation. Five Public owned hospitals that would implement the HSAP as pioneers were selected.

The governmental efforts to reform the accounting system of the health sector escalated in 2003, after taking the pilot implementation experiences into account and making the necessary modification to the HSAP, when a law, the Presidential Decree 146/03 (P.D. 146/03), was passed. The P.D. 146/03 enforced the mandatory adoption of the new accounting system, based on accrual accounting, to all public hospitals that are part of the Greek NHS. However, the previous traditional budgetary cash accounting system was not totally abandoned but instead, the public hospitals just added accrual accounting system separately and most of the budgetary accounting principles were maintained (Christiaens, 2001). The new accounting framework of the P.D. 146/03 defined two accounting systems that should work in parallel under two independent accounting cycles within the same general ledger and while each one would still retain its autonomy. The legislator believed that the solution of introducing this combined approach, for accrual accounting and budgetary cash accounting, of two separate accounting systems should be the most beneficial in order to reap the best of the two accounting systems, as each one has its own strengths and weaknesses. The simultaneous existence of the two accounting regimes, accrual and cash, was evaluated as necessary due to different accounting objectives and processes that have to support. The former system is aiming at reporting the financial position and the yearly profit and loss statement of hospitals and the latter system is aiming at authorizing and controlling of public spending (Christiaens and Rommel, 2008).

The P.D. 146/03 pointed out that the deadline for the implementation of accrual financial accounting in public hospitals was the 1<sup>st</sup> of January 2005, while the deadline for cost accounting introduction was the 1<sup>st</sup> of January 2006.

## **METHODOLOGY**

The principal area of investigation is to present the rate of adoption of the accounting reform as well as the problems regarding the implementation of the new accounting system. To determine all the above a survey using questionnaires was conducted during 2008 in all Greek public hospitals in order to gather the necessary data. The questionnaire was sent by e-mail and Fax to 132 finance directors working within the public hospitals accounting and finance departments, on the understanding that they are the key actors that used the new accounting system Eventually, out of 132 distributed questionnaires, 54 were returned, a response rate of 41% health units covering all the regions of the country (see table 2). In order to analyze the data collected the SPSS version 14 was used as the most common statistical package.

**Table 2. Coverage Ratio of answered questionnaires per Health Region**

<i>Health Regions</i>	<i>Total Number of Hospitals</i>	<i>No of Hospitals answered the questionnaire</i>	<i>% of Hospitals answered the questionnaire</i>
1 <sup>st</sup> Attiki	27	11	40,7%
2 <sup>nd</sup> Peiraia- Aigaio	20	8	40%
3 <sup>rd</sup> Makedonia	17	10	59%
4 <sup>th</sup> Anat. Makedonia & Thraki	15	5	33%
5 <sup>th</sup> Thessalia - Sterea Ellada	13	3	24%
6 <sup>th</sup> Peloponnisos - Ionia Nisia - Dytiki Ellada	31	13	42%
7 <sup>th</sup> Kriti	9	4	44%
<b>Total number</b>	<b>132</b>	<b>55</b>	<b>41%</b>

## SURVEY RESULTS

Prior to the presentation of the research findings, we would like to refer to the demographic characteristics of the public hospitals that are comprised in the sample. Table 3 shows the hospitals profile, such as, geographical residence, financial turnover, number of employees and no of beds.

**Table 3. Demographic Characteristics of public hospitals sample**

<b>Residence of the Hospital</b>	<b>Frequency</b>	<b>Hospitals capacity (No of Beds)</b>	<b>Frequency</b>	<b>Hospitals Financial Turnover (Euro)</b>	<b>Frequency</b>	<b>Number of employees</b>	<b>Frequency</b>
Attiki - Peiraia-Aigaio	19	below 100	17	0 -3.000.000	15	0 - 100	9
Makedonia & Thraki	15	from 101 to 350	17	3.000.000 - 15.000.000	14	101 - 400	12
Thessalia - Sterea Ellada	3	351 - 500 beds	5	15.000.000 - 30.000.000	6	401 - 700	12
Peloponnisos - Ionia Nisia - Dytiki Ellada	13	above 501	15	30.000.000 - 50.000.000	2	above 701	21
Kriti	4			above 50.000.000	17		
<b>Total</b>	<b>54</b>	<b>Total</b>	<b>54</b>	<b>Total</b>	<b>54</b>	<b>Total</b>	<b>54</b>

As displayed in Table 4, even though the accrual basis financial accounting system has been adopted and used by 45 out of 54 (83,3%) public hospitals, which is quite satisfactory rate, on the other hand, only 10 out of 54 (18,5%) hospitals had developed and adopted an operating cost accounting system. However, according to our survey data, another 32 (60%) hospitals are in the process of developing and implementing a cost accounting system that will be completed by the year 2010. Despite the fact, that the deadline, imposed by the Presidential Decree 146/03, concerning cost accounting system implementation was formally the 1<sup>st</sup> January, 2006, the remaining 12 (23%) hospitals answered that the introduction of such an accounting system was not for them an option even in their future plans

**Table 4. Implementation Rate of accrual accounting systems**

	YES	NO
Financial accrual accounting (N = 54)	83,3%	16,7%
Cost accounting (N = 54)	18,5%	81,5%

In Table 5 we present the perceptions of financial directors regarding the usefulness of the new accounting system in producing and presenting adequate accounting information for decision-making purpose

**Table 5. Results of respondents' perception regarding the usefulness of the financial information provided by Accrual Basis financial accounting system**

Benefits	Percentage of Hospitals					Mean	St deviation
	1*	2	3	4	5		
Improved decisions based on accurate, relevant, and reliable information	4,4%	8,9%	13,3%	33,3%	40,0%	3,96	1,147
Improved disclosure of the true and accurate financial position	0%	2,2%	13,3%	48,9 %	35,6%	4,18	0,747
Provides enough financial data to facilitate the control process	2,2%	13,3%	22,2%	35,6%	26,7%	3,71	1,079
Provides enough data to facilitate the determination of cost and performance of services	0%	11,1%	24,4	33,3%	31,1%	3,84	0,999
Reduction of public expenditures	6,7%	20%	17,8%	33,3%	22,2%	3,44	1,235
Increased Efficiency and effectiveness use of resources	0%	13,3%	28,9%	24,4%	33,3%	3,78	1,064
Improved Transparency and accountability	4,4%	15,6%	28,9%	24,4%	26,7%	3,53	1,179
Increased comparability of output among departments and organizations	6,7%	8,9%	26,7%	33,3%	24,4%	3,60	1,156

\*Notes: scale 1 = strongly Disagree to 5 = strongly Agree

Respondents have quoted a number of benefits regarding the accrual accounting system adoption. As indicated in Table 5 the most important perceived benefits are the "Improved disclosure of the true and accurate financial position" (Mean 4,18), the "Improved decisions based on accurate, relevant, and reliable information" (Mean 3,96) and the "Provides enough data to facilitate the determination of cost and performance of services" (Mean 3,84).

On the contrary, the variables that do not seem to have influenced the respondents to a great extent and received the lowest rating are the "Reduction of public expenditures" (Mean 3,44) and the "Improved Transparency and accountability" (Mean 3,53). It seems that accrual accounting adoption in the public hospitals does not have an important effect in public expenditures reduction.



Moreover, the respondents of the Health units that implemented the accrual accounting system stated, as displayed in table 6, that it was a difficult and time and resource consuming project accompanied by many organizational difficulties and implementation obstacles.

**Table 6. Results of respondents' perception regarding the difficultness of Accrual accounting implementation process**

	Percentage of Hospitals					Mean	St deviation
	1*	2	3	4	5		
The implementation process of Accrual accounting system	40,0%	22,2%	28,9%	4,4%	4,4%	<b>2,11%</b>	1,133
(N=45)	(18)	(10)	(13)	(2)	(2)		

\*Notes: measured on scale 1 = very difficult to 5 = Very easy.

That is why, the accrual accounting implementation must be an “easier” process to hospitals that employ a larger number of finance and accountant officers. In order to confirm it, we created two groups, the first contains observations from hospitals that employ less than 15 finance and accountant officers and the second contains observations from these ones that employ more than 15 officers and then, we used the T-Test measure in order to compare the means of the two variables. The results in table 7 indicate that there is a statistical significant difference ( $t = -3,252$ , sig. =0,002) between the two group means at 5% level, suggesting the existence of a size effect.

**Table 7. Results of respondents' perception regarding the difficultness of Accrual accounting implementation process based on finance and accounting Dept. employees (Independent Samples T Test)**

	Number of employees within finance and accounting department		N	Mean	Std. Deviation
	Below 15 employees	Above 15 employees			
The implementation process of Accrual accounting system	Below 15 employees		23	1,73	0,827
	Above 15 employees		22	2,74	1,214
Mean Difference	- 1,01				
t-test	<b>-3,252</b>				
Sig. (2-tailed)	<b>0,002</b>				

\*Notes: measured on scale 1 = very difficult to 5 = Very easy.

The difficulties that the public hospitals had to face during the implementation process regarding the accrual accounting system are presented in the Table below.

**Table 8. Results of respondents' perception regarding problems of adopting and implementing accrual basis financial accounting**

Problems	Percentage of Hospitals				
	1*	2	3	Mean	St deviation
Insufficient political and Top Management Support and commitment	62,2%	33,3%	4,4%	1,42	0,583
Personnel's complaints and reluctance against change	13,3%	53,3%	33,3%	2,20	0,661
Selection of accounting software	42,2%	48,9%	8,9%	1,67	0,640

Problems	Percentage of Hospitals				
	1*	2	3	Mean	St deviation
lack of additional resources and manpower	15,6%	37,8%	46,7%	2,31	0,733
Absence of incentives to implement such a system	20,0%	73,3%	6,7%	1,87	0,505
lack of knowledge and expertise to implement such a system	20,0%	37,8%	42,2%	2,22	0,765
Absence of clear accounting objectives and standards (ie, valuation policy for fixed assets)	22,2%	48,9%	28,9%	2,07	0,720
lack of accounting training	20%	48,9%	31,1%	2,11	0,714

\*Notes: scale 1 = no problems encountered to 3 = significant problems encountered

The analysis of the answers in Table 8 revealed that the most highly-rated problems regarding the adoption of accrual basis of accounting appeared to be the “lack of additional resources and manpower” (Mean 2,31), the “lack of knowledge and expertise to implement such a system” (Mean 2,22) and the “Personnel’s complaints and reluctance against change”. The areas that were indicated by the public hospitals sample as the ones being less problematic are the “Insufficient political and Top Management Support and commitment” (Mean 1,42) and the “Selection of the appropriate accounting software” (Mean 1,67).

## CONCLUSIONS

This paper presents the “journey” of introducing an accrual and management accounting system to NHS in Greece and examines its diffusion rate. Our findings, based on a sample of 54 public owned hospitals, indicate that the adoption rate (83%) of the accrual basis of accounting in public health sector is quite satisfactory, regarding the financial accrual accounting system, compared to the adoption rate (18,5%) of the cost accrual accounting system the implementation of which has not yet seriously progressed almost 6 years after the declared NHS accounting reform (P.D. 146/03) .

Furthermore, the present study is trying to investigate the usefulness level of the accrual accounting system in producing and presenting adequate accounting information for decision-making purposes as well as the perceived obstacles and problems concerning the implementation of this new accounting system.

More specifically, the majority of the respondents agree that the accrual-based accounting system is very useful in producing and providing adequate financial information to users and stakeholders regarding the overall picture of hospitals financial position, the evaluation of hospital’s performance, the real level of liabilities, the determination of full cost of services delivered, the improvement of hospitals assets management and decision making process.

According to our survey results, the most significant problems and difficulties that adopters encountered during the change to the accrual-based accounting system are the inadequacy of resources, the personnel’s shortage of knowledge on accrual accounting principles and standards, the personnel’s resistance to change, the lack of adequate training and the absence of incentives for accrual basis accounting adoption.

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# MEASURING EXCHANGE RATE PASS-THROUGH FOR A CANDIDATE COUNTRY OF THE EUROZONE

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## Abstract

*I provide time series multivariate cointegration evidence about the complete long run and incomplete short run, exchange rate pass-through (ERPT) on the prices of imported final goods in Hellas, from its 4 major countries-origin, during its post Bretton-Woods and pre-European Monetary Union (EMU) era 1975-1998. Also, I investigate exchange rate connection to the home industrial production. Both sets of estimations are used to assess the effectiveness of the managed float conducted by the Bank of Greece during the sample period. Full long-run ERPT estimated coefficients, in three out of four cases, are explained in the basis of the intertemporal deficit of domestic supply of capital goods within the policy trilemma framework. These estimations result in exchange rate puzzle as regards the regime's choice. In the same puzzle I end up with the estimated exchange rate connection, in three out of four cases, with domestic industrial production. Further research is needed.*

**Keywords:** exchange rate pass-through, exchange rate disconnect, managed float, EMU, exchange rate regimes, producer vs local currency pricing (PCP vs LCP).

**JEL Classification:** F32; F36; F37; C50.

## I. Introduction

One of the perennial concerns for small open economies, such as Hellas (Greece), is the choice of exchange rate regime. In February 1998 the Bank of Greece (BoG) put the national currency, Hellenic Drachma (GRD), within the Exchange Rate Mechanism II (ERM-II) limits, of the European Monetary System (EMS), so as after a two year of GRD's relative stabilisation course the country-member of the European Union (EU) could apply for adhesion to the euro-zone. In fact the Hellenic government passed the Maastricht criteria tests, and since January 1<sup>st</sup> 2001 the euro is the legal national currency in the Hellenic republic. Besides political reasons, the abolition of the GRD and the respective euro's adoption may be justified by several sets of economic criteria, e.g., through the optimum currency area (OCA) theory or the ineffectiveness of the managed float conducted by the BoG the past twenty four years (1975-1998). This policy targeted either to trade balance adjustment (1975-1987), or, through the alleged insulating power of the floating rates (Gandolfo, 2001), to keep out the domestic inflation influence from abroad (1987-1998). The effectiveness of such a foreign exchange policy may be assessed through the extent of the exchange rate pass-through (ERPT) into import prices.

The purpose of this paper is to provide time series cointegration evidence on ERPT into import prices in Hellas during its pre-European Monetary Union (EMU) era 1975-1998, and through these estimated elasticities to assess the foreign exchange policy conducted by the BoG. If this policy could be proved ineffective we might have an argument in favour of a change in the country's exchange rate regime, which would be in the absolutely opposite direction, i.e. fixed exchange rates or monetary union with a single currency that is adhesion to the euro, as EU's member-country.

In the next section we present the empirical framework, while in the third we briefly describe the theoretical model and the data used. In the fourth section we give the final estimations and justifications we made, while the fifth section concludes the paper.

## II. Conceptual underpinnings

If the managed float of the Hellenic Drachmae (GRD), could not fully pass through to import prices, then "expenditure-switching" effects get weaker, and consequently exchange rate policy did not have the suitable effectiveness in restoring external trade equilibrium. That is, the active intervention policy of the Bank of Greece (BoG) over the sample period, may not lead to much substitution effects, because the incomplete exchange rate pass-through (ERPT) on import prices, did not change the relative prices of domestic vs.

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internationally produced goods much for final users (Devereux and Engel, 2002). Accordingly, if pass-through rates were low, then these invalidate the famous Marshall-Lerner-Robinson (1923, '44, and '47) condition for the balance of trade adjustment, and consequently, the issue of exchange rate regime optimality is emerging.

If the opposite is proved true, i.e. the nominal exchange rates of the GRD to the import prices were complete, then, the danger of their endogeneity to the country's inflation performance is prevalent. Once again, the extent of this monetary policy effectiveness, which may be fragile and regime-specific (Taylor, 2000), may be assessed.

The purpose of this paper is to provide time-series evidence on GRD's pass-through into the import prices of the Hellenic bilateral trade, namely, with Germany, Italy, France and the United Kingdom (UK). Using quarterly data from 1975 through 1998, we document the producer currency pricing (PCP, i.e. complete ERPT) strategy of the foreign exporters to Greece, in the long-run and the local currency pricing (LCP, i.e. incomplete ERPT) in the short run elasticities. The aforementioned four main trade partners of Hellas cover for Europe's zone total imports, approximately and on average for the sample period, 60% of the agricultural goods (0+1+4 of the Standard International Trade Classification - SITC-), 45% of the raw materials (2+3 of the SITC), and 68% in the manufacturing goods (5+6+7+8+9 of the SITC). In addition, the intra-Europe Hellenic imports represent, approximately and on average during the sample period, 83% in agricultural goods, 28% in raw materials, and 80% in manufacturing goods, respectively, of the great total from all over the globe (OECD 1997 & 2005, see Table 1).

The conclusions may be useful, as one more argument, in assessing the GRD's adhesion to the euro-zone (EMU) since 2001, from the Hellenic authorities which abandoned their managed float (1975-1998) in the post Bretton-Woods era.

The theoretical framework we use, is discussed analytically in Koujianou-Goldberg and Knetter (1997) and treats ERPT as a macro phenomenon (Campa and Goldberg, 2002) which might manifest, (1) the high sliding GRD's rate as a necessity to raise the relative price of foreign goods enough to reduce import demand sufficiently (Krugman, 1989; Betts and Devereux, 1996); (2) the exchange rate disconnection from the domestic production (Devereux and Engel, 2002), which may also justify the regime's change towards the adoption of the euro; and (3) the foreign exporters' currency pricing strategy which may be local (LCP) in the short-run, or producer's (PCP) in the long-run, for the import prices of the Hellenic market.

**Table 1 Relative importance of the 4 main countries-origin for the Hellenic imports, 1975-1998**

	A	B	C	D
89 Miscellaneous manufactured articles, n.e.s.	0.024 (.010)	0.031 (.010)	0.021 (.006)	0.045 (.020)
87 Professional, scientific & controlling instruments	0.015 (.003)	---	---	---
84 Articles of apparel and clothing accessories	---	0.035 (.024)	0.019 (.011)	0.025 (.015)
79 Other transport equipment	0.042 (.046)	---	0.040 (.030)	0.109 (.104)
78 Road vehicles (including air-cushion vehicles)	0.150 (.038)	0.074 (.032)	0.087 (.046)	0.071 (.031)
77 Electrical machinery, apparatus & appliances n.e.s.	0.059 (.009)	0.049 (.005)	0.042 (.009)	0.029 (.004)
76 Telecommunications & sound recording apparatus	0.035 (.009)	0.015 (.007)	---	0.021 (.018)
75 Office machines & automatic data processing equipment	---	---	---	0.026 (.016)
74 General industrial machinery & equipment, and parts	0.048 (.009)	0.080 (.009)	0.043 (.013)	0.033 (.006)
72 Machinery specialized for particular industries	0.074 (.033)	0.096 (.037)	0.030 (.017)	0.068 (.036)
71 Power generating machinery and equipment	0.019 (.008)	0.017 (.007)	0.022 (.018)	0.019 (.009)
69 Manufactures of metal, n.e.s.	0.025 (.003)	0.042 (.006)	0.023 (.006)	0.018 (.004)
67 Iron and steel	0.030 (.011)	0.047 (.009)	0.098 (.046)	0.075 (.048)
66 Non-metallic mineral manufactures, n.e.s.	---	0.037 (.007)	---	---
65 Textile yarn, fabrics, made-up articles, related products	0.067 (.029)	0.073 (.022)	0.045 (.009)	0.029 (.006)
64 Paper, paperboard, articles of paper, paper pulp/board	0.022 (.008)	0.022 (.006)	---	---
61 Leather, leather manufactures, n.e.s. and dressed furskins	0.048 (.038)	0.014 (.005)	---	---
59 Chemical materials and products, n.e.s.	0.020 (.002)	0.017 (.005)	0.031 (.005)	0.022 (.005)
58 Artificial resins, plastic materials, cellulose esters and ...	0.031 (.004)	0.048 (.010)	0.038 (.008)	0.026 (.008)
55 Essential oils & perfume materials; toilet polishing and ...	---	---	0.020 (.014)	---
54 Medicinal and pharmaceutical products	0.021 (.008)	0.016 (.005)	0.027 (.019)	0.038 (.011)
53 Dyeing, tanning and colouring materials	---	---	---	0.022 (.004)
51 Organic chemicals	0.017 (.003)	0.018 (.007)	0.026 (.005)	0.019 (.006)

	A	B	C	D
33 Petroleum, petroleum products and related materials	---	0.029 (.025)	0.019 (.017)	0.021 (.017)
11 Beverages	---	---	---	0.066 (.040)
04 Cereals and cereal preparations	---	---	0.059 (.061)	---
02 Dairy products and birds' eggs	0.029 (.012)	---	0.022 (.009)	---
01 Meat and meat preparations	0.044 (.037)	0.015 (.010)	0.058 (.039)	---
	E	F	G	H
0 Food and live animals	0.441 (.112)	0.177 (.048)	0.304 (.080)	0.077 (.041)
1 Beverages and tobacco	0.266 (.112)	0.059 (.022)	0.090 (.023)	0.585 (.099)
2 Crude materials, inedible, except fuels	0.342 (.044)	0.271 (.073)	0.221 (.058)	0.166 (.036)
3 Mineral fuels, lubricants and related materials	0.149 (.078)	0.498 (.120)	0.202 (.093)	0.152 (.072)
4 Animal and vegetable oils, fats and waxes	0.404 (.264)	0.333 (.260)	0.206 (.126)	0.057 (.065)
5 Chemicals and related products, n.e.s.	0.378 (.035)	0.274 (.014)	0.215 (.022)	0.132 (.018)
6 Manufactured goods classified chiefly by material	0.404 (.079)	0.329 (.103)	0.175 (.047)	0.092 (.018)
7 Machinery and transport equipment	0.483 (.045)	0.267 (.041)	0.129 (.021)	0.121 (.026)
8 Miscellaneous manufactured articles	0.334 (.069)	0.389 (.089)	0.132 (.023)	0.145 (.017)
9 Commodities and transactions not elsewhere classified	0.431 (.201)	0.270 (.198)	0.104 (.140)	0.195 (.239)
Total	<b>0.421 (.057)</b>	<b>0.286 (.048)</b>	<b>0.171 (.011)</b>	<b>0.123 (.018)</b>
	I		J	
0 Food and live animals	0.418 (.107)		0.779 (.153)	
1 Beverages and tobacco	0.700 (.110)		0.893 (.049)	
2 Crude materials, inedible, except fuels	0.378 (.067)		0.473 (.058)	
3 Mineral fuels, lubricants and related materials	0.522 (.087)		0.093 (.027)	
4 Animal and vegetable oils, fats and waxes	0.587 (.105)		0.824 (.099)	
5 Chemicals and related products, n.e.s.	0.630 (.027)		0.908 (.012)	
6 Manufactured goods classified chiefly by material	0.686 (.045)		0.826 (.039)	
7 Machinery and transport equipment	0.730 (.038)		0.702 (.035)	
8 Miscellaneous manufactured articles	0.784 (.036)		0.774 (.027)	
9 Commodities and transactions not elsewhere classified	0.546 (.264)		0.811 (.207)	
Total	<b>0.650 (.018)</b>		<b>0.653 (.082)</b>	

Source: OECD (1997 and 2005), *International Trade by Commodity Statistics (ITCS)*, *Standard International Trade Classification (SITC) Revision 2*, in current USD prices.

Notes:

All numbers in brackets represent the value of the respective standard deviation.

$A =$  the average of the sample 1975-1998, of the ratio  $(\frac{M_j^{GER}}{TM^{GER}})$ , while  $M_j^{GER} =$  Hellenic imports -in thousand of USD- of  $j$  category of the SITC from Germany, and  $TM^{GER} =$  Total Hellenic imports from Germany.  $B, C, D$  stand for these ratios for Italy, France and the UK, respectively.  $E =$  the share of the Hellenic imports from Germany to the sum of these 4 countries.  $F, G, H$  stand for these shares for Italy, France and the UK, respectively.  $I =$  the ratio of the Hellenic imports from the sum of these 4 countries to the total of Europe zone.  $J =$  the ratio of the Hellenic imports from Europe zone to the World one.

Key limitations of our study may be considered (1) the partial equilibrium theoretical and therefore empirical framework; (2) the macro-level analysis which brings in question possible aggregation biases in general import prices due to sectoral heterogeneity; (3) many reforms and policy interventions, over the sample period, mainly in the trade and foreign exchange policies, used by policy makers so as to push Hellenic economy to converge in nominal terms to its European partners; some of them are taken into account through dummy variables, to deal with the lack of normality in the residuals of our Vector Error Correction (VEC) models.

Other studies, namely this of Campa and Goldberg (2002) estimated the long run ERPT on overall Hellenic import prices as near zero (-0.02), while 0.40 in the short run, which expresses a somewhat strange LCP behaviour of large foreign exporters to the small Hellenic market. The authors used the same basic ERPT equation as we do (Koujianou-Goldberg and Knetter, 1997), approximately over the same sample period (1975q1-1999q4), but they did not find cointegration probably because of the data sources. However, it seems difficult to accept that these estimated extremely low ERPT coefficients may be attributed to exporters' competition for the small Hellenic market shares (Froot and Klemperer, 1989), even if they could

restore their profit margins the next contract period (Maggee, 1973) after the devaluation. The high nominal exchange rate variability of the sliding GRD does not justify it, as Taylor's (2000) hypothesis argues, "all else equal, ERPT would be higher for countries with more volatile monetary policy, i.e., with higher inflation rates", as was the Hellenic case during that period, as well as Dornbusch's (1987) country size's argument says, "ERPT may be higher if the exporters are large in number relative to the presence of local competitors". The volatile Hellenic monetary policy until the early 90s, as well as the large foreign exporters to the local market did not match this near zero ERPT on import prices, estimated by Campa and Goldberg (2002).

Our empirical evidence is strongly supportive of partial ERPT on import prices in the short-run, defined as one quarter, and almost complete ERPT rates in the long-run; the short-run elasticities vary from 0.35 for the Hellenic-French trade through 0.75 for the Hellenic-German one, while the long-run ERPT coefficients lie between 0.45 in the French imported goods case and 1.71 in the British one, supporting, however, the PCP strategy in the three out of four cases. Our estimations do agree with those of Faruquee (2004) and Frankel et al. (2005) though they have used different methodologies.

### III. Structural Model, data description and pre-estimation tests

We use the generic regression model proposed by Koujianou-Goldberg and Knetter (1997), which is able to give answers in all three areas of research on prices and exchange rates, i.e., the low of one price (LOP), the ERPT which is of interest for this paper, and the pricing to market.

$$p_t = \alpha + \delta c_t^* + \gamma E_t + \psi y_t + \varepsilon_t \quad (1)$$

Where all variables in equation (1) are in logs and, here  $\{p\}$  is the vector of Hellenic import unit value indices (from Germany, Italy, France and the UK), drawn from the National Statistical Service of Greece (NSSG);  $\{c^*\}$  is the vector of primary "control" variables of the foreign producers cost, drawn from OECD databank, and which is referred to wage rate indices in manufacturing for Germany and Italy, and unit labour cost indices in manufacturing for France and the UK;  $\{E\}$  is the vector of the end of period fixing spot exchange rates of the GRD against all four trade partners home currencies, published by the BoG, which we transformed into indices;  $\{y\}$  represents the vector of other control variables, which in our case, is the index of Hellenic industrial production, used as a proxy for the quarterly import demand shifter, drawn from OECD's databank;  $\{\varepsilon\}$  is a vector of error terms, while the subscript  $t$  denotes the time period (quarters). All indices have the value 1 in the base year 1995.

In the first step of the pre-estimation procedure, i.e., the identification of the time series' properties, we performed formal tests for single unit roots and stationarity, i.e. Phillips-Perron (1988) test, where (PP) uses Newey-West (1987) standard errors to account for serial correlation, and the modified Dickey-Fuller  $t$ -test (DF-GLS test) proposed by Elliott, Rothenberg, and Stock (1996), who have shown that this test has significantly greater power than the previous version of the augmented Dickey-Fuller test<sup>1</sup>. The results are as usual mixed; DF-GLS tests do not reject the null hypothesis of a unit root in all thirteen variables' levels, or they look like I(1). On the other hand, PP tests support the hypothesis that import unit value indexes for Germany, Italy and France as well as the Hellenic industrial production index, are generated from trend stationary processes (TSP), while the foreign producers' cost indexes in the case of Italy, France and the UK are in fact stationary in the levels<sup>2</sup>. However, we are on the side of the sceptics on the importance of these unit root tests (e.g., Sims, 1988; Christiano and Eichenbaum, 1990), so we proceed to an I(1) analysis.

### IV. Econometric estimations

In the second step of the econometric estimation, that is, this of the co-integration analysis the 4-dimensional vector autoregressive (VAR) model is reformulated in the error correction form (VECM, equation 2 below) so as to be able to distinguish between stationarity created by linear combinations, that is the long-run "equilibrium" relationships or by differencing, i.e. the short-run dynamics,

$$\Delta x_t = \alpha \beta' x_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \Phi D_t + u_t, \quad u_t \sim iid N_p(0, \Omega) \quad (2)$$

<sup>1</sup> These unit root test have been performed by STATA release 9.

<sup>2</sup> The estimations are available upon request.

Where  $x_t = (p_{jt}, c_{jt}^*, E_{jt}, y_t)'$  is the data vector to be analyzed, and where  $j$  denotes the aforementioned four trade partners;  $\{D\}$  is a vector of deterministic variables<sup>3</sup>. The model (2) has been estimated<sup>4</sup> through the reduced rank regression methodology or Johansen multivariate cointegration technique (Johansen, 1988; Johansen & Juselius, 1990). In this technique, the most difficult task is to determine the number of cointegrating relations (CVs) against the common trends, by estimating an unrestricted VAR model in the four variables  $\{x\}$  for each one of the four trade partners ( $j$ ). The trace test statistic is firstly used along with testing the adequacy of the estimated model, through graphical inspection of key properties of the variables, misspecification tests of the estimated residuals and recursive estimation procedures for investigating parameters' constancy. Because the power of the trace test can be very low for relevant alternative hypotheses in the neighbourhood of the unit circle, we used, (Juselius, 2005), as much additional information CATS software could offer us, such as (a) the characteristic roots of the model, (b) the  $t$ -values of the  $\alpha$ -coefficients to the  $r^{th}+1$  CV, (c) the graphs of the cointegrating relations, and (d) the economic interpretability of the results. This procedure indicated the presence of two CVs among the variables in each one of the four cases (panel I of Table 2).

As is shown in panel II of Table 2 the exchange rate coefficients have the correct sign and their magnitude are greater than one in the cases of Germany ( $\hat{\gamma} = 1.16$ ) and the UK ( $\hat{\gamma} = 1.71$ ) while near to the unit for Italy ( $\hat{\gamma} = 0.85$ ) and small for France (just  $\hat{\gamma} = 0.45$ ). Because we are working in the context of the "law of one price"-type model [structural equation (1)] the exchange rate coefficients in equation (2) coincide with these of ERPT (Brissimis and Kosma, 2007). Accordingly, in the two out of four Hellenic cases the empirical evidence is in favour of more than complete ERPT on prices of imported goods from Germany and the UK which is an outlier strange case. A border case seems to be the Italian ERPT coefficient which is near to one, while for France which is small, it might be characterised as incomplete ERPT coefficient.

These estimations which are logical (except in the UK case) for a small open economy like Hellas, and higher than Campa & Goldberg (2001, '02) or Campa, Goldberg and Minguez (2005), perhaps because of the different methodology used, it is quite difficult to explain, in a macro-level data used in this study. A disaggregate trade dataset is needed so as to provide the essential justification of the aforementioned results.

Thus, because in 3 out of 4 cases we have evidence in favour of complete long-run ERPT, we may conclude that, the dirty float (sterilized monetary policy conducted by the BoG) was *effective in activating expenditure-switching effects*, during the 80s when the economy was relatively closed, and that's why then that managed float exchange rate regime was preferred. Conversely, since markets' deregulation, due to EEC or EMU state's obligations, the dirty float (strong GRD policy this time) was used as an *effective anti-inflationary instrument*, and consequently fixed exchange rate regime was then preferred.

The explanation factors of these long-run ERPT estimations might also be illuminated for the change in foreign exchange intervention of the BoG towards EMU and joining Euro. These potential explanation factors may be distinguished in internal and external ones. The internal refers to the major post WW-II structural problem of the Hellenic production, i.e., the deficit of the domestic supply of capital goods (Sakkas, 1996). The external explanation factor is the gradual opening of the national economy in its course towards EMU.

The intertemporal structural problem (I>S), established the dependence of the Hellenic production on the respective imports. This dependence on imports produces;

- o First, the pattern of trade (Tsavvas, 2001), mainly expressed by the concentration of the Hellenic import trade, especially in manufacturing, from 4 main origins, (i.e. Germany, Italy, France and the UK, see Table 1), and which, might be a good forecast for the existence of a very low demand for imports' price-elasticities. The latter, may justify our long run ERPT estimations. An exception could be France's case, for which we believe that its trade composition<sup>5</sup> faces more competitive pressures in the price level in the Hellenic import

<sup>3</sup> such as a constant  $\{c\}$ , linear trend and centred seasonal  $\{seas\}$  or intervention dummies, such as,  $Di8034_{t=-1_{(t=1980q3)}+1_{(t=1980q4)}}$  and  $Di8234_{t=-1_{(t=1982q3)}+1_{(t=1982q4)}}$ ,  $Di8112_{t=-1_{(t=1981q1)}-1_{(t=1981q2)}}$ ,  $Di8245_{t=-1_{(t=1982q4)}+1_{(t=1983q1)}}$ ,  $Di9812_{t=-1_{(t=1998q1)}+1_{(t=1998q2)}}$ , which are transitory intervention dummies to accommodate for, shocks in  $p_{jt}$  ( $Di8034$ , and  $Di8234$ ), Hellenic pre-elections period ( $Di8112$ ), or temporary shocks in  $p_{jt}$ , when  $j=UK$  ( $Di8245$  and  $Di9812$ );  $Di8385_{t=1_{(t=1983q1)}-1_{(t=1983q2)}+1_{(t=1985q4)}-1_{(t=1986q1)}}$  is the impulse dummy to accommodate for two de jure devaluations of the GRD in March 1983 and October 1985;  $DS861_{t=1_{(t=1986q1)}}$ , is a shift dummy marking the deceleration of the growth rate of GRD's sliding parity by the BoG.

<sup>4</sup> We used CATS in RATS, version 2, by J.G. Dennis, H. Hansen, S. Johansen and K. Juselius, Estima 2005.

<sup>5</sup> With the exclusion of, road vehicles (78), other transport equipments (79), general industrial machinery and equipment (74), we may mention as an example, iron and steel (67), Cereals and cereal preparations (04), Meat and meat preparations (01) Textile yarn, fabrics, madeup articles, related products (65) etc.



goods' market. Moreover, in manufacturing, there are some categories of the SITC for which the domestic production, either, is non-existent<sup>6</sup>, or, it uses imports as intermediate goods<sup>7</sup> essential for its production.

○ Second, producer currency pricing (PCP) strategies of foreign exporters to Hellas, which is also compatible with full ERPT coefficients, as in our case.

In association with the deficit of domestic supply of capital goods, the external explanation factor, i.e., the country's gradual opening towards EMU (e.g. Giannitsis, 1988; Katseli, 1990) refers to the liberation of the home markets, which is also in line with our complete long-run ERPT estimations.

○ The first sub-period, i.e., from Hellenic accession to the EEC (1981) to the Unified European Act (1987<sup>8</sup>), the goods market liberation, implied, (1) pressures in the infant Hellenic industry, the FX-policy of sliding GRD's left its main protective tool, putting off the necessary real production reforms, and (2) positive wealth effects for the local distributors of foreign PCP exporters to the small domestic economy. Both effects of European imports' deregulation seem compatible with low values of price elasticities demand for imports, which justify our full ERPT estimations.

○ The money and capital home markets deregulation, especially during 1994<sup>9</sup>-98<sup>10</sup> period, provoked the famous Mundell or Policy Trilemma (Rose, 1996), which in the Hellenic case suggested a fixed exchange rate regime, or perhaps for EEC's member countries, joining Euro. This suggestion is implied because, (1) free capital movement policy was an obligation of the Common European Market which became a fact for Hellas since May 1994; (2) Monetary policy autonomy, if any for a small open economy, should be abandoned because of the home markets' deregulation (i.e., managed float does not influence the relative prices, or "...only relatively closed economies can effectively use the exchange rate instrument..." as McKinnon 1963, mentioned); (3) Exchange rate stability was another understanding for application to the EMU. In total, in the framework of the policy trilemma it should be clear that given the authorities' choice for free capital movement and FX-stability (GRD's real appreciation to keep inflation in check through disinflation-competitiveness policy), the complete ERPT estimations, easily emerge as "natural", because of the monetary policy dependence and the competitiveness of foreign exporters.

The substitution effects of the Hellenic foreign exchange intervention were only transitory, as it may be verified from the short run (one quarter) incomplete ERPT into import prices estimations (Table 2, panel IV), which vary between 0.35 (France case), 0.61 (UK) and 0.76 (for Germany). Even though relatively low, these estimated coefficients they do not translate local currency pricing (LCP) behaviour.

These short-run estimated coefficients may be explained within the "contract period" terminology (Magee, 1973) and according to the aforementioned nature of Hellenic imports, as well as from the gradual restoration of local distributors' (of foreign exporters -PCP-) margins so as not to lose their markets' shares.

As regards our estimations of the exchange rate connection or dis-connection to the real Hellenic industrial production these can be seen in Table 2, panel II. These coefficients ( $\Delta y/\Delta E$ ) which are statistically significant and have the right sign, indicate low (0.17 for imported goods from UK and 0.21 for those from France) or zero (for Italian case) reaction of the domestic production to the GRD's crawling peg shocks. However, this low connection of the home production to exchange rate changes became greater (0.58) for the German imported goods. These estimations are almost alike when we restricted the VECM to exclude foreign producers' cost  $\beta_2(c^*) = 0$  (or the constant  $\beta_5(cnst) = 0$ ) from the CVs.

Explanation factors of long-run exchange rate elasticities of income, for Germany, France and UK cases, might be that these imports referred to mainly intermediate goods, necessary for domestic manufacturing, while, there may be present positive wealth effects and moral hazard of local distributors of foreign exporters. The relative Italian coefficient may be due to the fact that imports from this origin do not face domestic substitutes.

Hence, in 3 out of 4 cases the empirical evidence of even low exchange rate connection from the real production (Devereux and Engel, 2002), is equivalent with expenditure-changing effects (Germany, France, UK), pre-requiring non-autonomous monetary policy of the BoG (Laursen-Metzler, 1950, effect, for the alleged insulating power of floating rates, Gandolfo, 2001) and ineffectiveness of managed float, which suggests fixed exchange rate regime, or perhaps joining euro for an EEC member state case. However, the opposite seems true for the Italian case of exchange rate disconnect from the real Hellenic production,

<sup>6</sup> For instance, road vehicles (78), machinery specialized for particular industries (72), other transport equipments (79), general industrial machinery and equipment (74).

<sup>7</sup> For instance, electrical machinery (77), Textile yarn, fabrics, made up articles, related products (65), Leather, leather manufactures, n.e.s. and dressed furs (61), Telecommunications & sound recording apparatus (76), Artificial resins, plastic materials, cellulose esters and ethers (58) etc.

<sup>8</sup> Abolition of Hellenic import tariffs or other trade barriers for intra-EEC imports.

<sup>9</sup> Liberation of Hellenic money and capital markets for intra-EEC trades.

<sup>10</sup> Entrance of the GRD in the Exchange Rate Mechanism II (ERM II) of the European Monetary System (EMS), after its de jure devaluation of 15% against ECU, so as to satisfy the EMU agreement criteria for two years monetary stability before a member state's application.

equivalent with expenditure-switching effects, which, given Optimum Currency Area's single (Ishiyama, 1975) criteria (Mundell, 1961, McKinnon, 1963 and Kenen, 1969), suggests flexible exchange rate regime.

Herein, emerges a kind of exchange rate puzzle, with regard to regime's choice, because in 3 out of 4 cases fixed exchange rate regime is suggested, while, in the Italian case it seems better to choose flexible rates.

The same puzzle is also present in the full long-run ERPT estimated coefficients, which suggest, first, flexible exchange rate regime for the 80s, when Hellenic economy was relatively closed, while, fixed exchange rate regime in the 90s and the deregulation of the domestic markets due to EMU target.

**Table 2 Testing exchange rates pass through into import prices**

	Hellenic-German model		Hellenic-Italian model		Hellenic-French model		Hellenic-UK model	
No of CVs	2		2		2		2	
Trace testa	11.55 [20.16]		18.14 [20.16]		21.38 [20.16]		12.57 [20.16]	
Exactly identifying restrictions (normalizations)								
Coefficients on CVs' variables								
	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_1$	$\hat{\beta}_2$
<i>P</i>	-0.29	1.00	-0.05	1.00	1.00	0.40	-0.04	1.00
<i>C*</i>	1.72	0.24	0.67	-0.43	0.20	-0.42	-0.02	2.10
<i>E</i>	<b>-0.58</b>	<b>-1.16</b>	<b>0.06</b>	<b>-0.85</b>	<b>-.45</b>	<b>-0.21</b>	<b>-0.02</b>	<b>-1.71</b>
<i>Y</i>	1.00	1.87	1.00	-0.09	-2.1	1.00	1.00	-3.37
<i>constant</i>	-0.64	-0.32	-0.22	-0.04	-1.1	0.10	0.03	-0.06
Tests of the same exactly identifying restrictions on all CVs								
Coefficients on CVs' variables								
	$\beta_2(c^*) = 0$						$\beta_5(cnst) = 0$	
<i>P</i>	-0.24	1.00	0.33	1.00	1.00	0.33	0.11	1.00
<i>C*</i>	0.00	0.00	0.00	0.00	0.00	0.00	-0.04	3.91
<i>E</i>	<b>0.34</b>	<b>-1.06</b>	<b>-0.04</b>	<b>-1.50</b>	<b>-.41</b>	<b>-0.49</b>	<b>-0.17</b>	<b>-2.14</b>
<i>Y</i>	1.00	2.01	1.00	-0.79	-1.6	1.00	1.00	-8.29
<i>constant</i>	-0.17	-0.28	-0.19	0.14	-0.92	0.03	---	---
$\chi^2(2)^b$	3.90 [0.14]		4.45 [0.11]		1.76 [0.41]		3.61 [0.16]	
Estimates of the short-run dynamics ( $\Gamma 1$ ) <sup>c</sup>								
	$\Delta p$ -eq.	$\Delta y$ -eq.	$\Delta p$ -eq.	$\Delta y$ -eq.	$\Delta p$ -eq.	$\Delta y$ -eq.	$\Delta p$ -eq.	$\Delta y$ -eq.
$\Delta p_{t-1}$	-0.09 (-0.34)	0.03 (1.85)	0.056 (.59)	-.006 (-.30)	-0.15 (-2.1)	0.058 (2.43)	-0.44 (-4.7)	0.00 (0.02)
$\Delta c^*_{t-1}$	-0.52 (-0.50)	-0.83 (-0.29)	-0.555 (- .49)	-.548 (- 2.3)	1.72 (1.92)	-0.05 (-.17)	-1.26 (-1.8)	0.24 (1.47)
$\Delta E_{t-1}$	<b>0.76</b> (2.60)	-0.07 (-0.92)	<b>0.49</b> (1.46)	.104 (1.46)	<b>0.35</b> (1.90)	-0.07 (-1.1)	<b>0.61</b> (2.20)	0.04 (0.63)
$\Delta y_{t-1}$	-0.37 (-1.16)	-0.25 (-2.88)	-0.347 (-.77)	-.392 (- 4.1)	0.59 (2.09)	-0.29 (-2.9)	-0.78 (-1.8)	-0.15 (-1.4)

Where CVs=cointegrating vectors, eq.=equation.

<sup>a</sup> Numbers in brackets are critical values at the 5% significance level.

<sup>b</sup> Numbers in brackets are p-values.

<sup>c</sup> These are referred to the unrestricted model. Numbers in parentheses report t-values.

## V. Concluding remarks

In this article we have examined ERPT into general import index prices for the major four trade Hellenic partners, namely Germany, Italy, France and the UK, during 1975-1998. By means of time series cointegration techniques we showed that almost complete long run ERPT was verified in three out of four cases (Germany Italy and the UK), and incomplete long run ERPT detected in the case of France. The intertemporal deficit of domestic supply of capital goods, as well as the intervention policies in the context of the policy trilemma, empirically resulted from the country's course towards EMU, provided the framework for the justification of these estimations. These full long run ERPT estimations produce an exchange rate

puzzle, because it suggests flexible rates in the 80s with relatively closed domestic economy, while fixed exchange rate regime in the 90s with the deregulation of the home markets in the effort to accomplish EMU criteria. The incomplete short run (just one quarter) ERPT estimations verified the transitory substitution effects of the managed float of the GRD. In addition the detected exchange rate connection (in almost three out of four cases) from the real Hellenic production lays an argument against managed float and in favour of fixed exchange rates or perhaps joining euro. An exchange rate puzzle again is obviously present here, so a further research, with panel cointegration is needed.

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# NONPARAMETRIC REGRESSION: A BRIEF OVERVIEW AND DEVELOPMENTS

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## Abstract

*A regression curve describes a general relationship between two or more quantitative variables. In a multivariate situation vectors of explanatory variables as well as response variables may be present. For the simple case of one explanatory variable and one response variable,  $n$  data points  $S := \{(X_i, Y_i), i = 1, 2, \dots, n\}$  are collected. The regression relationship can be modeled by  $Y_i = m(X_i) + \varepsilon_i$  where  $m(x) = E(Y|X=x)$  is the unknown regression function and the  $\varepsilon_i$ 's are independent random errors with mean 0 and unknown variance  $\sigma^2$ .*

*Nonparametric methods (i.e. smoothing methods) to obtain consistent estimators  $\hat{m}(x)$  of  $m(x)$  are revised. Nonparametric methods relax on traditional assumptions and usually only assumes that  $m$  belongs to an infinite-dimensional collection of smooth functions.*

*Several nonparametric estimators are discussed, mostly of a weighted average form. Several kernel and nearest neighbour approaches to the weight functions are considered. Each of these estimators depends on a smoothing parameter and the critical issue of estimating it is discussed briefly.*

*The performance of  $\hat{m}(x)$  is assessed via methods involving the mean squared error (MSE) and the mean integrated squared error (MISE).*

*Two methods of improving the performance of  $\hat{m}(x)$  are "boosting" and "bagging", which are respectively an iterative computer intensive method, and an averaging method involving the generation of bootstrap samples. These methods are briefly introduced.*

## 1 Introduction

Strict theories and methodologies played an important role in the development of statistical science. People tend to believe that real data should be analysed using these rules and laws. However, the field of nonparametric regression has developed a variety of mathematically reliable techniques that are not governed by rigid forms such as linear curves or a normal distribution. It is a prominent tool in various fields such as the progress of computers, the advance in neural networks, data mining, modelling, pattern recognition and related subjects. Literature has expanded, as well as the number of software programs available for carrying out nonparametric regression on computers, so that nonparametric statistics are no longer available for only a few specialists, but became indispensable when dealing with diverse problems concerning every day life regarding human beings, nature and society (Takezawa 2006).

The traditional parametric regression curve (also referred to as a regression function or regression equation) describes a general relationship between an explanatory variable  $X$  and a response variable  $Y$ , revealing important information regarding monotonicity, location of special features such as extremes values, and may indicate a tendency of the response variable to vary with the predictor variable in a systematic fashion, or show a special dependence structure. Extension to multivariate situations can be handled in most cases. The present discussion will stick to the univariate case for simplicity, unless stated otherwise.

Suppose  $n$  data points  $\{(X_i, Y_i)\}_{i=1}^n$  have been collected. The regression relationship (function/equation) can be formulated as

$$Y_i = m(X_i) + \varepsilon_i, \quad i = 1, \dots, n, \quad (1)$$

where

$$m(x) = E(Y|X = x) \quad (2)$$

is the unknown regression function. The  $\varepsilon_i$ 's are independent random variables (referred to as "errors") with mean 0 and variance  $\sigma^2$ . The sample of size  $n$  is used to obtain a useful estimate of the regression equation. Roughly it can be said that the estimate  $\hat{m}(x)$  is regarded useful if it tends to  $m(x)$  as  $n \rightarrow \infty$ , when  $m(x)$  is a smooth function and if  $|Y_i - \hat{m}(X_i)| = |\hat{\varepsilon}_i|$  are small values. The  $\hat{\varepsilon}_i$ 's are referred to as residuals. (Watson 1964, Takezawa 2006, p. 359).

This problem can be approached in one of two ways: parametrically or nonparametrically. A parametric regression model assumes that the form of  $m$  is known except for finitely many unknown parameters. If, for example, it is assumed that  $Y = \beta_0 + \beta_1 X + \varepsilon$ , an unknown slope and intercept are assumed, as well as a known linear relationship.  $\beta_0$  and  $\beta_1$  are unknown regression coefficients, also termed parameters. Using an appropriate estimation methodology, it is possible to utilize the data to estimate the parameters  $\beta_0$  and  $\beta_1$  and thereby obtain an estimate of  $m$ . The resulting estimate is a curve that has been selected from the family of curves allowed under the parametric model and conforms to the data in some fashion (Eubank 1988, p. 2). Parametric regression prefers expressions of  $\hat{m}$  with as small a number of parameters as possible and selects a regression equation with a large number of parameters only when good representation of the data demands it. Nonparametric regression focuses mainly on deriving useful trends from the data rather than on the reduction of parameters.

It is often true that a scatterplot of the data indicates a flexible functional form of the regression curve without the restrictions imposed by a parametric model. The rigidity of parametric regression can be overcome by removing the restriction that  $m$  belongs to a parametric family and nonparametric regression techniques (also called smoothing) can be used for analysis (Wand and Jones 1995, p. 3). A nonparametric regression model generally only assumes that  $m$  belongs to some infinite dimensional collection of functions, for example  $m$  may be assumed to be differentiable. Nonparametric modelling assumptions are concerned only with qualitative properties of  $m$ , in contrast to the quite specific assumptions of parametric modelling (Eubank 1988, p. 3).

The nonparametric approach provides a versatile method of exploring a general relationship between two variables, it gives predictions of future observations without referring to a fixed parametric model, it provides a tool for finding and studying the influence of outliers and isolated observations and provides a flexible method of substituting missing values by interpolating between adjacent  $X$ -values. Detection and treatment of extreme points affecting the scale of plots so much that the main body of data may become invisible can be done. Nonparametric smoothing provides a versatile screening method for detecting outliers and diminishes their influence (Härdle 1990).

There are several methods to obtain a nonparametric regression estimate of  $m$ . We will consider smoothers consisting of local averages that give large weight to observations in a small neighbourhood around  $x$  and small or no weight to points more distant from  $x$ . This procedure can be defined as

$$\hat{m}(x) = \frac{1}{n} \sum_{i=1}^n W_{ni}(x) Y_i, \quad (3)$$

where  $\{W_{ni}(x)\}_{i=1}^n$  denotes a sequence of weights which may depend on the whole vector  $\{X_i\}_{i=1}^n$ . In particular, kernel and nearest neighbour approaches for determining the weight function, will be introduced. Smoothers, by definition, average over observations with different mean values. The averaging is controlled by the weight sequence  $\{W_{ni}(x)\}_{i=1}^n$  which is tuned by a smoothing parameter. The smoothing parameter regulates the size of the neighbourhood around  $x$ . Too large a neighbourhood causes oversmooth curves and biased estimates of  $m$ , while too small a number of observations would contribute to a very rough, undersmoothed estimate  $\hat{m}$ , with inflated variability. The smoothing parameter selection problem involves local weighted least squares estimates. Outliers in the  $Y$ 's affects results obtained from the small samples in the neighbourhoods and less weight should be given to outliers. These methods are referred to as robust smoothers (Härdle 1990, p. 16).

Aspects of nonparametric smoothing and more specific kernel and nearest neighbour regression smoothing will be highlighted. The discussion includes a brief distinction between the two design settings that could be used to produce the data. Kernel and nearest neighbour regression estimates are introduced as it appears in

several text books. The performance of an estimator can be assessed via many loss functions. The estimator's Mean Squared Error (MSE) and Mean Integrated Squared Error (MISE) properties, with specific reference to the asymptotic properties of the mentioned estimators will be discussed. The importance of bandwidth selection methods and methods to choose the bandwidth in practice will receive attention. Choosing the kernel function in kernel regression and problems regarding boundary bias, derivative estimation, the polynomial regression approach and the multivariate case will follow. Improving the performance of  $\hat{m}(x)$  by using "boosting" and "bagging" methods will conclude this talk.

## 2 The stochastic nature of the observations

Two possible scenarios for the origin of the data are now discussed (Härdle 1990, Chu and Marron 1991, p. 407), i.e. the fixed and random design settings. The data  $\{(X_i, Y_i)\}_{i=1}^n$  could have been generated from one of two schemes.

### 2.1 Fixed design setting

The fixed design model is concerned with controlled, nonstochastic  $X$ -variables, given by

$$Y_i = m(X_i) + \varepsilon_i, \quad i = 1, \dots, n,$$

where the  $X_i$ 's are nonrandom design points with  $a \leq X_1 \leq \dots \leq X_n \leq b$ , and the  $\varepsilon_i$ 's are independent random variables with mean 0 and variance  $\sigma^2$ . The  $X$ -values are usually chosen by the experimenter, as in a designed experiment, to be equidistributed on an interval  $[a, b]$ . Without loss of generality it can be assumed that  $[a, b] = [0, 1]$  and  $x_i = \frac{i}{n}$ .

### 2.2 Random design setting

The data could have been generated by the random design model. In this setting the data points are thought of as being realizations from a bivariate probability distribution:  $\{(X_i, Y_i)\}_{i=1}^n$  are independent, identically distributed random variables. The model stated in (2) is well defined if  $E(|Y|) < \infty$ . If the joint density  $f(x, y)$  exists, then  $m(x)$  can be calculated as

$$m(x) = \frac{\int y f(x, y) dy}{f(x)}, \quad (4)$$

where  $f(x) = \int f(x, y) dy$  denotes the marginal density of  $X$ . The  $\varepsilon_i$ 's are defined by  $\varepsilon_i = Y_i - m(X_i)$  and assumed to have mean 0 and variance  $\sigma^2$ .

## 3 Smoothing techniques

The topic of smoothing and smoothing techniques will be discussed by referring to three well known text-books (Härdle 1990, Wand and Jones 1995, Fan and Gijbels 1996). Smoothing of a dataset  $\{(X_i, Y_i)\}_{i=1}^n$  involves the approximation of the mean response curve  $m$  in the regression relationship (1). The functions of interest include the regression curve itself, or derivatives or functions of derivatives. The basic idea is that, if  $m$  is believed to be smooth, the information of  $X_i$  near a point  $x$  should contain usable information about the value of  $m$  at  $x$  and should therefore be used to estimate  $m(x)$  (Eubank 1988).

There exist several approaches to the nonparametric regression problem, for example those based on kernel functions, nearest neighbour functions, spline functions and orthogonal series. Kernel and nearest neighbour estimators have the advantage that they are mathematically and intuitively easy to understand and to implement. Within each of these broad classes there are also a variety of approaches. We will look into the Nadaraya-Watson (Nadaraya 1964, Watson 1964), Priestley-Chao (Priestley and Chao 1972) and Gasser-Müller (Gasser and Müller 1979) kernel regression estimators as well as the uniform weights version of the nearest neighbour estimate.

### 3.1 Kernel regression smoothing

The assumption that a data point remote from a point  $x$  carries little information about the value of  $m(x)$  incorporates weight functions surrounding  $x$  and the method of locally weighted averages. The shape of the weight function  $\{W_{ni}(x)\}_{i=1}^n$  is defined by a density function with a scale parameter that adjusts the size and form of the weights near  $x$ . Kernel regression smoothing utilizes a kernel function,  $K$ , as shape function. Such a function is usually a symmetric real-valued probability density that is continuous and bounded, with  $\int K(u)du = 1$ . A variety of different kernels could be used, such as the three basic examples in Table 1.

Kernel	$K(u)$
Gaussian	$\frac{1}{\sqrt{2\pi}}e^{-u^2/2}$
Triangular	$(1 -  u )I( u  \leq 1)$
Epanechnikov	$\frac{3}{4}(1 - u^2)I( u  \leq 1)$

Table 1: Examples of Kernels

More generally, the symmetric Beta family of densities

$$K(t) = \frac{1}{\text{Beta}(1/2, \gamma + 1)} (1 - t^2)_+^\gamma, \quad \gamma = 0, 1, \dots,$$

where the subscript  $+$  denotes the positive part, leads to well known kernel functions. The choices  $\gamma = 0, 1, 2$ , and  $3$  represents respectively the uniform, Epanechnikov and the so-called “biweight” and “triweight” kernel functions. According to Marron and Nolan (1988) this family includes the most widely used kernel functions, also the Gaussian kernel in the limit as  $\gamma \rightarrow \infty$ .

Wand and Jones (1995) show how to construct the kernel estimate by centering a scaled kernel at each observation, for a small set of points. The value of the kernel estimate at the point  $x$  is simply the average of the  $n$  kernel ordinates at that point.

More formally, we let  $h_n$  be a bandwidth which is a nonnegative number controlling the size of the local neighbourhood in the sense that the scale parameter determines the size of the weights (Härdle 1990, p. 24). Denote the weight sequence for kernel smoothers (for one-dimensional  $x$ ) by

$$W_{ni}(x) = \frac{K_{h_n}(x - X_i)}{\hat{f}_{h_n}(x)},$$

where

$$\hat{f}_{h_n}(x) = n^{-1} \sum_{i=1}^n K_{h_n}(x - X_i)$$

and where

$$K_{h_n}(u) = h_n^{-1} K(u/h_n)$$

is the kernel with scale factor  $h_n$ .  $\hat{f}_{h_n}(x)$  is known as the Rosenblatt-Parzen kernel density estimator and was introduced by Rosenblatt (1956) and Parzen (1962) to estimate the marginal distribution of the  $X$ -values, i.e.  $f(x)$ , which is the denominator in (4). Three main kernel estimators for (4) will now be defined.

Nadaraya (1964) and Watson (1964) proposed what is known as the Nadaraya-Watson estimator,

$$\hat{m}_{NW}(x) = \frac{\sum_{i=1}^n K_h(x - X_i) Y_i}{\sum_{i=1}^n K_h(x - X_i)}. \quad (5)$$

Note that the shape of the the kernel weights is determined by  $K$ , whereas the the size of the weights is parameterised by the bandwidth  $h = h_n$ . The above definition is stated for the random design setting, but also holds for the fixed design setting. The denominator is again the Rosenblatt-Parzen kernel density estimator and the numerator of  $\hat{m}_{NW}(\cdot)$  is the analogous estimate of  $\int y f(x, y) dy$ . By using this weight

function ensures that the weights add up to one.

For the fixed design setting with equidistant  $x$ -values chosen within the interval  $[0, 1]$ , Priestley and Chao (1972) defined the following estimator:

$$\hat{m}_{PC}(x) = \frac{1}{n} \sum_{i=1}^n K_h(x - X_i) Y_i. \quad (6)$$

For the random design model, with  $X$ -values chosen between 0 and 1, their estimator is given by:

$$\hat{m}_{PC}(x) = \sum_{i=1}^n (X_i - X_{i-1}) K_h(x - X_i) Y_i, \quad (7)$$

where  $\{(X_i, Y_i)\}_{i=1}^n$  is assumed to be ordered by the  $X$ -values. For the Priestley-Chao estimator the weights do not necessarily add up to one.

Gasser and Müller (1979) suggested a related estimator that modifies the 1972 Priestly-Chao estimator, and which is similar to the estimator of Cheng and Lin (1981):

$$\hat{m}_{GM}(x) = \sum_{i=1}^n Y_i \int_{S_{i-1}}^{S_i} K_h(x - u) du, \quad (8)$$

where  $\{(X_i, Y_i)\}_{i=1}^n$  is assumed to be ordered by the  $X$ -values. The  $S_i$ 's are interpolating the sequence of  $X_i$ 's, i.e., for the random design setting,  $S_0 = -\infty$ ,  $S_n = \infty$  and  $X_i \leq S_i \leq X_{i+1}$ ,  $i = 1, \dots, n-1$ ,  $S_i = \frac{X_i + X_{i+1}}{2}$ . The process is easily adapted for the fixed design setting. The choices of  $S_0$  and  $S_n$  given here ensure that the sum of the weights is one. This will create a strong boundary effect (discussed in more detail later), because observations near the end will receive a large weight. The Gasser-Müller and Priestley-Chao estimators are conveniently defined without the random denominator (see the definition of the Nadaraya-Watson estimator above). This makes both estimators easier to handle when deriving asymptotic properties, for example. For the Gasser-Müller estimator the sum of the weights is one.

### 3.2 Nearest neighbour regression smoothing

The construction of nearest neighbour estimates differs from that of kernel estimators. The kernel estimator  $\hat{m}_h(x)$  was defined as a weighted average of the response variable in a fixed neighbourhood around  $x$ , determined in shape by the kernel  $K$  and the bandwidth  $h$ . The  $k$ -nearest neighbour ( $k$ -NN) estimate is a weighted average in a varying neighbourhood, which is defined through those  $X$ -variables which are among the  $k$ -nearest neighbours of  $x$  in Euclidean distance (Härdle 1990). The  $k$ -NN weight sequence has been introduced by Loftsgaarden and Quesenberry (1965).

Another way to define the weights in (3) is to take the weighted average of a varying neighbourhood, where the number of data points in each strip stays constant. The  $k$ -NN estimate in a point  $x$  calculates the weighted average of the response variables whose corresponding  $X$ -values are among the  $k$ -nearest neighbours of  $x$  in Euclidean distance (Härdle 1990, p. 42).

More formally Härdle (1990, p. 177) defines the  $k$ -NN smoother as:

$$\hat{m}_k(x) = \frac{1}{n} \sum_{i=1}^n W_{ki}(x) Y_i, \quad (9)$$

where  $\{W_{ki}(x)\}_{i=1}^n$  is a weight sequence defined through the set of indices

$$J_x = \{i : X_i \text{ is one of the } k \text{ nearest observations to } x\}.$$

For the  $k$ -NN estimate with uniform weights, the weight sequence is defined through:

$$W_{ki}(x) = \begin{cases} \frac{n}{k}, & \text{if } i \in J_x \\ 0, & \text{otherwise} \end{cases} \quad (10)$$



The smoothing parameter  $k$  regulates the degree of smoothness of the estimated curve. It plays a role similar to the bandwidth for kernel smoothers. According to Härdle (1990) the influence of varying  $k$  on features of the estimated curve is similar to that observed for kernel estimation with a uniform kernel. Härdle (1990) states that the smoothing parameter selection problem is also present in this case:  $k$  has to be chosen as a function of  $n$  or even of the data. Two goals are identified, i.e. firstly to reduce the noise by letting  $k = k_n$  tend to infinity as a function of the sample size, and secondly to keep the approximation error (bias) low. The second goal is achieved if the neighbourhood around  $x$  shrinks asymptotically to zero. We therefore define  $k = k_n$  so that  $k_n/n \rightarrow 0$ . This is conflicting with the first aim because the variance is as small as possible for  $k$ -values as large as possible. This brings us to the trade-off situation again between a good approximation to the regression function and a good reduction of observational noise. Härdle (1990) supplies expressions for the bias and variance of the  $k - NN$ -estimate. The trade-off is achieved asymptotically by setting  $k \sim n^{4/5}$ . This influences the convergence rate of the mean squared error.

### 3.3 Spline smoothing

To motivate the smoothing spline, we first consider the problem of finding a function  $m$  that minimizes the expression  $\sum_{i=1}^n \{Y_i - m(X_i)\}^2$ . Most models are over-parametrized, resulting in estimated parameters with large variability (Fan and Gijbels 1996). In the literature, a penalty for over-parametrization was considered and introduced via the roughness, measured by  $\int \{m''(x)\}^2 dx$ . The resulting penalizing least squares regression goal is: find  $\hat{m}_\lambda$  that minimizes

$$\sum_{i=1}^n \{Y_i - m(X_i)\}^2 + \lambda \int \{m''(x)\}^2 dx \quad (11)$$

for a nonnegative real number  $\lambda > 0$ , also called the smoothing parameter. The first part of the expression penalizes the lack of fit which is in some sense the modelling base and the second part puts a penalty on the roughness, which relates to the over-parametrization. If  $\lambda = 0$  or if  $\lambda = +\infty$  the estimate ranges from the complex interpolation model to a simple linear model respectively, indicating that the model complexity of the smoothing spline approach is effectively controlled by the smoothing parameter  $\lambda$ . The estimator  $\hat{m}_\lambda$  is called the smoothing spline estimator.

$\hat{m}_\lambda$  is defined implicitly as the solution to a functional minimization problem. To judge the behaviour of the estimator and to see how the data react to the estimator are not possible in a straight forward manner. However, Härdle (1990) points out that  $\hat{m}_\lambda$  is in fact a weighted average of the  $Y$ -observations, i.e.

$$\hat{m}_\lambda(x) = n^{-1} \sum_{i=1}^n W_{\lambda i}(x) Y_i.$$

Silverman (1982) (Theorem A) showed that the effective weight function  $W_{\lambda i}(\cdot)$  looks like a kernel  $K_s$ , where the kernel function  $K_s$  is given by

$$K_s = 1/2 \exp(-|u|/\sqrt{2}) \sin(|u|/\sqrt{2} + \pi/4).$$

Also, Härdle (1990) states that for large  $n$ , small  $\lambda$  and  $X_i$  not too close to the boundary, the weight function of interest is

$$W_{\lambda i}(\cdot) \approx f(X_i)^{-1} h(X_i)^{-1} K_s \left( \frac{\cdot - X_i}{h(X_i)} \right)$$

and the local bandwidth  $h(X_i) = \lambda^{1/4} n^{-1/4} f(X_i)^{-1/4}$ .  $K_s$  is a symmetric kernel function with negative lobes and vanishing second moment, i.e.  $\int u^2 K_s(u) du = 0$ . A survey of the literature on the question of how much to smooth regarding mean squared error properties can be found in Eubank (1988). The smoothing parameter selection problem (optimizing  $\lambda$ ) studies convergence rates of the splines and related issues have been studied especially by Grace Wahba in several publications (see Härdle (1990), Chapter 3).

Statistical software packages computing the spline coefficients of the local cubic polynomials require a bound  $\Lambda$  on the sum of squares  $\sum_{i=1}^n \{Y_i - m(X_i)\}^2$ . These programs solve  $\lambda \int \{m''(x)\}^2 dx$  under the constraint  $\sum_{i=1}^n \{Y_i - m(X_i)\}^2 \leq \Lambda$ . A connection between the two parameters  $\lambda$  and  $\Lambda$  is provided in Härdle (1990).

The smoothing parameter  $\lambda$  can be chosen by using the data (Fan and Gijbels 1996). One way of selecting  $\lambda$  is to minimize the cross-validation (*CV*) criterion

$$CV(\lambda) = n^{-1} \sum_{i=1}^n \{Y_i - \hat{m}_{\lambda,i}(X_i)\}^2,$$

where  $\hat{m}_{\lambda,i}$  is the estimator satisfying (11) without using the  $i^{\text{th}}$  observation (Allen 1974, Stone 1974). Cross-validation methods are computer intensive, especially the improved generalized cross-validation method (*GCV*) proposed by Wahba (1977). This method is explained and discussed by Fan and Gijbels (1996), paragraph 2.6. Fast computation issues of smoothing splines can be found in Eubank (1988) and Wahba (1990).

### 3.4 Treatment of outliers

The treatment of outliers or extreme points needs consideration when exploring features of a data set (Härdle 1990). By applying some diagnostic techniques for parametric models may cope with outliers but often extreme points dominate the rest of the observations and affect the structures of the data as well as the resulting analysis. In regression, outliers are powerful in the sense that any smoother based on local averages that is applied to data will exhibit the tendency to follow the outlying observations. Methods for coping with outliers are referred to as robust or resistant.

#### 3.4.1 Median smoothing

Median smoothing is a straightforward resistant technique. It is an approximating technique where the conditional median curve  $\text{med}(Y|X = x)$  rather than the conditional mean curve is of importance. Median smoothing is a highly robust technique since the extreme response observations do not have any effect on the local median of the response variables. The downside of median smoothing is that it produces a rough, wiggly curve. Velleman (1980) and Mallows (1980) developed remedial resmoothing and twicing techniques to improve the process of median smoothing.

#### 3.4.2 *L*-smoothing

In this method, local trimmed averages of the response variable are used instead of the local means or local medians. If  $Z_{(1)}, Z_{(2)}, \dots, Z_{(N)}$  denote the order statistics from  $N$  observations  $\{Z_j\}_{j=1}^N$ , a trimmed mean is defined by

$$\bar{Z}_\alpha = (N - 2[\alpha N])^{-1} \sum_{j=[\alpha N]}^{N - [\alpha N]} Z_{(j)}, \quad 0 < \alpha < 1/2,$$

i.e. the mean of the inner  $100(1 - 2\alpha)$  percent of the data. Asymptotic results for *L*-smoothers were derived by Stute (1984), Owen (1987) and Härdle, Janssen and Serfling (1988).

#### 3.4.3 *R*-smoothing

This is a procedure motivated by rank tests. Cheng and Cheng (1987) developed asymptotic results for *R*-smoothing methods.

### 3.4.4 $M$ -smoothing

$M$ -smoothing is an outlier resistant smoothing technique, based on  $M$ -estimates of location. Cox (1983) defined an  $M$ -type spline

$$\arg \min_m \left\{ n^{-1} \sum_{i=1}^n \rho(Y_i - m(X_i)) + \lambda \int [m''(x)]^2 dx \right\}$$

where  $\rho$  is a loss function with lighter tails than the usual quadratic form. Several authors considered  $M$ -smoothers (Härdle 1990). The kernel  $M$ -smoother is implicitly defined and requires iterative numerical methods of which some existing methods are fast algorithms (see Härdle (1990), Chapter 6). The question is how to determine the amount gained or lost in asymptotic accuracy when using  $M$ -smoothers. The bias is the same as for kernel smoothers, so that the ratio of asymptotic variances must be studied (Huber 1981). Literature reveals that the influence of outliers is obviously reduced by using  $M$ -smoothers.

## 3.5 Local polynomial fitting

Fan and Gijbels (1996) provide a brief summary of the basic literature of local polynomial fitting. The issue of derivative estimation is closely linked to this topic. The  $\gamma$ -th derivative of  $m(x)$  is denoted by  $m^{(\gamma)}(x)$ . Fan and Gijbels (1996) summarise the procedure as follows:

Suppose that the regression function can locally be approximated by

$$m(x) \approx \sum_{j=0}^p \frac{m^{(j)}(x)}{j!} (z-x)^j \equiv \sum_{j=0}^p B_j (z-x)^j$$

for  $z$  in a neighbourhood of  $x$ , by using Taylor expansions. This is a simple local polynomial model, which suggest locally weighted regression

$$\sum_{i=1}^n \left\{ Y_i - \sum_{j=0}^p \beta_j (X_i - x)^j \right\}^2 K_h(X_i - x)$$

where  $K_h(\cdot)$  denotes a kernel function and  $h$  is a bandwidth.

Important issues such as the choice of the bandwidth parameter  $h$ , the order of the local polynomials and the choice of the kernel function  $K$  are discussed in Fan and Gijbels (1996), Chapter 3. The main advantage of local polynomial fitting procedures is that the bias at the boundary points stays at the same order as the inner-point bias. No boundary modifications or boundary kernels are required. This is a great advantage since boundary modifications in higher dimensions are difficult to achieve. The method is easily applied to censored data.

## 4 Measuring the discrepancy

Discrepancy measures between the estimator and the true regression function are defined and ways to evaluate these expressions are suggested from the literature. The measures can be evaluated pointwise (for a specific value of  $x$ ), or globally.

### 4.1 Pointwise measures

#### 4.1.1 The mean squared error

A popular pointwise discrepancy measure is the mean squared error (MSE) (Wand and Jones 1995). The MSE of  $\hat{m}(x)$  at some point  $x \in \mathbb{R}$  is defined as:

$$\text{MSE}[\hat{m}(x)] = E[\hat{m}(x) - m(x)]^2. \quad (12)$$

The aim is to choose an estimator that minimizes the MSE. Although other criteria such as the mean absolute error  $\text{MAE}[\hat{m}(x)] = E[|\hat{m}(x) - m(x)|]$  exist, Wand and Jones (1995, p. 14) argue that the MSE is preferred, due to its mathematical simplicity.

A feature of the MSE is that it can be written as the sum of the variance and the squared bias of the estimator:

$$\text{MSE}[\hat{m}(x)] = \text{Var}(\hat{m}(x)) + [E(\hat{m}(x)) - m(x)]^2. \tag{13}$$

Estimators for  $\text{Var}(\hat{m}(x))$  and  $[E(\hat{m}(x)) - m(x)]^2$  are available so that this decomposition is very useful in the analysis and interpretation of the estimator. Important questions regarding the rate at which the MSE tends to zero, why this measure of accuracy should only be computed in one point, and why not rather investigate the more global measures such as the mean integrated squared error (MISE), are answered in standard textbooks (Härdle 1990).

#### 4.1.2 Asymptotic mean squared error results

The MSE relies on the bandwidth  $h$  (or  $k$  for the  $k$ -NN estimator) in a complex way. Wand and Jones (1995, p. 19) pointed out that large sample approximations for the leading bias and variance terms help interpretation of the measures concerned. The asymptotic bias and variance of the estimators under consideration have been studied extensively in the literature. Tables 2 and 3 provide some theoretical approximation results for the fixed and random design cases respectively, given that specific assumptions hold and  $c_K$  and  $d_K$  are defined as:

$$c_K = \int K^2(u)du \tag{14}$$

$$d_K = \int u^2 K(u)du \tag{15}$$

Estimator	Bias	Variance	Reference
Nadaraya-Watson	$\frac{h^2}{2} d_K m''(x)$	$\frac{\sigma^2}{nh} c_K$	Gasser and Müller (1984, p. 175)
Priestley-Chao	$\frac{h^2}{2} d_K m''(x)$	$\frac{\sigma^2}{nh} c_K$	Bias: Priestley and Chao (1972, p. 389) Variance: Chu and Marron (1991, p. 410)
Gasser-Müller	$\frac{h^2}{2} d_K m''(x)$	$\frac{\sigma^2}{nh} c_K$	Mack and Müller (1989, p. 230)
$k$ -NN	$\frac{1}{8} \left(\frac{k}{n}\right)^2 d_K m''(x)$	$\frac{2\sigma^2}{k} c_K$	(Härdle 1990, p. 76)

Table 2: Asymptotic MSE properties: Fixed design model

It is clear that the first two entries in Table 2 have the same mean squared error properties for the fixed equispaced design case. The  $k$ -NN estimator behaves like a kernel estimator for the choice  $h = \frac{k}{2n}$ . Computations for equispaced uniform  $X_i = i/n$  values showed that the  $k$ -NN estimator  $\hat{m}_k$  and the kernel estimator  $\hat{m}_h$  coincide for  $k$  roughly equal to  $2nh$  (Härdle 1990). From Table 3, the bias and variance are complicated functionals of  $m$  and of the density  $f$  for the random design case. For the random design setting additional assumptions are made.

In all of the bias-variance combinations in Tables 2 and 3 we notice that a choice of  $h$  (or  $k$ ) that will reduce the bias will cause an increase in variance and vice versa. In order to find an optimal bandwidth that solves this trade-off problem we will have to solve what is called the “smoothing parameter problem”. This topic is further discussed in Section 5.

Estimator	Bias	Variance	Reference
Nadaraya-Watson	$\frac{h^2}{2} d_K \left( m''(x) + \frac{2m'(x)f'(x)}{f(x)} \right)$	$\frac{\sigma^2}{f(x)nh} c_K$	Härdle (1990, p. 77)
Gasser-Müller	$\frac{h^2}{2} d_K m''(x)$	$\frac{3\sigma^2}{2f(x)nh} c_K$	Härdle (1990, p. 77)
$k$ -NN	$\frac{1}{24} \left( \frac{k}{n} \right)^2 \frac{m''(x)f(x) + 2m'(x)f'(x)}{f^3(x)}$	$\frac{\sigma^2}{k}$	Härdle (1990, p. 43)

Table 3: Asymptotic MSE properties: Random design model

## 4.2 Global measures

Global measures that represent the discrepancy over the entire range of  $X$ -values exist and (Härdle 1990, p. 90) defines a variety of such “global” measures.

a) The integrated absolute deviation:

$$d_L(\hat{m}, m) = \left[ \int |\hat{m}(x) - m(x)| f(x) w(x) dx \right],$$

where  $w$  denotes a weight function.

b) The integrated squared error (ISE):

$$d_I(\hat{m}, m) = \int (\hat{m}(x) - m(x))^2 f(x) w(x) dx,$$

c) The averaged squared error (ASE):

$$d_A(\hat{m}, m) = \frac{1}{n} \sum_{i=1}^n (\hat{m}(X_i) - m(X_i))^2 w(X_i),$$

d) The maximal absolute deviation:

$$d_{L_\infty}(\hat{m}, m) = \sup_{x \in \mathcal{X}} |\hat{m}(x) - m(x)|,$$

where the  $\sup_x$  ranges over a set  $\mathcal{X} \in \mathfrak{R}^d$  of interest.

e) A conditional version of  $d_A$  is:

$$d_C(\hat{m}, m) = E\{d_A(\hat{m}, m) | X_1, \dots, X_n\}$$

The distance  $d_C$  is a random distance throughout the distribution of the  $X$ 's.

The above measures are global in the sense that they cover the whole curve. However, it is based on only the data set at hand. To recover the whole curve over the entire population the expected value of the integrated squared error (ISE) is taken, called the mean integrated squared error (MISE):

$$\text{MISE} = E(d_I(\hat{m}, m)).$$

Usually most error calculations expand in a way to show that kernel smoothers converge in the above global measure of accuracy to the true curve. It is, however, important to exactly quantify the speed of convergence over a class of functions (Härdle 1990). Wand and Jones (1995) state that a problem of the MSE and MISE expressions is that they depend on the bandwidth in a complicated way, which makes the interpretation of the influence of the bandwidth on the performance of the estimators difficult. Large sample approximations of the variance and bias terms play an important role in solving the dilemmas as Wand and Jones (1995) pointed out by deriving expressions for MISE under conditions on  $K$ ,  $h$  and  $m$ .

## 5 Choosing the smoothing parameter

The choice of smoothing parameter is critical to the performance of nonparametric regression estimators. A vast literature exists regarding the choice of smoothing parameters and only brief discussions of the basic ideas follow below.

### 5.1 Methods for choosing the smoothing parameter

Härdle (1990) states that the accuracy of kernel smoothers when estimating  $m$  or derivatives of  $m$  is a function of the kernel  $K$ , but more importantly, of the bandwidth  $h$ . In real life situations, the underlying regression curve  $m$  is unknown. This implies that the ASE, ISE or MISE defined in the paragraph above cannot be calculated. We need to estimate these theoretical measures and hope that the bandwidths that minimize the estimates would also minimize their corresponding theoretical measures. The following methods deserve attention:

#### 5.1.1 Cross-validation

The leave-one-out cross-validation method utilizes the regression smoother in which the  $j^{\text{th}}$  observation is deleted when the estimate  $\hat{m}$  is calculated in the point  $X_j$ :

$$\hat{m}_{h,j}(X_j) = \frac{1}{n} \sum_{i=1, i \neq j}^n W_{hi}(X_j) Y_i. \quad (16)$$

The resulting cross-validation function is given by the (weighted) sum of the squared deleted residuals

$$CV(h) = \frac{1}{n} \sum_{j=1}^n [Y_j - \hat{m}_{h,j}(X_j)]^2 w(X_j). \quad (17)$$

The cross-validation method chooses the bandwidth that minimizes  $CV(h)$ .

#### 5.1.2 Penalizing functions

Another solution to the problem of having a biased estimate of ASE, say  $p(h)$ , is to multiply  $p(h)$  by a correction factor that will cause the asymptotic cancellation of the bias. A penalizing function  $\Xi(u)$  with first order Taylor expansion  $\Xi(u) = 1 + 2u + O(u^2)$ ,  $u \rightarrow 0$ , is introduced. The prediction error is adjusted by  $\Xi(n^{-1}W_{hj}(X_j))$ , i.e. it is modified to

$$G(h) = n^{-1} \sum_{j=1}^n (Y_j - \hat{m}_h(X_j))^2 \Xi(n^{-1}W_{hj}(X_j)) w(X_j).$$

This results in writing  $G(h)$  in three terms. The second and third cancel out and the first term is independent of  $h$ .  $G(h)$  is then roughly equal to  $d_A(\hat{m}_h, m)$ . Some examples of penalizing functions include:

Generalized cross-validation (Craven and Wahba 1979),

$$\Xi_{GCV}(n^{-1}h^{-1}) = (1 - n^{-1}h^{-1}K(0))^{-2};$$

Akaike's information criteria (Akaike 1974),

$$\Xi_{AIC}(n^{-1}h^{-1}) = \exp(2n^{-1}h^{-1}K(0));$$

Finite prediction error (Akaike 1970),

$$\Xi_{FPE}(n^{-1}h^{-1}) = (1 + n^{-1}h^{-1}K(0))/(1 - n^{-1}h^{-1}K(0));$$

A model selector of (Shibata 1981),

$$\Xi_S(n^{-1}h^{-1}) = 1 + 2n^{-1}h^{-1}K(0);$$

The bandwidth selector  $T$  of (Rice 1984a),

$$\Xi_T(n^{-1}h^{-1}) = (1 - 2n^{-1}h^{-1}K(0))^{-1}.$$

### 5.1.3 The plug-in method

A third method to find a data-driven optimal bandwidth is to find the theoretical expression of  $h$  that will minimize the asymptotic MSE which was discussed in Section 4.1. The plug-in procedure in the random design setting for example, is therefore based on the asymptotic expansion of the squared error for kernel smoothers:

$$MSE = n^{-1}h^{-1}\sigma^2(x)c_K/f(x) + h^4[d_K(m''(x) + 2m'(x)(f'/f)(x))/2]^2.$$

The unknown parameters in this expression, such as  $m''(x)$ ,  $m'(x)$  and  $\sigma^2(x)$ , should then be estimated by using the data. This method is less popular, even though it achieves the same efficiency as the cross-validation and penalizing-function methods.

### 5.1.4 Remark

Which method to apply to optimize  $h$  is no easy task. Härdle and Marron (1985a) and Härdle and Marron (1985b) stated six conditions and formulated the bandwidth selection rule: Choosing  $\hat{h}$  to minimize  $CV(h)$  or  $G(h)$  is asymptotically optimal. Both cross-validation and penalizing functions yield asymptotically optimal bandwidths under certain assumptions (Härdle and Marron 1985a, Härdle and Marron 1985b). Härdle (1990) provides valuable discussions and remarks regarding this topic in Chapter 5, and reminds that selecting the smoothing parameter in derivative estimation is similar to finding a bandwidth for estimating  $m$  itself.

## 6 Choosing the Kernel

The aim is to find a suitable estimate  $\hat{m}$  for the unknown  $m$  by using the data set at hand. A “good” choice for  $\hat{m}$  (i.e. a choice for which the discrepancy measure such as those defined in Section 4 is small) was associated with finding the optimal bandwidth. The discrepancy measures such as the MSE and MISE also depend on the kernel function through  $c_K$  and  $d_K$ , defined in (14) and (15) respectively. Härdle (1990, p. 134) showed that the minimal MSE depends on the kernel,  $K$ , through the factor  $c_K^2 d_K$ . We need the kernel  $K$  that minimizes this expression. For density estimation Epanechnikov (1969) derived an optimal kernel with respect to the MSE. Gasser, Müller and Mammitzsch (1985) derived optimal kernels with respect to the MSE for the estimation of the  $v^{\text{th}}$  derivative of  $m$  where  $m$  is assumed to be  $p$ -times differentiable. The question: how important is the choice of the kernel, i.e. what is the influence of choosing a suboptimal kernel, needs to be answered. To do this, the efficiency ratio:  $D(K_{opt}, K) = \frac{c_K^2 d_K}{c_{K_{opt}}^2 d_{K_{opt}}}$ , must be considered where  $K_{opt}$  denotes the optimal kernel and  $K$  is a suboptimal kernel in question.

$v$	$p$	Kernel $K_{opt}(u)$
0	2	$(3/4)(-u^2 + 1)I( u  \leq 1)$
0	4	$(15/32)(7u^4 - 10u^2 + 3)I( u  \leq 1)$
1	3	$(15/4)(u^3 - u)I( u  \leq 1)$
1	5	$(105/32)(-9u^5 + 14u^3 - 5u)I( u  \leq 1)$
2	4	$(105/16)(-5u^4 + 6u^2 - 1)I( u  \leq 1)$
2	6	$(315/64)(77u^6 - 135u^4 + 63u^2 - 5)I( u  \leq 1)$

Table 4: Optimal kernels with respect to the MSE

## 7 Behaviour at the boundary

For both kernel and nearest neighbour regression estimation there is a considerable increase in bias near the boundaries of the data interval. The idea is intuitively simple, especially for small samples: at the boundary fewer observations can be averaged and thus variance or bias can be affected. For example, suppose that  $x \in [0, 1]$ . Whenever  $x \in [0, h) \cup (1-h, 1]$  the window over which the local average is to be computed, becomes

asymmetric, since the effective window is  $[x - h, x + h]$  which is not fully contained in  $[0, 1]$ , resulting in an increase in bias in the boundary region  $[0, h) \cup (1 - h, 1]$ .

Asymptotically the MSE reflects this problem only in the end points 0 and 1. The boundary effects vanish asymptotically for all interior points,  $x \in (0, 1)$  (Müller 1988, p. 32). However for global measures, such as the MISE, the influence of the increased bias in the limit points 0 and 1 dominates the measure. Gasser and Müller (1979, p. 58) showed that the bias becomes worse for higher order kernels.

From the above discussion it is clear that boundary bias is a problem, whether we look at it from a finite sample or asymptotic point of view. One way to deal with this problem is to use “boundary kernels”. See Gasser and Müller (1979), Gasser and Müller (1984) and Rice (1984b) for further discussions of this topic. As mentioned before, local polynomial fitting offers a partial solution to this problem as well.

## 8 Estimating derivatives of $m$

Kernel estimation can be used to estimate derivatives of  $m$  as well. We simply replace the weights in (3) by its derivatives, which implies differentiating the kernel function. For example, using the Priestley-Chao weights in the equidistant design setting, taking the  $k$ -th derivative with respect to  $x$  gives

$$\hat{m}_h^{(k)}(x) = n^{-1}h^{-(k+1)} \sum_{i=1}^n K^{(k)}\left(\frac{x - X_i}{h}\right) Y_i.$$

This estimate of the  $k$ -th derivative of  $m$  is thus a local average of the response variables in which the  $k$ -th derivative of the kernel weights have been used as weights (Härdle 1990). As for kernel estimation of  $m$ , the aim is to find an estimate that converges to the derivative under consideration. If the weights adhere to certain smoothness conditions and the smoothing parameter is suitable, convergence is achieved. See Härdle (1990, p. 32) for a more detailed discussion.

## 9 Multidimensional predictor variables

Our discussion thus far was confined to the case of univariate design points. The ideas in this chapter can be extended to the case where multidimensional fixed predictor variables,  $\mathbf{x}_i = (x_{i1}, \dots, x_{id})$ , or multidimensional random predictor variables,  $\mathbf{X}_i = (X_{i1}, \dots, X_{id})$ , are present. The multivariate fixed and random design models are notationally analogues to the models in Section 3, except that  $K$ ,  $x$ ,  $x_i$  and  $X_i$  are replaced by their multivariate extensions, where the multidimensional product kernel function is defined by  $K(u_1, \dots, u_d) = \prod_{j=1}^d K(u_j)$ .

## 10 Boosting

Boosting is a general method for improving the accuracy of any given learning algorithm (Schapire 1999, p. 1). It was proposed by Schapire (1990) and Freund (1995) in the context of machine learning. This method attracted much attention in the machine learning community, mainly because of its good empirical performance (Lutz, Kalisch and Bühlmann 2008, p. 3331). In the regression context some boosting algorithms were proposed, but it was not until Breiman (1999) showed that boosting can be viewed as a functional gradient descent algorithm that practical boosting algorithms for regression was possible (Lutz et al. 2008, p. 3331). Boosting connects statistics and numerical minimization (Lutz and Bühlmann 2006) and Friedman (2001) developed boosting methods for regression which involve minimizing the squared error loss function, known as  $L_2$ -boosting (Bühlmann 2006).

### 10.1 Boosting for regression

For univariate regression the learning problem is based on a dataset  $S = \{(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)\}$ , where  $x_i \in X$ , the range of possible values the predictor variable can attain, and  $y_i \in \mathbb{R}$  implying that  $y_i$  can take on real values, rather than being restricted to a finite set (Meir and Rätsch 2003, p. 165).



Several boosting methods for regression have been proposed. Initially these methods involved the reduction of the regression problem to a classification problem. The AdaBoost.R algorithm, proposed by Freund and Schapire (1997), is one example of this approach. These methods are however subject to several drawbacks. In the regression context some boosting algorithms were proposed, but Breiman (1999) laid the ground for a functional gradient descent (FGD) view of boosting that made practical boosting algorithms for regression possible (Lutz et al. 2008, p. 3331). We will skip the earlier developments and immediately proceed to  $L_2$ -boosting.

## 10.2 $L_2$ -boosting

Bühlmann and Hothorn (2007, p. 483) present  $L_2$ -boosting as the “simplest and perhaps most instructive boosting algorithm” that is “very useful for regression, in particular in presence of very many predictor variables”. Basically this algorithm starts off by fitting some initial learner, like fitting the base procedure to the original data, then uses the residuals from the previous iteration as new response vector and refits the base procedure and so on (Bühlmann and Yu 2006, p. 1003).

Bühlmann and Hothorn (2007, p. 483) present the  $L_2$ -boosting algorithm of Friedman (2001) as follows:

1. Fit an initial learner,  $\hat{m}_0(\cdot)$ . The default value is  $\hat{m}_0(\cdot) \equiv \bar{Y}$ . Set  $t = 0$ .
2. Let  $t=t+1$ . Compute the residuals,

$$U_i = Y_i - \hat{m}_{t-1}(X_i), i = 1, \dots, n.$$

3. Fit the residual vector  $U_1, U_2, \dots, U_n$  to  $X_1, X_2, \dots, X_n$  by the base procedure. Call this fit  $\tilde{m}_t(\cdot)$ .
4. Update

$$\hat{m}_t(\cdot) = \hat{m}_{t-1}(\cdot) + \nu \tilde{m}_t(\cdot),$$

where  $0 < \nu \leq 1$  is a real-valued step-length factor, as in the general FGD algorithm.

5. Repeat steps 2 to 4 until  $t=T$ , where  $T$  is some stopping value for the number of iterations.

Tukey (1977) has already proposed this method for one iteration, i.e.  $t = 2$  and  $\nu = 1$  under the name “twicing”.  $L_2$ -boosting can be used for both regression and classification.

## 10.3 Regularization in $L_2$ -boosting

Boosting until  $T = \infty$  is typically not a good idea. The MSE with  $T = \infty$  is not smaller than the noise level  $\sigma^2$ . This is due to the fact that repeating the boosting process infinitely many times yields the fully saturated model that exactly fits the data - that is, the bias is zero, but the variance is  $\sigma^2$ . Regularization is needed by controlling the number of boosting iterations,  $T$ . When working with real data, this implies monitoring an estimate of the MSE, for example by using cross-validation (Bühlmann and Yu 2003, p. 328). Bühlmann and Yu (2003, p. 327) discuss the regularization problem for  $L_2$ -boosting in the case of symmetric linear learners, such as smoothing splines. They proved a very interesting bias-variance trade-off, uncommon in literature: as the number of boosting iterations,  $T$ , varies, both the bias and variance terms change exponentially, with the bias decreasing exponentially fast and the variance increasing exponentially slow. This is in contrast with the standard algebraic trade-off commonly seen in nonparametric estimation. The advantage of this new exponential trade-off is a flatter near-optimal region for the optimal  $T$ : the trade-off not only gets very close to the optimal MSE, but also stays quite flat afterwards.

The need for regularization provides insight in the requirement that a “weak” learner, that is a learner with sufficiently low variance, should be used for boosting. If the learner is too strong (follows the data too closely) then even after one boosting iteration the MSE will increase, rather than decrease (Bühlmann and Yu 2003, p. 336).

## 10.4 $L_2$ -boosting for the Nadaraya-Watson regression estimator

Suppose that the aim is to estimate  $m(x) = E[Y|X = x]$ , given a sample  $S$ . Kernel regression estimators can be implemented. Marzio and Taylor (2008) proposed using the Nadaraya-Watson (N-W) kernel regression estimator as base learner which could be boosted for better performance. Recall that the N-W estimator is given by (5). The method can be described by the following algorithm  $L_2$ -boostNW:

1. Fit an initial learner,  $\hat{m}_0(\cdot)$  by fitting the N-W regression estimator to the original data:  $\hat{m}_0(\cdot) \equiv \hat{m}_{NW}(\cdot)$ , using some bandwidth,  $h$ . The bandwidth can be chosen by cross-validation, or using penalizing functions. Set  $t = 0$ .
2. Let  $t=t+1$ . Compute the residuals,

$$U_i = Y_i - \hat{m}_{t-1}(X_i), i = 1, \dots, n.$$

3. Fit the residual vector  $U_1, U_2, \dots, U_n$  to  $X_1, X_2, \dots, X_n$  by the N-W estimator. Call this fit  $\tilde{m}_t(\cdot)$ .
4. Update

$$\hat{m}_t(\cdot) = \hat{m}_{t-1}(\cdot) + \nu \tilde{m}_t(\cdot),$$

where  $0 < \nu \leq 1$  is a real-valued step-length factor. Marzio and Taylor (2008) chose  $\nu = 1$ .

5. Repeat steps 2 to 4 until  $t=T$ , where  $T$  is some stopping value for the number of iterations.

## 10.5 Features of $L_2$ -boostNW

1. Choice of the kernel

When describing the properties of  $L_2$ -BoostNW, Marzio and Taylor (2008) found by setting conditions for the characteristic roots of some square matrix, that not many popular kernel functions hold this property, such as the Epanechnikov, Biweight and Triweight kernels. Gaussian and Triangular kernels do yield strictly positive characteristic roots and could be used. This phenomenon is surprising, since the choice of kernel as described in Section 6 is often done merely by computational convenience.

2. Bias-variance trade-off

Marzio and Taylor (2008, p. 2487) show that, similar to the case where  $L_2$ -boosting was applied to symmetric learners, an exponential bias-variance trade-off occurs: the bias decreases exponentially fast towards zero, while the variance increases exponentially slow towards  $\sigma^2$ . Once again the suboptimal area is quite flat, resulting in a resistance to overfitting. They note that bandwidth selection should take into account the optimal pair  $(h, T)$  (i.e. not  $T$  and the bandwidth  $h$  separately), where  $T$  denotes the number of boosting iterations and  $h$  the bandwidth. This could be done by cross-validation when working with real data. However, boosted kernel estimators seem to be less sensitive to the bandwidth choice than standard kernel regression estimators. Regularizing through oversmoothing in conjunction with many boosting iterations increases the combinations of  $(h, T)$  for which boosting works. Therefore, an accurate bandwidth selection and stopping rule are needed (Marzio and Taylor 2008, p. 2492).

3. Asymptotic properties after one boosting iteration

In Section 4.1 the asymptotic bias and variance for the N-W regression estimate are provided, given that a set of conditions hold. Note that the bias is  $O(h^2)$ . Marzio and Taylor (2008, p. 2487) show that the asymptotic MSE properties of a once boosted N-W estimator are as follows:  $\text{Bias}[\hat{m}_1(x)] = o(h^2)$  and  $\text{Var}[\hat{m}_1(x)] \leq 4\text{Var}[\hat{m}_0(x)]$  under the usual set of assumptions. Thus bias is reduced from  $O(h^2)$  to  $o(h^2)$ . Since at the first step the magnitude order of the variance is preserved, the MSE is reduced if  $n$  is large enough.

4. Comparison with boosted splines

By using simulation studies, Marzio and Taylor (2008, p. 2491) show that  $L_2$ -boostNW outperforms boosted splines, suggested by Bühlmann and Yu (2003), for all sample sizes used in the study. This is the case even though the N-W base learner is asymptotically inferior to splines. This phenomenon confirms the need for a weak learner to employ boosting.

## 10.6 Extension to the multivariate case

As stated before, boosting is especially effective in the case of multiple predictor variables. Marzio and Taylor (2008, p. 2493) extend their method to the multivariate case:

Suppose that  $d$ -dimensional data,  $S = \{(\mathbf{X}_1, Y_1), (\mathbf{X}_2, Y_2), \dots, (\mathbf{X}_n, Y_n)\}$  are given, where each predictor variable has  $d$  dimensions,  $\mathbf{X}_i = (X_{i1}, X_{i2}, \dots, X_{id})$ ,  $i = 1, 2, \dots, n$ . The smoother is extended in the usual way, by building multiplicative kernels with a diagonal bandwidth matrix:  $\prod_{j=1}^d K_h(x_j - X_{ij})$ . In a real data scenario, the bandwidth  $h$  and number of boosting iterations  $T$  can be chosen by cross-validation as the pair  $(h_{CV}, T_{CV})$  that solves  $\min_{h,t} \sum_{i=1}^n (Y_i - \hat{m}_t^{(-i)}(\mathbf{X}_i))^2$ , where  $\hat{m}_t^{(-i)}(\mathbf{X}_i)$  is the  $L_2$ -boostNW estimate of  $m(\mathbf{X}_i)$  when the  $i$ th vector observation is omitted.

## 11 Bagging

According to Hall and Samworth (2005), Bagging, or bootstrap aggregation, was introduced by Breiman (1999) as a means for improving the performance of a predictor, e.g. a classifier, by combining the results of many empirically simulated predictions. Bagging a conventional classifier, in particular one based on nearest neighbours, can sometimes, although not always, reduce the error rate. Several authors recently contributed to the bagging literature and to related methodology (see Hall and Samworth (2005)).

Bagging was introduced as a means for improving the accuracy of estimators of functions  $\theta(x)$  of data  $\mathbf{x} = \{x_1, \dots, x_N\}$ , i.e.  $\hat{\theta}(\mathbf{x}) = \arg \min_{\theta(\mathbf{x}) \in \Theta} L(\theta(\mathbf{x}))$ , where  $\Theta$  denotes a function class representable by the estimator, such as neural networks. The function  $L(\theta(\mathbf{x}))$  is a data-based estimate of the expected value of some functional such as the negative log-likelihood or other loss function. Bagging involves repeatedly drawing random resamples  $\mathbf{x}_b$  of the data, and either optimizing the value of  $L(\theta(\mathbf{x}_b))$  averaged over the resamples, or averaging the resample values of  $\hat{\theta}$ . The bagged estimator is therefore defined as either

$$\hat{\theta}_{bagg}(\mathbf{x}) = \arg \min_{\theta(\mathbf{x}) \in \Theta} \frac{1}{B} \sum_{b=1}^B L(\theta(\mathbf{x}_b)) \quad \text{or} \quad \hat{\theta}_{bagg}(\mathbf{x}) = \frac{1}{B} \sum_{b=1}^B \hat{\theta}(\mathbf{x}_b)$$

where  $\hat{\theta}(\mathbf{x}_b)$  is the version of  $\hat{\theta}(\mathbf{x})$  computed from the  $b$ -th resample.

Bühlmann and Yu (2002) state that bagging is one of the most effective computationally intensive procedures to improve on unstable estimators or classifiers, useful especially for high dimensional data set problems. They formalize the notion of instability and derive theoretical results to analyze the variance reduction effect of bagging (or variants thereof) in mainly hard decision problems, which include estimation after testing in regression and decision trees for regression functions and classifiers. In unstable situations bagging was shown to smooth hard decisions, yielding smaller variance and mean squared error. The authors motivate a procedure, i.e. subbagging, based on subsampling as an alternative aggregation scheme. It is computationally cheaper but still shows approximately the same accuracy as bagging. Moreover, their theory reveals improvements in first order. They obtain asymptotic limiting distribution results for specific problems.

Hall and Samworth (2005) show for classification problems, that bagging, a computationally intensive method, asymptotically improves the performance of nearest neighbour classifiers provided that the resample size is less than 69% of the actual sample size, in the case of with-replacement bagging, or less than 50% of the sample size, for without-replacement bagging. However, for larger sampling fractions there is no asymptotic difference between the risk of the regular nearest neighbour classifier and its bagged version. In particular, neither achieves the large sample performance of the Bayes classifier.

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# THE BOOTSTRAP: RECENT SIGNIFICANT TRENDS AND DEVELOPMENTS

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## Abstract

A survey of some recent developments in the bootstrap methodology is given, concentrating on basic ideas and applications rather than theoretical considerations. Topics include statistical error, double bootstrapping, bootstrapping complicated data sets, wild bootstrap, smoothed bootstrap, modified bootstrap, confidence intervals, bootstrap calibration and bootstrap-based hypothesis testing. The above topics are discussed under the assumption of independent data.

A major development recently of bootstrap methods has been their application to dependent data. Topics that are discussed under this heading include the moving block bootstrap, circular block bootstrap, stationary bootstrap and the autoregressive sieve bootstrap. The problem of choosing the block length data-dependently is also addressed.

## 1 Introduction

The basic objective of statistical analysis is “extracting all the information from the data” (Rao, 1989) to deduce properties of the population that generated the data. Statistical analyses are generally based on *statistics*, which are functions of data and are selected according to some principle (e.g., the likelihood principle, sufficiency, and robustness). A statistic is, therefore, a random variable with a probability distribution, called the *sampling distribution*, and a central objective of statistical inference is to characterise it. Knowledge of the sampling distribution enables one to, among other things, measure the precision and bias of an estimator, develop confidence intervals and test hypotheses about the parameter being estimated.

The sampling distribution of a statistic and its characteristics usually depend on the underlying population and therefore are unknown. They have to be estimated from the observed data in most inference problems. Efron (1979) introduced a very general resampling scheme (the *bootstrap*) for estimating the sampling distributions of statistics. Efron and Tibshirani (1993) defined this technique as “A computer-based method for assigning measures of accuracy to statistical estimates.” The bootstrap is essentially a method that attempts to mimic the process of sampling from a population (like one does in Monte-Carlo simulations), by instead drawing samples from the observed sample data.

The bootstrap has many attractive properties, especially for the statistical practitioner: it requires few assumptions, little modeling or analysis, and can be applied in an automatic way in a wide variety of situations, regardless of their theoretical complexity. One of the most important benefits of the bootstrap methodology is summarised by Efron and Tibshirani (1985) as follows: “The bootstrap can answer questions which are too complicated for traditional statistical analysis.”

## 2 Bootstrap estimate of standard error

Assume we have a random sample  $\mathbf{X}_n = (X_1, X_2, \dots, X_n)$  from an unknown distribution function (d.f.)  $F$ . Bootstrap methods depend on the notion of a *bootstrap sample*:

Let  $F_n$  be the empirical distribution function (e.d.f.) of  $\mathbf{X}_n$  that places probability  $1/n$  on each  $X_i$ ,  $i =$

$1, \dots, n$ . A bootstrap sample is defined as a random sample of size  $n$  drawn from  $F_n$ , say

$$\mathbf{X}_n^* = (X_1^*, X_2^*, \dots, X_n^*).$$

The star notation indicates that  $\mathbf{X}_n^*$  is not the same as the actual data set  $\mathbf{X}_n$ , but rather a randomised, or resampled, version of  $\mathbf{X}_n$ . In other words,  $\mathbf{X}_n^*$  is a random sample of size  $n$ , drawn with replacement from the “population” of  $n$  objects  $(X_1, \dots, X_n)$ . More formally, we write, for  $j = 1, \dots, n$ ,

$$P^*(X_j^* = X_i) = 1/n, \quad \text{for } i = 1, \dots, n,$$

where  $P^*$  denotes the conditional probability law of  $\mathbf{X}_n^*$  given  $\mathbf{X}_n$ .

Suppose  $\hat{\theta} = \hat{\theta}(X_1, X_2, \dots, X_n)$  is some estimator of a parameter  $\theta$ . The standard error of  $\hat{\theta}$  is

$$\sigma(F) = \{Var_F(\hat{\theta})\}^{1/2},$$

and the bootstrap estimate of  $\sigma(F)$  is simply

$$\hat{\sigma} \equiv \sigma(F_n) = \{Var_*(\hat{\theta}^*)\}^{1/2}, \quad \text{where}$$

$\hat{\theta}^* = \hat{\theta}(X_1^*, \dots, X_n^*)$  and  $Var_*$  denotes the variance under  $P^*$ .

One reason for the success of the bootstrap method is that a simple and accurate Monte-Carlo approximation can be given for  $\hat{\sigma}$  (Efron, 1979):

- i) For  $b = 1, 2, \dots, B$  (large), generate independent bootstrap samples from  $F_n$ :

$$\mathbf{X}_n^*(b) = (X_1^*(b), X_2^*(b), \dots, X_n^*(b)).$$

- ii) Calculate  $\hat{\theta}^*(1), \hat{\theta}^*(2), \dots, \hat{\theta}^*(B)$  (so-called *bootstrap replications*), where  $\hat{\theta}^*(b) = \hat{\theta}(X_1^*(b), X_2^*(b), \dots, X_n^*(b))$ .

- iii) Approximate  $\hat{\sigma}$  by

$$\hat{\sigma}_B = \left\{ \frac{1}{B-1} \sum_{b=1}^B (\hat{\theta}^*(b) - \hat{\theta}^*(\cdot))^2 \right\}^{1/2}, \quad \text{where}$$

$$\hat{\theta}^*(\cdot) = \frac{1}{B} \sum_{b=1}^B \hat{\theta}^*(b).$$

**Remarks:**

- (a) The strong law of large numbers implies that  $\hat{\sigma}_B \rightarrow \hat{\sigma}$  a.s. as  $B \rightarrow \infty$ .
- (b) Booth and Sarkar (1998) suggest that a choice of  $B$  between 200 and 800 is satisfactory for the estimation of standard errors and the construction of confidence intervals. With the powerful computers we have nowadays a safe choice to use is  $B=1000$ .
- (c) Bootstrap estimators of other measures of statistical error (or accuracy), such as bias or prediction error, can be obtained in a similar manner.
- (d) The bootstrap method, discussed above, is often called the *nonparametric bootstrap*.
- (e) If  $F(\cdot) = G(\cdot, \theta)$ , with  $G$  a known d.f. and  $\theta$  a vector of unknown parameters, we can estimate  $\theta$  by  $\hat{\theta}$ , and generate bootstrap random samples  $\mathbf{X}_n^* = (X_1^*, X_2^*, \dots, X_n^*)$  from  $G(\cdot, \hat{\theta})$  and then continue as before. This is known as the *parametric bootstrap*. An example of the application of the parametric bootstrap is given in Section 9.



### 3 The double bootstrap

The question of how accurate  $\hat{\sigma}$  is (the bootstrap estimate of the standard error of  $\hat{\theta}$ , defined in Section 2) now arises. What is, for example, its standard error? The bootstrap can, once again, be applied to estimate

$$\tau(F) = \{Var_F(\hat{\sigma})\}^{1/2}.$$

The bootstrap estimator is simply

$$\hat{\tau} \equiv \tau(F_n) = \{Var_*(\hat{\sigma}^*)\}^{1/2},$$

where  $\hat{\sigma}^* = \hat{\sigma}(X_1^*, \dots, X_n^*)$ .

The double bootstrap thus involves resampling resampled data, i.e., bootstrapping the bootstrap (see, e.g., Chapman and Hinkley, 1986). The following Monte-Carlo approximation can be given for  $\hat{\tau}$ :

i) Generate a bootstrap sample  $X_1^*, \dots, X_n^*$  from  $F_n$ :

(a) Generate a bootstrap sample  $X_1^{**}, \dots, X_n^{**}$  from  $F_n^*$ , the e.d.f. of  $X_1^*, \dots, X_n^*$ , and calculate

$$\hat{\theta}^{**} = \hat{\theta}(X_1^{**}, \dots, X_n^{**}) \equiv \hat{\theta}^{**}(1).$$

(b) Repeat step (a)  $C$  times independently, to obtain bootstrap replications

$$\hat{\theta}^{**}(1), \dots, \hat{\theta}^{**}(C).$$

(c) Calculate

$$\hat{\sigma}_C^*(1) = \left\{ \frac{1}{C-1} \sum_{c=1}^C \left( \hat{\theta}^{**}(c) - \frac{1}{C} \sum_{c=1}^C \hat{\theta}^{**}(c) \right)^2 \right\}^{1/2}.$$

ii) Repeat step i)  $B$  times independently, to obtain  $\hat{\sigma}_C^*(1), \dots, \hat{\sigma}_C^*(B)$ .

iii) Calculate

$$\hat{\tau}_{B,C} = \left\{ \frac{1}{B-1} \sum_{b=1}^B \left( \hat{\sigma}_C^*(b) - \frac{1}{B} \sum_{b=1}^B \hat{\sigma}_C^*(b) \right)^2 \right\}^{1/2}.$$

Note that the strong law of large numbers implies that

$$\hat{\tau}_{B,C} \rightarrow \hat{\tau} \quad \text{a.s. as } B, C \rightarrow \infty.$$

#### Remarks:

- (a) The double (or nested) bootstrap has been applied to various problems in the statistical literature (see, e.g., Tibshirani, 1988; Davison and Hinkley, 1997).
- (b) Important applications include, among others, its application to the construction of *bootstrap calibration confidence intervals* (which will be discussed later) and the construction of *bootstrap partial likelihoods*.

### 4 Partial likelihood approach

The *bootstrap partial likelihood approach* estimates the density function of  $\hat{\theta}$ , when the true value is  $\theta$ , using a double bootstrap procedure. The method proceeds as follows:

- i) Generate bootstrap samples  $\mathbf{X}_n^*(1), \mathbf{X}_n^*(2), \dots, \mathbf{X}_n^*(B)$ , giving bootstrap replications  $\hat{\theta}_1^*, \dots, \hat{\theta}_B^*$ .
- ii) From each of  $\mathbf{X}_n^*(b), b = 1, \dots, B$ , generate  $C$  second stage bootstrap samples, giving second stage bootstrap replicates  $\hat{\theta}_1^{**}(b), \dots, \hat{\theta}_C^{**}(b)$ .

iii) Calculate, e.g., the kernel density estimate

$$\hat{f}(t|\hat{\theta}_b^*) = \frac{1}{Ch} \sum_{c=1}^C k\left(\frac{t - \hat{\theta}_c^{**}(b)}{h}\right),$$

for  $b = 1, \dots, B$ . Here  $k$  is a known symmetric density function and  $h$  the bandwidth.

iv) Evaluate  $\hat{f}(\hat{\theta}|\hat{\theta}_b^*)$  for  $b = 1, \dots, B$ .

v)  $\hat{f}(\hat{\theta}|\hat{\theta}_b^*)$  provides an estimate of the likelihood of  $\theta$  for parameter value  $\theta = \hat{\theta}_b^*$ .

A smooth estimate of the likelihood of  $\theta$  is then obtained by applying a scatter plot smoother to the pairs  $(\hat{\theta}_b^*, \hat{f}(\hat{\theta}|\hat{\theta}_b^*))$ ,  $b = 1, \dots, B$ . This construction is called *bootstrap partial likelihood* because it estimates the likelihood of  $\theta$  based on  $\hat{\theta}$  rather than the full data set  $\mathbf{X}_n$ . The interested reader is referred to Davison et al. (1992) for a more in depth discussion of this partial likelihood approach.

## 5 Estimation of sampling distributions

Consider the problem of estimating the sampling distribution of a random variable  $R_n(\mathbf{X}_n; F)$ :

$$H_F(x) = P_F(R_n(\mathbf{X}_n; F) \leq x), \quad x \in \mathbb{R}.$$

The bootstrap estimator of  $H_F(x)$  is simply

$$\hat{H}(x) = H_{F_n}(x) = P^*(R_n(\mathbf{X}_n^*; F_n) \leq x).$$

Note: If, e.g.,  $R_n(\mathbf{X}_n; F) = \sqrt{n}(\bar{X}_n - \mu)/S_n(\mathbf{X}_n)$ , with  $\bar{X}_n$  and  $S_n(\mathbf{X}_n)$  defined as the sample mean and sample standard deviation respectively, then the bootstrap statistic becomes

$$R_n(\mathbf{X}_n^*; F_n) = \sqrt{n}(\bar{X}_n^* - \bar{X}_n)/S_n(\mathbf{X}_n^*).$$

The Monte-Carlo approximation of  $\hat{H}(x)$  is then simply:

$$\hat{H}_B(x) = \frac{1}{B} \sum_{b=1}^B I(R_n(\mathbf{X}_n^*(b); F_n) \leq x),$$

where  $\mathbf{X}_n^*(1), \dots, \mathbf{X}_n^*(B)$  are independent bootstrap samples of size  $n$  drawn from  $F_n$ .

### Remarks:

- (a) The approximation  $H_{F_n}(x) \approx H_F(x)$  is asymptotically ( $n \rightarrow \infty$ ) valid in a large number of situations. This is usually established by proving theorems of the form:

$$\sup_{-\infty < x < \infty} |H_{F_n}(x) - H_F(x)| = o(1),$$

almost surely (or in probability). We shall also refer to this by saying that the bootstrap estimator is “first-order accurate”. If  $o(1)$  can be replaced by  $o(n^{-1/2})$ , the bootstrap estimator is said to be “second-order accurate”. In this case the bootstrap approximation is better than the normal approximation, which is typically of the order  $O(n^{-1/2})$ .

- (b) First- and second-order accuracy results have been proved for a large number of statistics in the literature, including  $L$ -estimators,  $M$ -estimators,  $U$ -statistics, nonparametric density and regression estimators,  $U$ -quantiles, empirical and quantile processes, and general classes of statistical functionals (see, e.g., Hall, 1992; Shao and Tu, 1995; Janssen, 1997; Jiménez-Gamero et al., 2003).

## 6 Bootstrap confidence intervals

Suppose that  $X_1, X_2, \dots, X_n$  are i.i.d. (independent and identically distributed) random variables with d.f.  $F$  and  $\hat{\theta} = \hat{\theta}(X_1, X_2, \dots, X_n)$  is an estimator for a parameter  $\theta$ . Let  $\hat{\sigma}$  be the estimated standard error of  $\hat{\theta}$ . A  $100(1 - \alpha)\%$ -confidence interval (c.i.) for  $\theta$  based on the traditional method (using asymptotic theory) is:

$$I_{1-\alpha}^N = [\hat{\theta} - z(\alpha/2)\hat{\sigma}; \hat{\theta} + z(\alpha/2)\hat{\sigma}],$$

where  $z(\alpha/2)$  is the  $100(1 - \alpha/2)\%$  percentile point of  $\Phi$  (the standard normal distribution), e.g., if  $1 - \alpha = 0.95$ , then  $z(\alpha/2) = z(0.025) = 1.96$ . However, these standard intervals for  $\theta$  can often be quite inaccurate, because they rely on the central limit theorem and the conditions under which this theorem is valid. For small to moderate sample sizes, the coverage error  $|P(\theta \in I_{1-\alpha}^N) - (1 - \alpha)|$  can be large.

The bootstrap can be used to construct c.i.'s that frequently perform better, especially for small and moderate sample sizes. Since the early 1980's, a bewildering array of methods for constructing bootstrap confidence intervals have been proposed (see, e.g., Hall, 1988, 1992; Swanepoel, 1990; Efron and Tibshirani, 1993; Shao and Tu, 1995; DiCiccio and Efron, 1996; Davison and Hinkley, 1997). Carpenter and Bithell (2000) wrote an interesting paper addressing the questions of when bootstrap c.i.'s should be used, which method should be chosen and how it should be implemented.

Suppose  $F$  is unknown. The best-known procedures for constructing nonparametric bootstrap confidence intervals are:

1. Percentile, bias-corrected percentile ( $BC$ ), accelerated bias-corrected percentile ( $BC_a$ ).
2. Bootstrap- $t$ .

We now provide a quick summary of these procedures (a more detailed discussion can be found, e.g., in the books by Efron and Tibshirani, 1993; Shao and Tu, 1995).

### 6.1 Percentile intervals

Let  $\hat{G}$  denote the d.f. of  $\hat{\theta}^* = \hat{\theta}(X_1^*, \dots, X_n^*)$ , i.e.,

$$\hat{G}(t) = P^*(\hat{\theta}^* \leq t).$$

The percentile  $100(1 - \alpha)\%$  c.i.'s are given by

$$I_{1-\alpha} = [\hat{G}^{-1}(\alpha/2), \hat{G}^{-1}(1 - \alpha/2)],$$

which can be approximated by the Monte-Carlo method as follows:

- i) Draw  $B$  independent bootstrap samples of size  $n$  and calculate  $\hat{\theta}_1^*, \hat{\theta}_2^*, \dots, \hat{\theta}_B^*$ .
- ii) Calculate the corresponding order statistics  $\hat{\theta}_{(1)}^* \leq \hat{\theta}_{(2)}^* \leq \dots \leq \hat{\theta}_{(B)}^*$ .
- iii) Approximate  $I_{1-\alpha}$  by

$$\hat{I}_{1-\alpha} = [\hat{\theta}_{(r)}^*, \hat{\theta}_{(s)}^*],$$

where  $r = \lfloor B\alpha/2 \rfloor$ ,  $s = \lfloor B(1 - \alpha/2) \rfloor$  and  $\lfloor x \rfloor$  denotes the largest integer less than or equal to  $x$ .

#### Remarks:

- (a) An alternative percentile interval, in the literature known as the *basic* c.i. or *hybrid* percentile c.i. (see, e.g., Davison and Hinkley, 1997), is given by

$$\hat{I}_{1-\alpha}^0 = [2\hat{\theta} - \hat{\theta}_{(s)}^*, 2\hat{\theta} - \hat{\theta}_{(r)}^*].$$

- (b) The  $BC$  percentile c.i.'s are merely adjustments of the percentile intervals and they attempt to eliminate the effects of the *bias* of the bootstrap distribution of  $\hat{\theta}^*$ . They can be calculated as  $\hat{I}_{1-\alpha}$ , except that other values of  $r$  and  $s$  are used.
- (c) The  $BC_a$  percentile method is an improved version of the  $BC$  percentile method. It incorporates both a *bias* and *skewness* correction. The  $BC_a$  percentile c.i.'s can also be calculated as  $\hat{I}_{1-\alpha}$ , using different values of  $r$  and  $s$ , which are somewhat complex to compute.
- (d) Among the percentile bootstrap intervals, the  $BC_a$  interval generally performs best.

## 6.2 Bootstrap- $t$ intervals

A  $100(1 - \alpha)\%$  two-sided *symmetric* bootstrap- $t$  c.i. is given by

$$\left[ \hat{\theta} - q(F_n)\hat{\sigma}, \hat{\theta} + q(F_n)\hat{\sigma} \right],$$

where  $q(F_n)$  is defined by

$$P^*(|\hat{\theta}^* - \hat{\theta}|/\hat{\sigma}^* \leq q(F_n)) \approx 1 - \alpha.$$

$q(F_n)$  can be approximated by obtaining  $B$  independent bootstrap replications

$$T_n^*(b) = |\hat{\theta}^*(b) - \hat{\theta}|/\hat{\sigma}^*(b), \quad b = 1, \dots, B,$$

and then finding the  $[B(1 - \alpha)]$ -th smallest among the  $T_n^*(b)$ 's.

### Remarks:

- (a) Two-sided *equal-tailed* and one-sided bootstrap- $t$  c.i.'s can be derived similarly.
- (b) Both the  $BC_a$  percentile interval and the bootstrap- $t$  interval are second-order accurate; that is, their coverage probabilities differ from the nominal  $1 - \alpha$  level by only  $O(n^{-1})$ , instead of  $O(n^{-1/2})$ , which is usually achieved by the standard c.i.'s based on quantiles of the standard normal distribution (Hall, 1988).
- (c) However, these procedures also have some drawbacks. The  $BC_a$  procedure depends on some tuning parameter  $a$  that has to be estimated satisfactorily. The performance of the bootstrap- $t$  procedure is highly dependent on the quality of the estimator  $\hat{\sigma}$ . For nonlinear statistics the derivation of a good estimator  $\hat{\sigma}$  can be problematic.
- (d) In view of (c) above and due to personal experience, we advocate the use of the simple percentile method for small and moderate sample sizes, provided these intervals are *calibrated*. The calibration of an interval is discussed in the next section.

## 7 Bootstrap calibration

Bootstrap *calibration* confidence intervals were first proposed by Beran (1987) and Loh (1987) and have become very popular in recent years. The basic idea is to improve the original c.i.  $I_{1-\alpha}$  by *adjusting* its nominal level  $1 - \alpha$  using a double bootstrap. This is accomplished as follows:

Recall that  $\hat{G}(t) = P^*(\hat{\theta}^* \leq t)$ , hence

$$\begin{aligned} P_F(\theta \in I_{1-\alpha}) &= P_F\left(|2\hat{G}(\theta) - 1| \leq 1 - \alpha\right) \\ &=: \Pi_F(1 - \alpha). \end{aligned}$$

Suppose

$$\Pi_F(1 - \alpha) \neq 1 - \alpha,$$

then choose a  $\lambda$ ,  $0 < 1 - \alpha + \lambda < 1$ , such that

$$\Pi_F(1 - \alpha + \lambda) = 1 - \alpha.$$

$I_{1-\alpha+\lambda}$  has a coverage level exactly equal to  $1 - \alpha$ . Note, however, that  $\lambda$  is unknown, since

$$\lambda = \Pi_F^{-1}(1 - \alpha) - (1 - \alpha).$$

The bootstrap estimator of  $\lambda$  is simply

$$\hat{\lambda} = \Pi_{F_n}^{-1}(1 - \alpha) - (1 - \alpha),$$

and the adjusted interval is, therefore,

$$I_{1-\alpha+\hat{\lambda}} = \left[ \hat{G}^{-1} \left( \frac{\alpha - \hat{\lambda}}{2} \right), \hat{G}^{-1} \left( 1 - \frac{\alpha - \hat{\lambda}}{2} \right) \right].$$

**Remarks:**

- (a) Booth and Hall (1994) provide a discussion of the Monte-Carlo approximation of  $I_{1-\alpha+\hat{\lambda}}$ .
- (b) Hall and Martin (1989) showed that bootstrap calibration of percentile-method intervals has no role to play in *quantile* problems and thus cannot be used to improve coverage accuracy.

## 8 Bootstrapping complicated data sets

The bootstrap can be applied to much more complicated situations. A *regression* model is a familiar example of a complicated data structure. Consider, for example, the following model:

$$Y_i = g(\beta; \mathbf{x}_i) + \varepsilon_i, \quad i = 1, \dots, n.$$

Here,  $\beta$  is a  $(p \times 1)$  vector of unknown parameters; for each  $i$ ,  $\mathbf{x}_i$  is a  $(p \times 1)$  observed vector of covariates and  $g$  is a known function. The  $\varepsilon_i$ 's are i.i.d. random errors with *unknown* d.f.  $F$  such that  $E(\varepsilon_i) = 0$ ,  $i = 1, \dots, n$ .

Suppose that  $\beta$  is estimated by  $\hat{\beta}$  (e.g., the least-squares estimator). The bootstrap can be applied to approximate the sampling distribution of

$$\hat{\beta} = \hat{\beta}((Y_1, \mathbf{x}_1), \dots, (Y_n, \mathbf{x}_n))$$

as follows:

- (1) Let  $F_n$  be the e.d.f. of the centered residuals, defined for  $i = 1, \dots, n$ , by

$$\hat{\varepsilon}_i = Y_i - g(\hat{\beta}; \mathbf{x}_i) - \frac{1}{n} \sum_{j=1}^n \{Y_j - g(\hat{\beta}; \mathbf{x}_j)\}.$$

- (2) Generate i.i.d. bootstrap residuals  $\varepsilon_1^*, \varepsilon_2^*, \dots, \varepsilon_n^*$  from  $F_n$ .
- (3) Calculate bootstrap observations

$$Y_i^* = g(\hat{\beta}; \mathbf{x}_i) + \varepsilon_i^*, \quad i = 1, \dots, n.$$

- (4) Approximate the sampling distribution of  $\hat{\beta}$  by the bootstrap distribution of

$$\hat{\beta}^* = \hat{\beta}((Y_1^*, \mathbf{x}_1), \dots, (Y_n^*, \mathbf{x}_n)).$$

**Remarks:**

- (a) The above resampling scheme is called “bootstrapping residuals” or “resampling residuals” in the literature.
- (b) If the covariates  $\mathbf{x}_i$  are random, researchers often apply the so-called “pairs bootstrap”, which is less dependent on the underlying model assumption than the bootstrap based on residuals: Bootstrap data  $(Y_1^*, \mathbf{x}_1^*), \dots, (Y_n^*, \mathbf{x}_n^*)$  are generated by simple random sampling with replacement from  $(Y_1, \mathbf{x}_1), \dots, (Y_n, \mathbf{x}_n)$  and the sampling distribution of  $\hat{\beta}$  is approximated by the bootstrap distribution of

$$\hat{\beta}^* = \hat{\beta}((Y_1^*, \mathbf{x}_1^*), \dots, (Y_n^*, \mathbf{x}_n^*)).$$

- (c) If the  $\varepsilon_i$ 's are *heteroscedastic errors* one can apply the *pairs bootstrap*. An alternative way to deal with heteroscedasticity is to use the so-called *wild bootstrap* (see, e.g., Wu 1986; Liu, 1988; Härdle and Maron, 1991; Cao-Abad, 1991; Mammen, 1993; Hall and Mammen, 1994; Helmers and Wegkamp, 1998; Davidson and Flachaire, 2001). To implement this resampling scheme, we proceed exactly as in the implementation of the bootstrap based on residuals, except that step (2) must now be replaced by:

- (2') Generate  $n$  independent copies  $Z_1, \dots, Z_n$  of a random variable  $Z$  satisfying

$$E(Z) = 0; E(Z^2) = E(Z^3) = 1.$$

Calculate bootstrap residuals  $\varepsilon_i^* = \hat{\varepsilon}_i Z_i, i = 1, \dots, n$ .

The most popular choice in the literature for the distribution of  $Z$  (introduced by Mammen (1993)) is:

$$\begin{aligned} P\left(Z = (1 - \sqrt{5})/2\right) &= (5 + \sqrt{5})/10 \\ P\left(Z = (1 + \sqrt{5})/2\right) &= (5 - \sqrt{5})/10. \end{aligned}$$

Another popular choice is the simple two-point distribution (Rademacher distribution):

$$P(Z = -1) = P(Z = 1) = 1/2.$$

## 9 Bootstrap-based hypothesis tests

In Section 6 a brief overview of bootstrap confidence intervals was provided. The construction of bootstrap confidence intervals are linked to the execution of bootstrap hypothesis tests because of the duality between confidence intervals and hypothesis tests, i.e., the null hypothesis is rejected if the hypothesized value under the null hypothesis lies outside the confidence interval. Shao and Tu (1995), however, provided a few reasons why it is important to consider bootstrap hypothesis testing separately:

*“Firstly, finding a test directly is much easier than getting a test through constructing a confidence interval, which is impossible in some cases. Secondly, the test obtained directly may be better since they usually take account of the special nature of the hypothesis.”*

Hall and Wilson (1991) highlighted two important guidelines for bootstrap hypothesis testing. Their first guideline states that, when one wants to estimate the critical value, resampling must be done in a way that reflects the null hypothesis. This must be done even if the data were generated from a distribution specified by the alternative hypothesis. This guideline is crucial to the success of bootstrap hypothesis testing and have been mentioned by, among others, Young (1988); Beran (1988); Fisher and Hall (1990); Westfall and Young (1993) and most recently by Martin (2007). In some tests, however, it is not so easy to “mimic” the null hypothesis when resampling, and careful thought should be given as to how this resampling might take place. In their second guideline, Hall and Wilson (1991) recommended that bootstrap hypothesis tests should be based on test statistics that are (asymptotically) pivotal. The importance of using pivotal statistics in the bootstrap was considered by, among others, Beran (1987, 1988) and Hall (1992). The books by

Westfall and Young (1993); Efron and Tibshirani (1993) and Davison and Hinkley (1997) cover bootstrap testing in some detail. Hypothesis testing based on the bootstrap has also been discussed by several authors in Econometrics (see, e.g., Horowitz, 2001; MacKinnon, 2002; Park, 2003; Davidson and MacKinnon, 2004).

In his dissertation, Allison (2008) proposed a method for evaluating the performance of a bootstrap-based test. This new method clearly highlights the importance of the two guidelines suggested by Hall and Wilson (1991).

There are currently three methods that can be applied to satisfy the first guideline, viz. the *transformation method* (see, e.g., Fisher and Hall, 1990; Efron and Tibshirani, 1993 and Martin, 2007), the *exponentially tilted version of the e.d.f.* ( see Efron, 1981) and the method based on resampling residuals. When working with complicated data sets (like regression models), using the first two methods to “mimic”  $H_0$  in the bootstrap world can be very difficult. However, if we resample residuals, one can apply them to build a model that conforms to  $H_0$ . Examples of where this technique is applied to perform bootstrap-based testing are especially common in the econometric literature. Some of these applications include:

- bootstrapping P-values and power in the first-order autoregression model (Rayner, 1990);
- the level and power of the bootstrap  $t$ -test in the AR(1)-model with trend (Nankervis and Savin, 1996);
- bootstrap testing in nonlinear models (Davidson and MacKinnon, 1999);
- implementing the bootstrap in static or stable dynamic regression models (van Giesbergen and Kiviet, 2002);
- bootstrap unit root tests (Park, 2003); and
- testing for autoregressive conditional heteroscedasticity (Davidson and MacKinnon, 2007).

We will now consider two examples. The first example involves a nonparametric bootstrap and the second one applies the parametric bootstrap.

#### Example 1: Simple linear regression with errors following an AR(1) process

Consider the simple linear regression model:

$$Y_t = \beta_0 + \beta_1 X_t + u_t, \quad (1)$$

with

$$u_t = \rho u_{t-1} + \epsilon_t, \quad t = 2, 3, \dots, n, \quad (2)$$

and  $|\rho| < 1$ . Here,  $\beta_0$  and  $\beta_1$  are parameters;  $Y_t$  is the value of the response variable in the  $t^{\text{th}}$  trial;  $X_t$  is the value of the covariate in the  $t^{\text{th}}$  trial and  $\{\epsilon_t\}$  are the random errors with some unknown d.f. F such that  $E(\epsilon_t) = 0$ ,  $t = 1, 2, \dots, n$ . Let  $\mathbf{X}_n = (X_1, X_2, \dots, X_n)^T$  and  $\mathbf{Y}_n = (Y_1, Y_2, \dots, Y_n)^T$ .

Consider testing the hypothesis:

$$H_0 : \rho = \rho_0 \quad \text{vs.} \quad H_A : \rho > \rho_0.$$

The following residual-based algorithm can be applied to obtain the bootstrap P-value for testing  $H_0$ :

- i) Estimate  $\beta_0$  and  $\beta_1$  by  $\hat{\beta}_0$  and  $\hat{\beta}_1$  (e.g., least squares) in the regression equation:

$$Y_t = \beta_0 + \beta_1 X_t + u_t, \quad t = 1, 2, \dots, n.$$

- ii) Obtain the residuals:

$$\hat{u}_t = Y_t - \hat{\beta}_0 - \hat{\beta}_1 X_t.$$

iii) Estimate  $\rho$  by  $\hat{\rho}$  (e.g., least squares) in the regression equation:

$$\hat{u}_t = \rho \hat{u}_{t-1} + \varepsilon_t, \quad t = 2, 3, \dots, n.$$

iv) Obtain the centered residuals as:

$$\hat{\varepsilon}_t = \hat{u}_t - \hat{\rho} \hat{u}_{t-1} - \frac{1}{n-1} \sum_{j=2}^n (\hat{u}_j - \hat{\rho} \hat{u}_{j-1}), \quad t = 2, 3, \dots, n.$$

v) Under  $H_0^*$  ( $H_0$  in the bootstrap world) we have that:

$$\begin{aligned} Y_t^* &= \hat{\beta}_0 + \hat{\beta}_1 X_t + \hat{u}_t^*, \\ \hat{u}_t^* &= \rho_0 \hat{u}_{t-1}^* + \varepsilon_t^*, \quad t = 2, 3, \dots, n, \end{aligned}$$

where  $\{\varepsilon_t^*\}$  are i.i.d. drawn from the e.d.f. of  $\{\hat{\varepsilon}_t\}$ .

In order to obtain the bootstrap residual value at  $t = 1$  we can choose  $\hat{u}_1^* = \hat{u}_1$  or alternatively we can make use of a “burn-in” period (see, e.g., Davison and Hinkley, 1997).

vi) The bootstrap P-value is

$$P_{H_0^*}^*(T_n(\mathbf{Y}_n^*, \mathbf{X}_n) \geq T_n(\mathbf{Y}_n, \mathbf{X}_n)),$$

where

$$T_n(\mathbf{Y}_n, \mathbf{X}_n) = \frac{\hat{\rho} - \rho_0}{\sqrt{SE(\hat{\rho})}}.$$

### Example 2: Simple logistic regression

Consider a simple logistic regression model, where the responses  $Y_t$ ,  $t = 1, 2, \dots, n$ , are binary, i.e., the  $Y_t$ 's are Bernoulli random variables with

$$P(Y_t = 1) = \pi_t = \frac{e^{\beta_0 + \beta_1 X_t}}{1 + e^{\beta_0 + \beta_1 X_t}}, \quad \text{and } P(Y_t = 0) = 1 - \pi_t.$$

Consider testing the hypothesis:

$$H_0 : \beta_1 = b_1 \quad \text{vs.} \quad H_A : \beta_1 > b_1.$$

The following *parametric* bootstrap method can be applied to obtain the bootstrap P-value for testing  $H_0$ :

- i) Estimate  $\beta_0$  and  $\beta_1$  by  $\hat{\beta}_0$  and  $\hat{\beta}_1$  using maximum likelihood.
- ii) Obtain bootstrap Bernoulli random variables  $Y_1^*, Y_2^*, \dots, Y_n^*$  under  $H_0^*$ , where

$$Y_t^* = \begin{cases} 1, & \text{with probability } \hat{\pi}_t^0 \\ 0, & \text{with probability } 1 - \hat{\pi}_t^0, \end{cases}$$

with

$$\hat{\pi}_t^0 = \frac{e^{\hat{\beta}_0 + b_1 X_t}}{1 + e^{\hat{\beta}_0 + b_1 X_t}}.$$

iii) The bootstrap P-value is

$$P_{H_0^*}^*(T_n(\mathbf{Y}_n^*, \mathbf{X}_n) \geq T_n(\mathbf{Y}_n, \mathbf{X}_n)),$$

where

$$T_n(\mathbf{Y}_n, \mathbf{X}_n) = \frac{\hat{\beta}_1 - b_1}{\sqrt{SE(\hat{\beta}_1)}}.$$



## 10 The modified bootstrap

Bickel and Freedman (1981) provided *counter-examples* to show where the standard (naive) bootstrap fails (i.e., the bootstrap estimators are not first-order accurate). Examples include degenerate  $U$ -statistics, extreme order statistics and spacings of the observations. Swanepoel (1986) showed how these counter-examples can be mended by introducing the *modified bootstrap* or *m-out-of-n bootstrap*, as it is more popularly known.

For any random variable  $R_n(\mathbf{X}_n; F)$ , the modified bootstrap consists of approximating the sampling distribution of  $R_n(\mathbf{X}_n; F)$  under  $F$  by the bootstrap distribution of  $R_m(\mathbf{X}_m^*; F_n)$  under  $F_n$ , i.e.,

$$P^*(R_m(\mathbf{X}_m^*; F_n) \leq x) \approx P_F(R_n(\mathbf{X}_n; F) \leq x),$$

where  $\mathbf{X}_m^* = (X_1^*, \dots, X_m^*)$ , for some suitable choice of the bootstrap sample size  $m$ .

Since 1986 several new cases have been reported, illustrating the failure of the naive bootstrap. However, in each case the “m-out-of-n bootstrap” led to consistent (first-order accurate) bootstrap estimators, emphasising the ongoing success of the methodology. Some of the above-mentioned cases include the application of the naive bootstrap to:

- the mean in the infinite variance case (Athreya, 1987; Knight, 1989; Arcones and Giné, 1989, 1991);
- extreme order statistics (Deheuvels et al., 1993);
- the Cramér-von Mises goodness-of-fit test statistic with doubly censored data (Bickel and Ren, 1995);
- unstable first-order autoregressive processes (Basawa et al., 1991; Datta, 1996; Heimann and Kreiss, 1996);
- critical branching processes with immigration (Sriram, 1994);
- normalised sums of *stationary* random variables with a heavy-tailed marginal d.f. (Lahiri, 1995);
- the estimation of the distribution of the Studentized mean (Hall and LePage, 1996);
- a sample quantile when the density has a jump (Huang et al., 1996);
- confidence intervals for endpoints of a d.f. (Athreya and Fukuchi, 1997);
- the maximum of a stationary process (Athreya et al., 1999);
- unstable first-order autoregressive processes, with *errors* which belong to the domain of attraction of a *stable law* with index  $\alpha \in (0, 2]$  (Zarepour and Knight, 1999).

Recent papers on the modified bootstrap caused a revival of this idea:

- Chung and Lee (2001) applied the modified bootstrap to correct coverage error in the construction of bootstrap confidence bounds. They showed that the coverage error of a standard bootstrap *percentile* method confidence bound, which is of order  $O(n^{-1/2})$  typically, can be reduced to  $O(n^{-1})$  by use of an *optimal* bootstrap sample size  $m$  in the modified bootstrap. The authors also conducted a simulation study to illustrate their findings, which suggest that the modified bootstrap method yields intervals of shorter length and greater stability compared to competitors of similar coverage accuracy (see also Lee, 1999).
- Janssen et al. (2001, 2002) showed that, compared to the standard (naive) bootstrap, the modified bootstrap provides faster consistency rates for the bootstrap distribution of  $U$ -quantiles and Kaplan-Meier quantiles (comprehensive surveys of bootstrapping  $U$ -statistics and bootstrapping applied to survival analysis were written by Janssen (1997) and Veraverbeke (1997), respectively). The results of Chung and Lee (2001) and those of Janssen et al. (2001, 2002) illustrate that *the modified bootstrap is useful, not only in cases where the standard bootstrap fails, but also in situations where it is valid.*

**Remarks:**

- (a) It is well-known that the ordinary delete-1 jackknife fails (i.e., it is not asymptotically consistent) when estimating, for example, the variance of a sample quantile (Efron, 1979). It is known (see, e.g., Wu, 1986) that by carefully choosing  $d$ , a delete- $d$  jackknife estimator overcomes some of the deficiencies of the ordinary jackknife.
- (b) Unlike the delete- $d$  jackknife, however, which suffers from a combinatoric explosion of computation with *increasing*  $d$ , the  $m$ -out-of- $n$  bootstrap is just the opposite. The *smaller* the resample size  $m$ , the easier it is to resample and to compute.
- (c) The choice of  $m$  is crucial. In order to make the modified bootstrap accessible for the statistical practitioner, a *data-dependent* rule to choose  $m$  is very important.
- (d) Research on this topic has only started recently. Data-based choices of  $m$  were proposed, for example, by Bickel and Ren (1996); Sakov (1998); Sakov and Bickel (1999); Götze and Račkauskas (2001); Chung and Lee (2001); Bickel and Sakov (2002, 2008) and Cheung and Lee (2005).

## 11 The smoothed bootstrap

The e.d.f.  $F_n$  is a *discrete* d.f. and this seems undesirable when dealing with a continuous d.f.  $F$ . Efron (1979) suggested the *smoothed bootstrap*:

Instead of resampling from  $F_n$ , resample from a smoothed version  $\hat{F}_n$  of  $F_n$ , viz.

$$\hat{F}_n = K_n * F_n,$$

where  $K_n(\cdot)$  is a sequence of continuous d.f.'s and  $*$  denotes convolution. We have

$$\hat{F}_n(x) = \int_{-\infty}^{+\infty} K_n(x-y) dF_n(y).$$

$K_n(\cdot)$  is mostly a *kernel* sequence:

$$K_n(t) = K(t/h),$$

where  $K$  is a *known* continuous d.f. (e.g.,  $K = \Phi$ ) and  $h = h_n$  is a *bandwidth* sequence. In this case

$$\hat{F}_n(x) = \frac{1}{n} \sum_{i=1}^n K\left(\frac{x - X_i}{h}\right).$$

A bootstrap sample  $Y_1^*, \dots, Y_n^*$  from  $\hat{F}_n$  can be obtained in a simple way. Let  $X_1^*, \dots, X_n^*$  be i.i.d. random variables with d.f.  $F_n$  and let  $R_1, \dots, R_n$  be i.i.d. random variables with d.f.  $K$ . If  $(X_1^*, \dots, X_n^*)$  and  $(R_1, \dots, R_n)$  are independent, we may take

$$Y_i^* = X_i^* + hR_i, \quad i = 1, \dots, n.$$

**Remarks:**

- (a) Romano (1988) showed that if a parameter  $\theta$ , which can be viewed as a functional  $T(f)$  of the *density*  $f$ , is to be estimated, the standard bootstrap can fail (i.e., it is inconsistent) unless the resampling is done from  $\hat{F}_n$ .
- (b) Hall and DiCiccio (1989) showed that in estimating the *variance* of a *sample quantile*, the rate of convergence of the *relative error* can be improved by using a smoothed bootstrap instead of the standard bootstrap (see also the review paper by De Angelis and Young, 1992).
- (c) The correct choice of the bandwidth  $h$  is crucial. In order to make the smoothed bootstrap more accessible for the statistical practitioner, a reliable data-dependent bandwidth (*selector*) is of the utmost importance.
- (d) Polansky (2001) derived a bandwidth selector for the smoothed bootstrap applied to construct *one-sided percentile* confidence intervals.

## 12 The generalised (weighted) bootstrap

The e.d.f.  $F_n^*$  of a bootstrap random sample  $X_1^*, \dots, X_n^*$  from  $F_n$  can be written in terms of the original sample  $\mathbf{X}_n = (X_1, \dots, X_n)$  as

$$F_n^*(x) = \frac{1}{n} \sum_{i=1}^n M_{ni} I(X_i \leq x),$$

where  $(M_{n1}, \dots, M_{nn})$  is  $Mult(n; 1/n, \dots, 1/n)$  distributed.

A generalisation is obtained if the multinomial weights are replaced by a vector of *general* weights:

$$F_{n,W}^*(x) = \frac{1}{n} \sum_{i=1}^n W_{ni} I(X_i \leq x),$$

where the components of  $(W_{n1}, \dots, W_{nn})$  are exchangeable, independent of the  $X_i$ 's,  $W_{ni} \geq 0$  and If  $T(F)$  is a functional, then we say that the *generalised bootstrap* works if (under certain regularity

$$\sup_{-\infty < x < \infty} |P^*(n^{1/2}(T(F_{n,W}^*) - T(F_n)) \leq x) - P(n^{1/2}(T(F_n) - T(F)) \leq x)| \rightarrow 0$$

as  $n \rightarrow \infty$  (almost surely or in probability).

### Remarks

- Bootstrapping with *random weights* was probably considered for the first time in Rubin (1981), who proposed the so-called *Bayesian bootstrap*.
- A detailed review of the generalised bootstrap may be found in Barbe and Bertail (1995), Shao and Tu (1995), Janssen (1997) and the references in these papers.
- A study of the above-mentioned papers reveals that many issues about choosing the weights  $\{W_{ni}, i = 1, \dots, n\}$  are still unsolved.
- In the context of *linear regression* models, the above references considered only the generalised *residual-based* bootstrap, and not the generalised *pairs* bootstrap.
- A *generalised pairs bootstrap* was introduced by Chatterjee (1998) in linear regression problems: As we already know, the *standard* pairs bootstrap proceeds by taking a random sample (with replacement) of size  $n$  from the data pairs  $\{(Y_i, \mathbf{x}_i), i = 1, \dots, n\}$ . This is the same as *transforming* the data to

$$\{\sqrt{M_{ni}}(Y_i, \mathbf{x}_i), i = 1, \dots, n\}.$$

Instead of multinomial weights, the generalised pairs bootstrap is carried out by using any nonnegative *exchangeable* random weights  $\{W_{ni}, i = 1, \dots, n\}$ , satisfying certain conditions.

- Chatterjee and Bose (2002) proved, with a *certain* choice of weights  $\{W_{ni}, i = 1, \dots, n\}$ , consistency of the generalised pairs bootstrap distribution of the least-squares estimator  $\hat{\beta}$  in a random-design linear regression, when the number of parameters  $p = p_n \rightarrow \infty$  as  $n \rightarrow \infty$  (so-called *dimension asymptotics* - see Mammen, 1996). Moreover, Chatterjee and Bose (2002) showed that with the above resampling scheme, *best* dimension asymptotic results are obtained.

## 13 Bootstrapping dependent data

A major development of bootstrap methods since the mid-1980's has been their application to dependent data. Two well-known methods relating to dependent data will now be discussed, namely the *moving block bootstrap* and the *autoregressive sieve bootstrap*. Throughout the discussion, we will assume that  $X_1, X_2, \dots$ , is a sequence of strictly stationary random variables (or vectors).

### 13.1 The moving block bootstrap(MBB)

The *MBB* was suggested by Künsch (1989) and is implemented as follows:

- (1) Define blocks  $\mathcal{B}_j = (X_j, \dots, X_{j+\ell-1})$ , for  $j = 1, \dots, N$ , where  $N = n - \ell + 1$  and  $1 \leq \ell \leq n$  denotes the block size.
- (2) Let  $b = \lfloor n/\ell \rfloor$ . Select a random sample (with replacement)  $\mathcal{B}_1^*, \dots, \mathcal{B}_b^*$  from  $\{\mathcal{B}_1, \dots, \mathcal{B}_N\}$ .
- (3) Arrange the components of  $\mathcal{B}_1^*, \dots, \mathcal{B}_b^*$  into a sequence.
- (4) This yields  $n_1 = b\ell$  bootstrap observations  $\mathbf{X}_{n_1}^* = (X_1^*, X_2^*, \dots, X_{n_1}^*)$ . Note that  $n_1/n \rightarrow 1$  as  $n \rightarrow \infty$ .

**Remarks:**

- (a) By sampling blocks of length  $\ell$ , the correlation present in observations less than  $\ell$  time units apart, is retained.
- (b) It has been shown that the *MBB* is asymptotically valid for a wide range of statistics and a wide range of data generating models, as long as they are *short-range* dependent (Naik-Nimbalkar and Rajarshi, 1994; Bühlmann, 1995; Bühlmann and Künsch, 1995; Radulović, 1996a,b).
- (c) Götze and Künsch (1996) as well as Lahiri (1996) proved that the *MBB* applied to certain statistics is *second-order* accurate.
- (d) The correct choice of the block length  $\ell$  is crucial and requires careful consideration.

Hall et al. (1995) derived a simple rule for choosing  $\ell$  data-dependently. They consider the performance of the *MBB* with different block lengths for *subsamples* of length  $m < n$ , yielding an optimal block length  $\hat{\ell}_m$ . The estimated optimal block length is then derived with a Richardson *extrapolation* adjusting to the original sample size  $n$  :

$$\hat{\ell}_n = (n/m)^{1/k} \hat{\ell}_m, \quad \text{where}$$

$k = 3$  when estimating bias or variance of  $\hat{\theta}_n$ ,  $k = 4$  for estimating the d.f. of  $(\hat{\theta}_n - \theta)/\hat{\sigma}_n$  and  $k = 5$  for estimating the d.f. of  $|\hat{\theta}_n - \theta|/\hat{\sigma}_n$ . The method described above is not fully data-driven, since  $m$  is another tuning constant. Moreover, the behaviour of bootstrapped *nonlinear* statistics  $\hat{\theta}_n$  for small  $m$  is unsatisfactory.

When the *MBB* is applied to estimate the *bias* or *standard error* of a statistic, Bühlmann and Künsch (1999) proposed a *fully* data-driven procedure for the selection of the block length  $\ell$ . It is based on an equivalence of  $\ell$  to the inverse of the bandwidth of a *lag weight* estimator of the *spectral* density at zero. The procedure can easily be implemented and performs at least as well as the procedure of Hall et al. (1995).

### 13.2 Other resampling schemes

- In the *MBB* sampling, the first and last few observations in the series do not have the same chance of being drawn as the observations in the middle part of the series. The *circular block bootstrap (CBB)* suggested by Politis and Romano (1992) wraps the observations  $\mathbf{X}_n = (X_1, X_2, \dots, X_n)$  around in a circle and then generate consecutive blocks of the bootstrap data from the circle.

- If the *MBB* is applied to *stationary* data, then (conditional on  $\mathbf{X}_n$ ) the resampled pseudo-time series  $\mathbf{X}_{n_1}^* = (X_1^*, X_2^*, \dots, X_{n_1}^*)$  is not stationary. The *stationary bootstrap (SB)*, proposed by Politis and Romano (1994), is generally applicable for *stationary weakly dependent* time series. The *SB* attempts to mimic the original model by retaining the stationarity property of the original series  $\mathbf{X}_n$  in the resampled pseudo-time series  $\mathbf{X}_n^*$ . Basically, the *SB* generates  $\mathbf{X}_n^*$  (using the *CBB* scheme) by resampling blocks of *random size*, where the length of each block has a *geometric distribution* with parameter  $\pi$ .

To make the *SB* applicable for the statistical practitioner, a fully *data-driven* procedure for selecting  $\pi$  will have to be invented. Lahiri (1999) showed rigorously that the *MBB* is generally better than the *SB*.

### 13.3 The autoregressive sieve bootstrap

The *autoregressive sieve bootstrap* method was originally proposed by Swanepoel and Van Wyk (1986). We will now provide a short discussion on this method:

Let  $\{X_j, -\infty < j < \infty\}$  denote a strictly stationary, invertible *linear time series*:

$$X_j = \mu + \sum_{i=0}^{\infty} \alpha_i \varepsilon_{j-i} \quad , \quad (12.1)$$

for constants  $\mu, \alpha_i$  and i.i.d. random errors  $\{\varepsilon_i\}$  with  $E(\varepsilon_i) = 0, i = 1, \dots, n$ .

Inverting (12.1), we obtain an  $AR(\infty)$ -process

$$X_j - \mu = \sum_{i=1}^{\infty} \beta_i (X_{j-i} - \mu) + \varepsilon_j, \quad (12.2)$$

for constants  $\beta_i$ .

The basic idea of the  $AR(\infty)$ -sieve bootstrap is to approximate the  $AR(\infty)$ -model in (12.2) with a finite  $AR(p)$ -model:

$$X_j - \mu = \sum_{i=1}^p \beta_i (X_{j-i} - \mu) + \varepsilon_j.$$

Choose an estimate  $\hat{p}$  of  $p$  by, e.g., the *AIC* model selection procedure with Gaussian innovations (Shibata, 1980, has shown optimality of the *AIC* for prediction in  $AR(\infty)$ -models). Some researchers recommend the use of the *AICC* criterion, which is a bias-corrected version of *AIC* (Hurvich and Tsai, 1989). One then proceeds further by applying classical resampling residuals. (See also Kreiss, 1992; Bühlmann, 1995, 1997, 1998; Bickel and Bühlmann, 1999; Choi and Hall, 2000)

### 13.4 Comparison between the MBB and the $AR(\infty)$ -sieve bootstrap

- The  $AR(\infty)$ -sieve bootstrap yields bootstrap pseudo-data  $\mathbf{X}_n^*$  that are conditionally (given  $\mathbf{X}_n$ ) stationary.
- Sieve bootstrap samples do not exhibit any of the *artifacts* that typically appear in series generated by the *MBB*, as the result of joining together *randomly* selected blocks of data.
- Since the  $AR(\infty)$ -sieve bootstrap does not corrupt second-order properties, it may be used in a *double-bootstrap* form and potentially leads to higher-order accuracy. For example, the  $AR(\infty)$ -sieve double bootstrap can be employed to calibrate a basic percentile method confidence interval. This gives second-order accuracy, without requiring *variance estimation* of the underlying statistic (Choi and Hall, 2000). Moving block double bootstrapping does not seem promising since the block bootstrap in the first iteration corrupts dependence of the data where blocks join (Bühlmann, 2002).
- The  $AR(\infty)$ -sieve bootstrap adapts to the *degree of dependence*: its accuracy improves as the degree of dependence decreases. This is not the case with the block bootstrap (Bühlmann, 2002).
- Empirical results of many authors in the literature show that the  $AR(\infty)$ -sieve bootstrap seems generally less sensitive to selection of a model in the sieve (i.e., the choice of  $p$ ) than the blockwise bootstraps to the block length  $\ell$ .
- Finally, if the underlying process  $\{X_t\}$  is a stationary *linear* time series, the  $AR(\infty)$ -sieve bootstrap is usually *superior* to the block bootstrap approach and offers a wider range of opportunities.

## 14 Further topics

In recent years the bootstrap has become an active and broad topic for research and application. Significant research areas where the bootstrap found extensive application (which have not been dealt with in this paper) are, among others, efficient bootstrap simulations, survey sampling, model selection, nonparametric curve estimation, sequential analysis, directional data, categorical data, Bayesian inference, discriminant analysis and nonparametric autoregression.

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# CAN INTERNATIONAL DIVERSIFICATION REDUCE PORTFOLIOS' RISK AND COSTS THROUGH THE USAGE OF VARIATIONS OF CAPITAL ASSET PRICING MODEL? AN EMPIRICAL REVIEW

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## Abstract

*Bibliography suggests many ways with which risk can be predicted or/and be minimized. Initially, diversification of a portfolio was first proposed as an idea by Markowitz (1952), who described how to combine assets into efficiently diversified portfolios. He demonstrated that investors failed to account correctly for the high correlation among security returns. Diversification, he concluded "reduces risk only when assets are combined whose prices move inversely, or at different times, in relation to each other". Modern portfolio theory constitutes the basis of this concept that is diversification reduces risk. This paper aims to analyze critically fundamental methods with which risk and returns of emerging market investments can be found and measured as well as if risk, discount rates, and transaction costs can be reduced for international diversified investments.*

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## 1. Introduction

In every aspect of an economy, investors make continual efforts to earn the maximum returns through the buy-and-hold method of securities, assets, and bonds. Markowitz (1952) was the first, at least officially, who demonstrated and proposed the combination of assets with specific characteristics. The Markowitz approach is often called a "mean-variance model". These concepts of efficiency were essential to the development of the Capital Asset Pricing Model (CAPM). Finally, he concluded that a diversified portfolio can reduce risk. From the early 50's until present, not only economic environment has altered, but also new security products have come up. Internationalization of local economies and stock exchanges creates new challenges as well as threats to the investors around the world. Nowadays, the matter is whether a diversified portfolio which holds assets from foreign markets is able to keep a satisfactory level of return (a given return expectation) with reduced risk. Considering the bibliography, this paper approaches various models such as Downside CAPM, International CAPM, and Weighted-Average Cost of Capital, in order to detect the impact of globalization on systematic risk level. Actually, we conclude that theory stands for the internationalization of the diversified portfolios, although empiric observation definitely shows that there is a deep consideration and hesitation among investors as far as international investing is concerned.

The remainder is as follows. Section 2 generally cites the advantages of international diversification as well as the threats that lurk. Section 3 contains the analysis of the crucial condition in order a diversified portfolio to be internationalized, namely market liberalization, as well as if an international diversified portfolio can reduce cost of capital. Section 4 explores the factors, which is possible to raise systematic risk in an international investment. Also, the CAPM is presented as a well-known benchmark for measuring risk. Section 5 presents the leading alternative and enhanced models of CAPM which are considered to be enhanced measures of risk of portfolio investments. Section 6 attempts to interpret the investors' behavior trying to answer the question why individual investors are averse to include in their diversified portfolios foreign investments. Section 7 concludes.

## **2. Becoming internationalized: The value and the ventures of diversification of portfolios**

As it is already stated, diversification of a portfolio was first introduced by Markowitz (1952) as well as modern portfolio theory constitutes the basis of this concept (Rockefeller, 2001). However, the significance of international diversification is not one-dimensional. From one hand, there is a viewpoint which support the idea that international equity diversification reduces risk (Solnik, 1974). On the other hand, although diversification contributes to the decrease of risk, the additional, new risks that are taken when investing in foreign securities outweigh potential returns (Rockefeller, 2001). The globalization of local economies, the trade relations, and politics creates expansive reactions, which conclude to the cross-country transmission of shocks or to cross-country spillover effects. Economic crises just quicken these reactions and there is no rule that crises are the only cause and/or factor to be blamed. As a result, the relationship between countries increases risk of a portfolio that is internationally diversified. If market correlations are low, then international diversification can really be indisputably beneficial (Forbes and Rigobon, 2002). These relatively weak relations exist between emerging and developed markets as well as emerging markets generally have higher average returns, greater serial correlation, and greater volatility (Solnik, 2003).

To be more specific, nowadays an international diversified portfolio suffers from currency risk, information costs, operating risk, legal risk, and country or political risk. As Solnik (2003) states, currency risk can affect both the total return and the volatility of the investment, but it can be managed by selling futures or forward currency contracts, buying put currency options, or by borrowing foreign currency to finance the investment. Information costs include two kinds of cost sources: firstly, the accrual cost of acquiring information and secondly, the non-monetary cost which is relative to the comprehension of foreign environments. Political risk can be focused on the prohibition of profits or capital investment handling from a foreign country (Solnik, 2003). Operating risk incurs when an investor fails to make the right transactions timely (Rockefeller, 2001). Legal and political risk includes cases of corruption, lack of market experts, technology, and/or know-how as well as uncertain political environment.

Finally, although emerging markets offer diversification benefits and returns' shifts of emerging markets are less connected with the volume of returns in more developed countries, an international diversified portfolio which holds securities of emerging stock exchanges, faces additional qualitative risks. Rockefeller (2001) has pointed out that the level of risk is magnified, when a market gather some specific characteristics, such as less information, unclear accounting standards, and low investor protection. Garcia and Liu (1999) conclude that economic development plays an important role in stock market development.

## **3. What makes a firm attractive for an international diversified portfolio? The cases of market liberalization and cost of capital**

There must be some preconditions for a diversified portfolio in order to become internationalized. Apart from any correlation between countries and stock returns, a firm's security appeals to an investor if its cost of capital is relatively low as well as stock market liberalization exists (Henry, 2000).

If an emerging country denies opening up its equity market to outside investors having restrictions on investments for outsiders, then a diversified portfolio has to limit its options by eliminating the possibility of investing in a company of this emerging market that appeals only to domestic investors. Under these circumstances, if an economy has international restrictions, then the stock price reaction will differ across markets and the volume of this reaction will differ according to the severity of these restrictions (Miller, 1999). When an economy opens up, foreign investments become legal (liberalized), and when the government of this economy allows foreigners to purchase shares of that country's stock market security, then price volatility should become global.

The notion that market liberalization has economic benefits has been stated by Levine and Zervos (1998) as well as by Errunza and Miller (2000). In particular, Errunza and Miller (2000) found that firms which can fully interact with other markets globally have diminished cost of capital rates. Cost of capital can be seriously reduced through mergers, acquisitions, foreign direct investment, and the globalization of the market. Eiteman, Stonehill, and Moffett (2006) set three compulsory rules as the conditions which make a firm appeal to an international diversified portfolio. According to Eiteman et al. (2006), the market in which a firm security is listed must have high liquidity, broad international participation, as well as its market price should be adjusted according to international standards. When the domestic economy is closed, and investors' access is restricted, there is no reason to expect domestic assets to be priced internationally (Solnik, 2003).

#### 4. International diversification, systematic risk and the role of CAPM

A vast amount of researches have concluded that international diversified investments embody reduced systematic risk. Also, Reeb, Kwok, and Baek (1998) as well as Kwok and Reeb (2000) found that firms which decided to expand their activities globally enjoy less risk as well as there is a negative relation between systematic risk and the degree of international involvement of a firm.

If the above conclusions are to be taken for granted, companies of a local economy which have already expand their activities globally, should have reduced systematic risk and therefore, should use a lower discount rate for their global projects. As a result, an international diversified portfolio which holds firms with the same characteristics just as they are mentioned by Eiteman et al. (2006), is expected to minimize risk. Yet, there is a paradox here. In modern reality, the unknown environment of a foreign market rises up the uncertainty and makes companies to use a higher discount rate for evaluating international projects.

As Reeb et al. (1998) note, this proportional relation between systematic risk and the level of globalization is attributed to:

- exchange rate risk,
- political risk,
- the agency problem,
- asymmetrical information, and
- manager's self-fulfilling prophecies.

Regarding foreign exchange risk, it is the kind of risk that is related with the variability of exchange rates. Political risk is relative to the destabilization of the political system of a country (confiscations, rebellions, transfer of funds in and out of the country etc.). Concerning the agency problem, it is the kind of risk that is related with the potential power of managers to act according with personal will ignoring the will of agents (shareholders) (Lee and Kwok, 1988). As far as asymmetrical information is concerned, local firms can acquire and have access to more and cheaper information and raw materials than foreign competitors. Finally, the factor "manager's self-fulfilling prophecies" was analyzed by Reeb et al. (1998). The fulfilling prophecies show how a manager's pessimistic expectations about the level of success of a project conclude to the accrual increase of firm's systematic risk.

As we have mentioned above, empirical results stand up for the idea that the more internationally diversified is an investment, the more systematic risk will bear.

In addition to the literature review, a relatively simple example of the effect of systematic risk can be extracted from the CAPM:

##### Figure 1: Capital Asset Pricing Model (CAPM)

$$R_{jt} - R_{ft} = \beta_j (R_{mt} - R_{ft}) + \varepsilon_t$$

##### Figure 2: Calculation for Beta

$$\beta_j = \left( \frac{\rho_{jm} \sigma_j}{\sigma_m} \right)$$

where  $R_{jt}$  is the random return on the  $j$ th security at time  $t$ ,  $R_{ft}$  is the risk-free rate at time  $t$ ,  $\beta_j$  (beta) is the measure of the systematic risk of firm  $j$ ,  $R_{mt}$  is the market return at time  $t$ , and  $\varepsilon_t$  is the mean zero error term.  $\beta_j$  is the correlation coefficient between security  $j$  ( $\rho_{jm}$ ) and the market and the standard deviation of the firm  $j$  ( $\sigma_j$ ), divided by the standard deviation of the market ( $\sigma_m$ ).

#### 5. Alternative and enhanced models of Capital Asset Pricing Model (CAPM) as measures of risk of market investments

##### A) Downside Capital Asset Pricing Model (D-CAPM)

Seeking for an alternative model of CAPM (Figure 1), Estrada (2002) presented the Downside Capital Asset Pricing Model (D-CAPM). It measures the downside beta of risk of emerging market investments. The

concepts of this belief are: firstly, investors are not particularly worrisome of upside risk, while downside risk is always a problem, and secondly, since the CAPM stems from an equilibrium in which investors maximize a utility function that depends on the mean and variance of returns where the variance is assumed to be symmetric and normally distributed, it does not correctly measure the downside beta of emerging market securities.

Continuing his rationale, Estrada (2002) made use of the Mean-Semivariance and the D-CAPM to measure returns by first computing the downside standard deviation of returns. While in the widely used CAPM the standard deviation is measured by the square root of the squared sum of deviations from the mean, Estrada (2002) took the square root of the sum of the minimum of the portfolio return ( $R_i$ ) minus a given benchmark return ( $\Sigma_{Bi}$ ) or zero squared, in order to measure the downside standard deviation. The forenamed equations are shown in Figures 3 and 4:

**Figure 3: Standard Deviation and Variance (or Squared Standard Deviation)**

$$\sigma_i = \sqrt{E[(R_i - \mu_i)^2]} \text{ and } \sigma_i^2 = E[(R_i - \mu_i)^2]$$

**Figure 4: Downside Standard Deviation (or Semideviation) and Downside Variance**

$$S_{Bi} = \sqrt{E\left\{ \text{Min}\left[ (R_i - (\Sigma_{Bi})), 0 \right]^2 \right\}} \text{ and } S_{Bi}^2 = E\left\{ \text{Min}\left[ (R_i - (\Sigma_{Bi})), 0 \right]^2 \right\}$$

Once the downside standard deviation of returns is found, Estrada (2002) calculates the downside covariance. Concerning the “simple” CAPM, covariance is the sum of the deviations of the portfolio returns ( $R_i - \mu_i$ ) multiplied by the deviations of the market returns ( $R_m - \mu_m$ ). On the contrary, the downside covariance is the sum of the minimum of the deviations of portfolio returns minus the benchmark or zero multiplied by the minimum of the market return deviations or zero. The forenamed equations are shown in Figures 5 and 6:

**Figure 5: Covariance**

$$\sigma_{im} = E[(R_i - \mu_i)(R_m - \mu_m)]$$

**Figure 6: Downside Covariance (or Cosemivariance)**

$$S_{Bi} = E\left\{ \text{Min}\left[ (R_i - (\Sigma_{Bi})), 0 \right] \times \text{Min}\left[ (R_m - \mu_m), 0 \right] \right\}$$

Furthermore, the correlation double equation combines the covariance and standard deviation. The correlation of an asset (i) with the market (m) is given as ( $\rho_{im}$ ). The downside correlation [ $\Theta_{Bi(m)}$ ] is a measure of the downside standard deviation and the downside covariance. The equations of correlation of an asset and downside correlation are shown in Figures 7 and 8 respectively:

**Figure 7: Correlation**

$$\rho_{im} = \frac{\sigma_{im}}{\sigma_i \times \sigma_m} = \frac{E[(R_i - \mu_i)(R_m - \mu_m)]}{\sqrt{E[(R_i - \mu_i)^2]E[(R_m - \mu_m)^2]}}$$

**Figure 8: Downside Correlation**

$$\Theta_{Bi(m)} = \frac{S_{Bi(m)}}{S_{Bi} \times S_m} = \frac{E\left\{ \text{Min}\left[ (R_i - (\Sigma_{Bi})), 0 \right] \times \text{Min}\left[ (R_m - \mu_m), 0 \right] \right\}}{\sqrt{E\left\{ \text{Min}\left[ (R_i - (\Sigma_{Bi})), 0 \right]^2 \right\} \times E\left\{ \text{Min}\left[ (R_m - \mu_m), 0 \right]^2 \right\}}}$$

The next factor of utmost importance which D-CAPM reexamines is the most famous and frequently used measure of risk in the asset pricing theory, that is Beta (or firm-specific risk). The Beta and the downside

Beta are measured as the covariance divided by the variance. The equations of Beta and Downside Beta are shown in Figures 9 and 10 respectively:

**Figure 9: Beta**

$$\beta_i = \frac{\sigma_{im}}{\sigma_m^2} = \frac{E[(R_i - \mu_i)(R_m - \mu_m)]}{E[(R_m - \mu_m)^2]}$$

**Figure 10: Downside Beta**

$$\beta_i^D = \frac{S_{Bi(m)}}{S_m^2} = \frac{E\{Min[(R_i - (\Sigma_{Bi})), 0] \times Min[(R_m - \mu_m), 0]\}}{E\{Min[(R_m - (\Sigma_m)), 0]^2\}}$$

Apart from Estrada (2002), Butler and Joaquin (2002) created implications for asset allocation and risk management. They looked at another aspect of downside Beta, which can measure the level of normality of correlation during extremely negative stock price volatility. Using simple and well-known patterns, namely the normal model of two variables, the ARCH/GARCH econometric model, and the student t distribution, they examined the consequences of prices' hyper-volatility in every model of the above. Consistent with financial literature, Butler and Joaquin (2002) found that returns of a diversified portfolio are affected by the stock markets' correlations. In days in which stock prices change sharply and rapidly, gains from diversification may be weakened.

The CAPM is the appropriate risk-free rate ( $R_f$ ) added to beta multiplied by the market risk premium where the market risk premium is the return on the market ( $R_m$ ) minus the risk-free rate ( $R_f$ ). Under the same rationale, D-CAPM uses an appropriate risk-free rate added to the downside Beta multiplied by the market risk premium. The equations of the CAPM and the D-CAPM are shown in Figures 11 and 12 respectively:

**Figure 11: CAPM**

$$E(R_i) = R_f + \beta_i(R_m - R_f)$$

**Figure 12: D-CAPM**

$$E(R_i^D) = R_f + \beta_i^D(R_m - R_f)$$

Finally, Estrada (2002) analyses data from the Morgan Stanley Capital Indices seeking and finding strong evidence that downside Beta clearly affects shift returns of securities especially those listed in emerging markets. It is remarkable that the D-CAPM is being taken under serious consideration by more and more academics and researchers as a reliable alternative model of the CAPM.

### B) International Capital Asset Pricing Model (I-CAPM)

Another model suitable for measuring risk is the International Capital Asset Pricing Model (I-CAPM). This model was initially developed by Grauer, Litzenberger, and Stehle (1976) with a single factor. Sercu (1980) and Solnik (1983) created an extension of the single factor I-CAPM presenting the multifactor I-CAPM. According to Koedijk, Kool, Schotman, and van Dijk (2002) as well as Koedijk and van Dijk (2004), the I-CAPM extract precise conclusions in perspective with the "simple" CAPM about returns, cost of capital and risk if the firms are exposed to global risk factors.

Assume a world with "n" currencies. Then the I-CAPM has "n" systematic risk factors (the global market portfolio and "n-1" exchange rates). "Currency 0" contains the return of asset i ( $R_i$ ) as well as the return of the global market ( $R_G$ ). The "currency 0" measure is one which lacks of actual money and currency. Also, this measure can be defined by the requirement that prices sum to a given constant. The symbol "\$" represents the home currency of asset i, "S" is the vector of nominal exchange rate returns on the other "n-1" currencies against "currency 0". The vector (r) denotes the nominal returns on the risk-free asset in country 1, and ( $r_i$ ) is the risk-free rate in the home country. Finally, (t) is the vector of ones, ( $d_{i1}$ ) and ( $d_{i2}$ ) represent the global market betas and the exchange rate betas (Koedijk et al., 2002). The equation of the I-CAPM is shown in Figure 13:

**Figure 13: International CAPM (I-CAPM)**

$$E[R_i] = r_f + E[R_G - r_s] d_{i1} + E[S + r - tr_s]' d_{i2}$$

The model of I-CAPM is based on the notion that investments and capital are free of restrictions. Generally, there has been an international relaxation of limitations the last years as far as investments are concerned (Solnik, 2003). Even if some loose restrictions exist in OCED countries, direct capital controls on foreign investments are no longer as important in determining portfolio choice and asset pricing (Sercu and Uppal, 1995). These potential restrictions are related with the number of shares that can be held by foreigners as well as with the option to which industries foreigners can invest.

**C) Weighted-Average Cost of Capital (WACC)**

In economic theory, the selection of an investment plan signifies the exclusion of another. Capital is always narrow and an investor creates opportunity cost for his/her options, diverting funds from market to market and/or from one project to another.

The concept of the Weighted-Average Cost of Capital (WACC) provides a guide for selecting investment plans. In the equation below, the weight of equity (the ratio of market value of equity divided by the total value of equity plus debt) is multiplied by the cost of equity ( $R_e$ ). This value is added to the weight of debt (the market value of debt divided by the total value of equity plus debt) multiplied by the cost of debt ( $R_D$ ) and reduced by the corporate tax rate ( $t$ ), in order to find the net value.

**Figure 14: Weighted-Average Cost of Capital (WACC)**

$$WACC = \frac{E}{E+D} (R_e) + \frac{D}{E+D} (R_D)(1-t)$$

Bruner, Eades, Harris, and Higgins (2003) underline that in theory and especially in practice, the calculation of WACC comes up against various difficulties. The most serious and compulsory requirement is the fact that not only the cost of equity but also the cost of debt and weights should be based on current market prices as well. In addition to the above, the cost of debt should be converted to the after-tax cost of debt in order to reflect the benefits of the net interest (interest free from taxation).

**6. Home Bias: Inhibitions of investors for the diversified portfolios to be internationalized**

There are many advantages for a portfolio to be internationally diversified. Specifically, emerging markets offer two fundamental benefits in comparison with mature markets: higher returns and weak correlations with developed economies (Levich, 2001). Nonetheless, portfolio diversification reflects home country biases. These biases can be also encountered in equities and bonds (Levich, 2001). These inhibitions which investors have can be attributed to transaction costs, tax rates, greater resources, foreign exchange risk and possible information disadvantages. Actually, as Solnik (2003) believes, while transaction costs and taxes do exist increasing the investors' costs up to 0.75%, the additional profits exceed the extra costs.

Additionally, Solnik (2003) spots a discouraging factor for the diversified portfolios which is connected with cultural differences. Foreign culture and markets make investors feel that the "market rules" are much less the same with the ones they already know. Finally, the different languages, trading processes and time all participate in the growth of an exaggerated risk sense in front of the "unknown" (Solnik, 2003).

Flamholtz, Bullen, and Hua (2002) stress that the bigger an investor is, the more internationalized his/her diversified portfolio will be. They continue stating up the percentages with which large organizations have their diversified portfolio internationalized. For example, institutional investors invest upon foreign assets about 13% of total funds. The largest 200 corporate pension plans in the U.S.A. had an average international allocation of 16%. Furthermore, pension plans in the United Kingdom have equity allocations outside the home market of between 20-30%. On the contrary, individual investors do not lay out more than the 3% of their funds on foreign assets diversifying their portfolios almost exclusively with local equities.

Home bias seems to have been transformed into a strong belief in investors' attitude. Due to this reality, some researchers have evolved models and theories which keep up with the persistence on home assets. Baxter, Jermann, and King (1998) state that the presence of non-traded consumption goods or non-traded factors of production does not explain the high degree of "home bias" displayed by investor portfolios, as



long as individuals have access to free international trade in financial assets. They persist on the idea that it is never optimal to exhibit home bias with respect to domestic traded-good equities. By contrast, holdings of non-traded-good equities in an optimal portfolio will depend sensitively on the elasticity of substitution between traded and non-traded goods.

Lewis (1999) wrote a survey underling that individuals do not do a good job of hedging risks across countries. Although theoretical analyses lead to the conclusion that diversified portfolios avoid to become global, empirical observation does not appear consistent with the conclusions of these analyses. Besides, in harmony with Solnik (2003), Lewis (1999) points out that potential gains clearly outweigh potential costs, when a diversified portfolio becomes expanded obtaining foreign securities too.

## 7. Conclusions

We look into the bibliography searching whether internationalization of a diversified portfolio can lead to lower levels of systematic risk and cost of capital. We quote a literature review of the CAPM and its alternative and more sophisticated models which show the correlation between risk and returns. We find that a vast amount of papers call into question home biases stating that the additional benefits of an international diversified portfolio outnumber the respective costs. However, empirical evidence shows that individual investors have high levels of risk aversion. To be more specific, while international investments make systematic risk to lower, other kinds of risk, such as transaction costs, tax rates, greater resources, foreign exchange risk and possible information disadvantages, are created. Investors are unable to allocate, fully understand and at the same time handle these risks and many times are driven to the choice of a regional (non-international) diversified portfolio.

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# COMPARISON OF THE CLASSICAL METHODS WITH THE BOOTSTRAP. COMPUTER INTENSIVE TECHNIQUES IN ESTIMATING PARAMETERS OF THE BIVARIATE POISSON DISTRIBUTION

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## Abstract

*The bivariate Poisson distribution can be formed with the help of three independent univariate Poisson distributions. We generated values from a bivariate Poisson distribution via simulation and tried to estimate the covariance parameter which is of great importance since the correlation coefficient is linked to it. There are several methods to estimate the parameters of this distribution and hence the correlation coefficient. In this study we provide a comparison of various non parametric methods for estimating the true value of this coefficient. Techniques such as bootstrap-t, BCA, Fisher's approximation and more, are discussed along with their advantages and drawbacks. The Studentized Bootstrap presented a good coverage probability and a tolerable Confidence Interval and Mean Length.*

*Key words: Bivariate, Poisson, bootstrap, correlation, confidence intervals*

## 1. Introduction

The bootstrap and jackknife are well-known resampling methodologies for obtaining nonparametric confidence intervals of or a parameter. In most statistical problems one needs an estimator of an unknown parameter of interest as well as some assessment of its variability. In many such problems the estimators are complicated functionals of the empirical distribution function and it is difficult to derive trustworthy analytical variance estimates for them. The bootstrap (Efron (1979, 1982, 1987)) and the jackknife (Miller (1974)) use straightforward but extensive computing to produce reliable indications of the variability of the estimator. For the justification of the bootstrap with regard to the foundation basis of the theoretical justification of bootstrap we have to say the following. The primary objective of this technique is to estimate the sampling distribution of a statistic. Essentially the bootstrap is a method that mimics the process of sampling from a population. Like one does in Monte Carlo simulations, by instead drawing samples from the observed sampling data. The tool of this mimic process is the wonderful Monte Carlo algorithm of Efron (1979). This process is explained properly in the book by Efron and Tibshirani (1993). Efron (1993) noted that the bootstrap confidence intervals are approximate yet better than the standard one. Nevertheless, they do not try to replace the theoretical ones. He also made clear that the bootstrap is not intended to be a substitute for precise parametric results, but rather a way to reasonably proceed when such results are unavailable.

“The bootstrap is in line with the general direction which Rao has imposed for the statistical discipline and is to extract all the possible information from the data” (Rao, 1989). One though, can pose the following question: why the bootstrap estimate of variance is converging to the true variance? The answer is the following: the strong law of large numbers implies that  $\hat{S}_B \rightarrow \hat{S}$  almost surely as  $B \rightarrow \infty$ . What is the permissible necessary value of B? In this respect we use the reference of Booth and Sarkar (1998). These researchers suggested that a choice between 200 and 800 is satisfactory for the estimation of the standard error and thus the construction of confidence intervals. With the great power of computing today we can have a safe choice of B equal to 1000.

In this paper we have not used powerful bootstrap variations like the double bootstrap (Tibshirani 1981 and Davison and Hinkley 1997) as well as the partial likelihood approach and the bootstrap calibration.

These methods have been proposed by Davison et. al. (1992), Beran (1987) and Loh (1987). The block bootstrap and the modified bootstrap were not implemented either.

The choice of the correlation coefficient for study was due to the fact that it has not been given much attention to this parameter. Most of the writers who dealt with it used the bivariate normal or lognormal distribution. Efron (1981) used a lot of bootstrap techniques to estimate the standard error of rho in the bivariate normal distribution. He also saw that the non parametric delta method can be badly biased. Dolker M. et. al. (1982) pointed out some possible problems in the correlation coefficient for very small sample sizes. The probability of such discrepancies (same bivariate vectors) is very low.

Rasmussen J.L. (1987) worked on the estimation of the correlation coefficient for normal and nonnormal distributions and saw that the Pearson coefficient was robust to deviations from the normality assumption. Hall P. et. al. (1989), Frangos C.C. and Schucany W.R. (1990) and Lee W. and Rodgers J.L. (1998), studied the bivariate normal and lognormal distributions. In all cases continuous bivariate distributions were examined and mainly the normal distribution.

In this paper the estimator of interest is the correlation coefficient in two bivariate discrete distributions, the Poisson and the Negative Binomial. Section 2 of this paper describes the Normal method, the Basic method, Percentile method, the ABC method, the Studentized method and the accelerated bootstrap (BCa), using either the positive and negative jackknives to estimate the acceleration constant  $\alpha$ . Section 3 describes the Classical method of constructing confidence intervals for the correlation coefficient. The comparison is accomplished by an extensive simulation study of the characteristics of interval estimators for correlation coefficient. Some characteristics of the selected methods are discussed in section 4 in terms of accuracy and transformation respecting property. The results are presented in section 5. The conclusions are that the Normal and the Basic methods do not work very well in these cases. The Studentized method does not work for low samples ( $n=10$ ), while as the sample size increases it produces the best results. The BCa methods are very stable regardless of the sample size and the value of the correlation coefficient. The Fisher's Z transform performed also very well in all cases. What is common for all methods is the reduction of the average length as we move to higher values of the correlation coefficient and/or of the sample size.

## 2. Non parametric bootstrap confidence intervals

Let  $X_1, X_2, \dots, X_n$ , be  $n$  independent and identically distributed random variables from an unknown probability distribution  $F_\theta(x)$ . Let  $\hat{F}$  be the usual empirical distribution function, having mass  $1/n$  at each observed  $x_i$ . The essence of the bootstrap method is that one draws random samples  $X_1^*, X_2^*, \dots, X_n^*$  with replacement from  $\hat{F}$  and then calculates  $\hat{\theta}^* = \hat{\theta}(X_1^*, \dots, X_n^*)$  as an estimate of  $\theta$ . After  $B$  replications of this mechanism, one has an empirical distribution of  $\hat{\theta}_b^*$  ( $b=1, \dots, B$ ) values which serves as an estimate of the unknown sampling distribution of  $\hat{\theta}$ . Following Efron (1987), to construct nonparametric confidence intervals for  $\theta$  by the percentile method, one uses the  $100a$  and  $100(1-a)$  percentiles of the bootstrap distribution of  $\theta$ . The  $1-2a$  central confidence interval for  $\theta$  is given by

$$\theta \in [\hat{G}_B^{-1}(a), \hat{G}_B^{-1}(1-a)], \text{ where} \tag{2.1}$$

$$\hat{G}_B(t) = \frac{\#\{\hat{\theta}_b^* \leq t\}}{B} \tag{2.2}$$

is the estimated bootstrap distribution function.

The Normal method (or standard confidence interval) has the known form of

$$\theta \in [\hat{\theta} - Z^{(1-\alpha)} \cdot SE(\hat{\theta}), \hat{\theta} + Z^{(\alpha)} \cdot SE(\hat{\theta})], \tag{2.3}$$

where  $SE(\hat{\theta})$  is a reasonable estimate of the standard error of  $\hat{\theta}$  and  $Z^{(a)} = \Phi^{-1}(\alpha)$  obtained from the tables of standard normal distribution.

The bias-corrected method with acceleration constant  $\alpha$ , ( $BC_a$ ), introduced by Efron and Tibshirani (1986) and discussed in detail by Efron (1987), is a procedure for improved confidence intervals for

problems where there exists a monotone transformation  $g$  such that  $\hat{\phi} = g(\hat{\theta})$  and  $\phi = g(\theta)$  satisfying the approximation

$$\hat{\phi} \sim N(\phi - Z_0\sigma_\phi, \sigma_\phi^2), \text{ where } \sigma_\phi = 1 + \alpha\phi.$$

This yields the  $1 - 2\alpha$  confidence interval

$$\theta \in \{G_B^{-1}(\Phi(Z[\alpha])), G_B^{-1}(\Phi(Z[1-\alpha]))\} \text{ where} \tag{2.4}$$

$$Z[\alpha] = Z_0 + \frac{Z_0 - Z_\alpha}{1 - \alpha(Z_0 - Z_\alpha)}.$$

Note that the BC intervals are BC, with  $a = 0$  and they further reduce to PM when  $Z_0 = 0$ .

How does one find  $a$ ? Efron (1987) shows that for one-parameter families,  $f_\theta(T)$ , of sampling distributions of  $T = \hat{\theta}$ , a good approximation is

$$a = \frac{1}{6} SKEW_{\theta=\hat{\theta}}(i_\theta(T)), \tag{2.5}$$

where  $SKEW_{\theta=\hat{\theta}}(i_\theta(T))$ , is the skewness at  $\theta = \hat{\theta}$  of the Fisher score function  $i_\theta(T) = (\partial/\partial\theta)\ln f_\theta(T)$ .

He also proposes that for data from an arbitrary distribution  $F_\theta$  and  $\theta = t(F_\theta)$  then  $a$  is reasonably well approximated by

$$\alpha = \frac{1}{6} \cdot \frac{\sum_{i=1}^n (I_i)^3}{\left\{ \sum_{i=1}^n (I_i)^2 \right\}^{3/2}}, \tag{2.6}$$

where  $I_i$  is the influence function of the functional  $t$  at the point  $x_i$ . Two different finite sample estimates of the influence function  $I_i$  are investigated here; the negative jackknife ( $I_-$ ):

$$I_{i-} = (n-1)[\hat{\theta}(x_1, \dots, x_n) - \hat{\theta}(x_1, \dots, x_{i-1}, x_{i+1}, \dots, x_n)], \tag{2.7}$$

and the positive jackknife ( $I_+$ ):

$$I_{i+} = (n+1)[\hat{\theta}(x_1, \dots, x_n, x_i) - \hat{\theta}(x_1, \dots, x_n)]. \tag{2.8}$$

The ABC method (stands for approximate bootstrap confidence intervals) is a method of approximating the BCa interval endpoints analytically, without using any Monte Carlo replications at all as Efron and Tibshirani describe (1993). It requires the resampling vector  $P^* = (P_1^*, P_2^*, \dots, P_n^*)$  which consists of the proportions

$$P_i^* = N_i^* / n = \frac{\#\{x_j^* > x_i^*\}}{n}, \quad i=1,2,\dots,n. \text{ Therefore the statistic e.g. } \hat{\theta}^* = \sum_{i=1}^n A_i^*$$

$\hat{\theta}^* = \sum_{i=1}^n P_i^* A_i$ . The calculation of the confidence limits require the calculation of some empirical influence component and of the acceleration constant which is again calculated as  $1/6$  times the standardized skewness of the empirical influence components.

Following Abramovitch and Singh (1985) and Loh (1987) we investigate a studentized statistic that is resampled to yield bootstrap confidence intervals for  $\theta$ . The approximation of the distribution of  $(\hat{\theta} - \theta) / SE(\hat{\theta})$ , by the bootstrap distribution of the studentized pivotal quantity (SPQ) namely

$$t^* = (\hat{\theta}^* - \hat{\theta}) / SE(\hat{\theta}^*), \tag{2.9}$$

where  $SE(\hat{\theta})$  is the square root of the estimated  $Var(\hat{\theta})$ . Denote by  $G_s(t) = \#\{t_b^* < t\} / B$  the bootstrap distribution of the studentized quantity  $t^*$ . The bootstrap confidence interval has the form:

$$\theta \in [\hat{\theta} - G_s^{-1}(1 - \alpha)SE(\hat{\theta}), \hat{\theta} - G_s^{-1}(\alpha)SE(\hat{\theta})] \tag{2.10}$$

The estimator for the standard error of the correlation coefficient was  $(1 - \theta^2) / \sqrt{n - 3}$ .

The Basic method is a combination of the Percentile and the Studentized method. Instead of trying to find the empirical distribution of  $\hat{\theta}_B^*$  ( $b=1, \dots, B$ ), this method finds the empirical distribution of  $\hat{\theta}_B^* - \hat{\theta}$ . Note that this statistic is the same as in the studentized method with the only difference that the denominator (standard error of  $\hat{\theta}$  is set equal to one). Then the confidence interval for the parameter  $\theta$  is given by the formula:

$$\theta \in [2\hat{\theta} - \hat{G}^{-1}(1 - \alpha), 2\hat{\theta} - \hat{G}^{-1}(\alpha)], \tag{2.11}$$

where  $G_B^{-1}(t)$  is the same as in (2.2).

### 3. Classical confidence interval

The classical confidence interval for the correlation coefficient is extracted through the Z-transform,  $\phi = 0.5 \ln\left(\frac{1 + \rho}{1 - \rho}\right) = \tanh^{-1}(\rho)$ . The confidence intervals for z is

$$\phi \in [\hat{\phi} - Z_\alpha \sigma(\phi), \hat{\phi} + Z_\alpha \sigma(\phi)] = [L, U], \text{ where } \hat{\phi} = \tanh^{-1}(r) \text{ and } \sigma^2(\phi) = 1/(n - 3).$$

It follows that the confidence intervals for the correlation coefficient are given by

$$\rho \in [(e^{2L} - 1)/(e^{2L} + 1), (e^{2U} - 1)/(e^{2U} + 1)]. \tag{3.1}$$

### 4. Characteristics of the above confidence intervals

The transformation respecting property is the characteristic that allows us to construct confidence intervals for a parameter and the transform the endpoints of the interval and end up with confidence intervals for a transform of the of the original parameter of interest. If for instance we have constructed a confidence interval for a parameter  $\theta$ , then the interval for  $\sqrt{\theta}$  will come easily by taking the square root of each of the endpoints of the initial confidence interval. The accuracy term refers to the rate of convergence, of the coverage probability, to the desired level of coverage. A central  $(1 - 2\alpha)$  confidence interval is supposed have probability  $\alpha$  of not covering the true value of  $\theta$  from above and below. In the case of a sample this probability is equal to  $\alpha + \frac{c}{n}$  or  $\alpha + \frac{c}{\sqrt{n}}$  for some constant  $c$ . In the first case the fraction goes to zero at rate

$1/n$ , whereas in the second case it goes to zero at rate  $1/\sqrt{n}$ . We refer to the first case with the term second-order accuracy and with the term first-order accuracy to the second case.

The Normal (or Standard) method is known to be neither transformation respecting nor second-order accurate. The Percentile and the basic methods are transformation respecting, but not second-order accurate. The BCa method is both transformation respecting and second-order accurate. The Studentized method is

second order accurate but not transformation respecting. If the interest lies in the estimation of the correlation coefficient of the bivariate normal distribution then the Fisher's transform works quite well in this method. The problem arises in non normal populations like in our case. The drawback of not using a transform is that you can end up with an interval not satisfying the range restriction. We did not use any transform in the Studentized method and the result was obvious for small sized samples ( $n=10$ ). The interval was larger than the set of permissible values for the correlation coefficient ( $[-1,1]$ ). This means that this method is not range-preserving. The ABC method is both second-order accurate and transformation respecting. One could also say that the Studentized method performs double bootstraps when the denominator is not known (in our case it is known), thus needs more computational effort. As already mentioned in the introduction the great power of computing these days, it is a serious problem no more. On the other hand the ABC method requires far less replications than its counterparty (BCa) needs. More information on the advantages and disadvantages of the various bootstrap methods can be found at Hall (1988) Efron and Tibshirani (1993) and DiCiccio and Efron (1996).

## 5. Simulations and results

A simulation study was performed as follows: 2000 independent-samples of size 10, 20, 50 and 100 were generated from each of two distributions; bivariate Poisson and bivariate Negative Binomial. The bivariate Poisson variates were generated according to the method described in the book of Morgan (1984). Three independent univariate Poisson variates are generated; say  $X_1$ ,  $X_2$  and  $X_3$  each with parameter  $\lambda_1$ ,  $\lambda_2$  and  $\lambda_3$  respectively. Then  $X=X_1+X_3$  and  $Y=X_2+X_3$  follow the bivariate Poisson distribution with covariance parameter  $\lambda_3$ . The parameters  $\lambda_1$  and  $\lambda_2$  were fixed at 0.5 and 1 respectively. What changed was the parameter of the covariance  $\lambda_3$ . The probability mass function is given by this formula

$$P(X = x, Y = y) = \sum_{\delta=0}^{\min(x,y)} \frac{\lambda_1^{x-\delta} \lambda_2^{y-\delta} \lambda_3^{\delta}}{(x-\delta)!(y-\delta)!\delta!} \exp[-(\lambda_1 + \lambda_2 + \lambda_3)] \quad (5.1)$$

The correlation coefficient based upon this bivariate distribution is given by the following formula

$$\rho = \frac{\lambda_3}{\sqrt{(\lambda_1 + \lambda_3)(\lambda_2 + \lambda_3)}} \quad (5.2)$$

For the selected values of the correlation, 0.25, 0.5, 0.75 and 0.9, the values of the covariance were 0.2393, 0.7287, 2.2184 and 6.7123 respectively.

The bivariate Negative Binomial distribution can be generated with many ways, by the process of compounding a Poisson distribution as in the univariate case or with the help of two univariate Negative Binomial variates and one univariate Binomial variate. These methods are better described in the book of Kocherlakota S. and Kocherlakota K. (1992). For this paper the method of rejection sampling was used. For more information on the computer generation of the bivariate Negative Binomial distribution one can look at Loukas and Kemp (1986). The distribution function is given by the formula

$$P(X = x, Y = y) = \frac{(r + x + y - 1)!}{(r - 1)! x! y!} \cdot p_1^x p_2^y (1 - p_1 - p_2)^r \quad (5.3)$$

The correlation coefficient for this distribution is given by the following formula

$$\rho = \frac{\sqrt{p_1 p_2}}{\sqrt{(1 - p_1)(1 - p_2)}} \quad (5.4)$$

The values of the correlation coefficients were set equal to 0.25, 0.5 and 0.75. The confidence intervals for the correlation coefficient valued 0.9 in the bivariate Negative Binomial distribution were not

computed due to computational difficulties. The pair of parameters  $p_1$  and  $p_2$  took the values (0.1393, 0.2786), (0.2287, 0.4574) and (0.2898, 0.5796) respectively. The number of successes ( $r$ ) was set equal to 5. The bootstrap confidence intervals with coverage probability  $1-2\alpha=\gamma_n=0.95$  for the correlation coefficient were calculated by each of the eight methods: Normal, Basic, Percentile, ABC, Studentized, Classical, BCa( $I_-$ ) and BCa( $I_+$ ). Table 1 and 2 present the expected coverage and length of the confidence intervals for the Poisson and Negative Binomial cases respectively.

When the values of the correlation coefficient are less than or equal to 0.5 and the ample size is equal to 10 the average length exceeds unity. The Studentized method provides probably the best confidence intervals in general (amongst the ones compared) but with a price, the average length is the largest in all cases. The average length exceeded the length of the interval of possible values of the correlation coefficient  $([-1,1])$ . However as the sample size increases they seem to reach the nominal level of 0.95 faster and better than the other methods. This happens due to the fact that this method is not transformation-respecting. Since the pivotal quantity used here was not the same as the Fisher's this problem is natural to occur. The Normal and Basic methods did not work very well in general. As the correlation and the sample size increase they tend to provide better results. The average lengths are in accordance with the ones of the other methods, but this is not true for estimated coverage. The highest value the coverage was estimated to have was 92.6% for a large sample size ( $n=100$ ) and high correlation ( $\rho=0.9$ ). The graphs after the table 1 show in a better way the way the estimated coverage changes as the sample size increases. The lines seem to converge at a point a little lower than 0.95. The BCa and the Fisher's based intervals are the most stable in general. No matter of the value of the correlation and the sample size they tend to produce stable results in terms of coverage probabilities. The ABC method performs well for large sample sizes but in general is not to be preferred as it tends to underestimate the true coverage probability, but not more than the Normal and Basic methods. The Percentile method leads to pretty similar conclusions (Figure 1).

The same conclusions as before are to be drawn fro the case of the bivariate Negative Binomial distribution as well, perhaps a little better. The Normal and Basic methods perform the same as before and as the sample size increases from  $n=20$  to  $n=50$  the estimation of the coverage probability is more close to the nominal one but the average length is not reduced at the same amount as before. The Percentile method estimates the coverage to be more than 0.90 irrespectively of the sample size or the correlation value. The ABC method performance is about the same as before, perhaps a little worse. The stability of the BCa and the Fisher's methods are met in this case also. The Studentized confidence intervals are more conservative; they overestimate the nominal level of 0.95 for small samples but later approximate the desired level.

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## Tables and Figures

**Table 1**

Estimates of the actual coverage,  $\gamma_n = 0.95$  in percent (first line) and the expected length, (second line): Poisson distribution

Correlations	Sample sizes	Methods								
		Normal	Basic	Percentile	ABC	BCa( $I_-$ )	BCa( $I_+$ )	Studentized	Fisher's	
$\rho=0.25$	n=10	85.4	76.6	89.6	90.45	92.8	93.6	98.4	94.2	
		1.154	1.136	1.136	1.128	1.188	1.194	*	1.126	
	n=20	87.35	82.7	91.85	91.2	92.95	93.5	95.8	93.15	
		0.826	0.819	0.819	0.794	0.826	0.829	1.064	0.829	
	n=50	90.95	88.95	93.0	92.4	92.5	92.85	94.15	92.9	
		0.534	0.533	0.533	0.526	0.534	0.534	0.584	0.534	
	n=100	91.8	90.4	92.85	93.15	92.65	93.05	93.6	92.9	
		0.386	0.386	0.386	0.383	0.387	0.386	0.404	0.386	
	$\rho=0.5$	n=10	84.35	75.4	90.1	87.74	92.35	93.8	96.55	92.75
			1.007	0.987	0.987	0.987	1.053	1.077	-	1.077
n=20		88.55	82.5	92.3	91.4	93.45	94.2	95.85	93.4	
		0.683	0.677	0.677	0.666	0.6927	0.701	0.875	0.701	
n=50		91.7	89.2	92.65	92.65	93.1	93.4	94.55	92.45	
		0.44	0.44	0.44	0.439	0.444	0.446	0.482	0.446	
n=100		92.5	91.1	93.6	93.6	93.45	93.45	94.45	92.75	
		0.316	0.316	0.316	0.316	0.317	0.317	0.33	0.317	
$\rho=0.75$		n=10	86.85	76.0	90.8	87.995	93.4	94.15	96.45	93.35
			0.692	0.672	0.672	0.696	0.747	0.798	-	0.798
	n=20	87.75	81.45	90.95	90.8	92.05	92.7	93.7	92.75	
		0.424	0.419	0.419	0.427	0.4407	0.455	0.54	0.455	
	n=50	91.55	88.15	93.55	93.45	93.45	93.75	95.0	92.85	
		0.263	0.263	0.263	0.267	0.269	0.272	0.285	0.272	
	n=100	92.5	89.95	93.65	92.9	93.0	93.25	93.55	92.15	
		0.187	0.187	0.187	0.19	0.19	0.191	0.195	0.191	
	$\rho=0.9$	n=10	87.7	73.3	89.4	84.2	91.6	92.5	95.25	93.15
			0.372	0.35	0.35	0.377	0.419	0.473	-	0.473
n=20		88.45	81.7	91.75	90.2	91.65	92.1	93.5	93.8	
		0.2	0.197	0.197	0.208	0.214	0.225	0.25	0.225	
n=50		91.5	86.05	93.7	93.65	93.5	93.65	94.4	93.4	
		0.116	0.116	0.116	0.12	0.12	0.122	0.125	0.122	
n=100		92.6	90.7	93.55	93.85	94.4	94.35	94.15	92.9	
		0.082	0.082	0.082	0.084	0.084	0.085	0.085	0.085	

\* Length larger than 2.

**Figure 1. Poisson distribution**

○=Normal, ■=Fisher, □=Percentile, ◇=ABC, ●=BCA(I<sub>+</sub>), ▽=BCa(I<sub>-</sub>), ▲=Studentized, △=Basic.

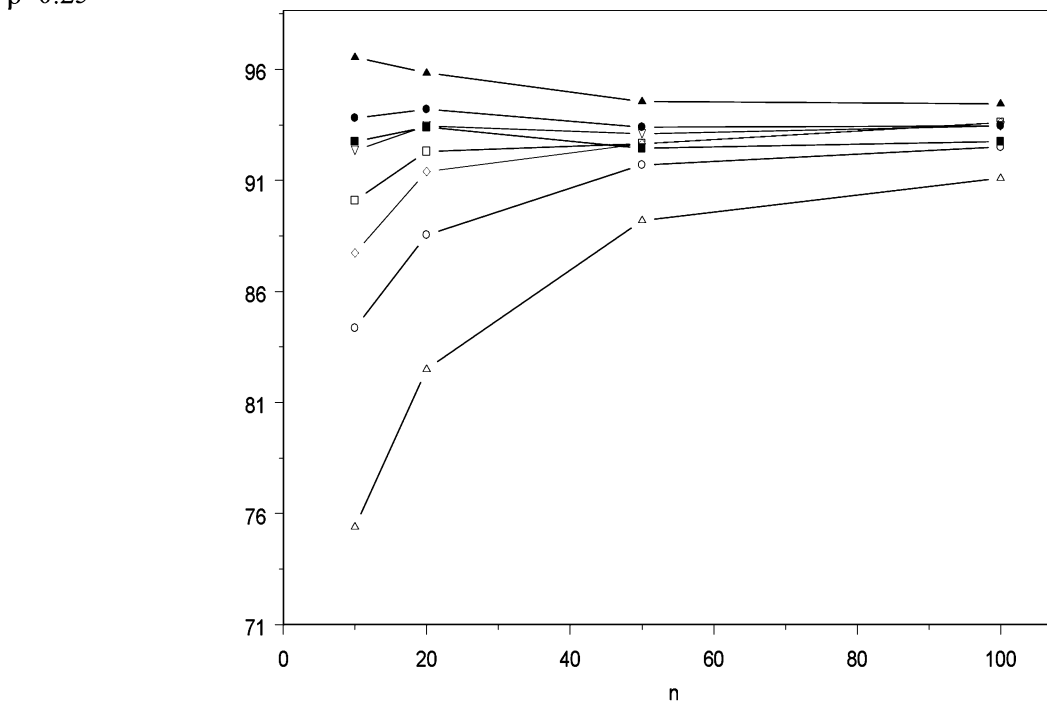
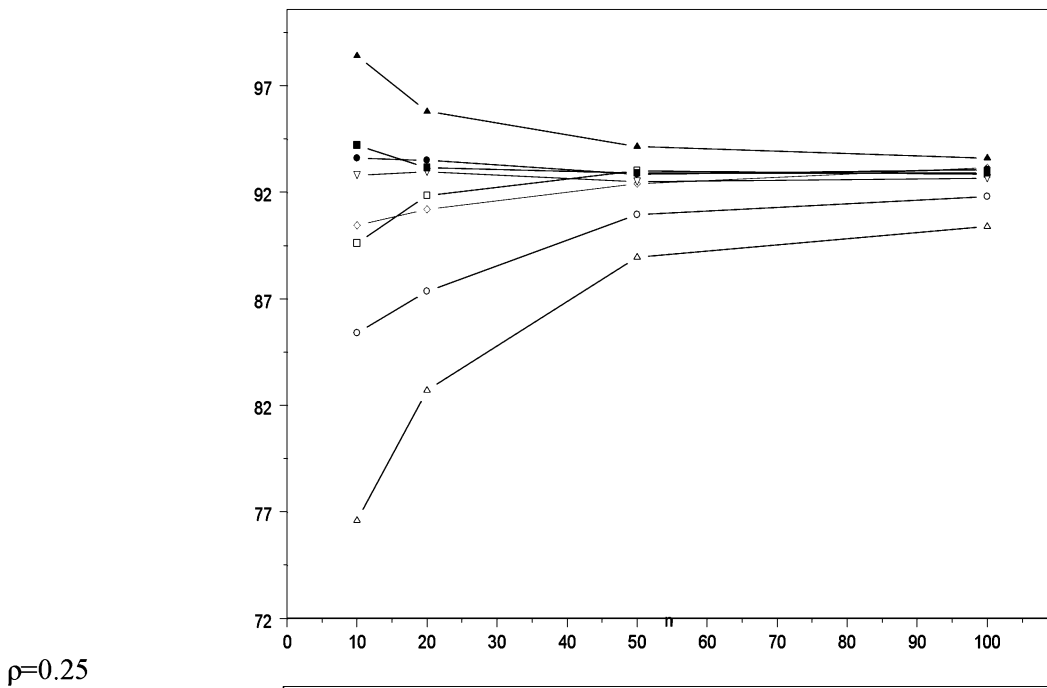


Table 2

Estimates of the actual coverage,  $\gamma_n = 0.95$  in percent (first line) and the expected length, (second line):  
Negative Binomial distribution

Correlations	Sample sizes	Methods							
		Normal	Basic	Percentile	ABC	BCa( $I_-$ )	BCa( $I_+$ )	Studentized	Fisher's
$\rho=0.25$	n=10	86.0	78.0	92.0	88.45	93.4	94.4	98.6	94.6
		1.19	1.173	1.173	1.151	1.209	1.218	-	1.218
	n=20	86.8	82.7	90.9	89.7	91.8	92.55	94.05	92.9
		0.824	0.817	0.817	0.787	0.825	0.826	1.05	0.826
	n=50	90.35	88.15	92.55	91.45	91.9	92.3	93.4	92.5
		0.535	0.533	0.533	0.525	0.535	0.534	0.583	0.534
	n=100	90.3	89.35	91.2	90.9	90.9	91.0	91.1	91.5
		0.387	0.386	0.386	0.384	0.387	0.387	0.404	0.387
$\rho=0.5$	n=10	87.2	77.9	91.4	88.05	93.45	94.35	98.05	93.75
		1.032	1.012	1.012	1.004	1.077	1.098	-	1.098
	n=20	88.9	83.9	91.7	89.85	92.0	92.85	94.65	93.5
		0.699	0.694	0.694	0.674	0.705	0.713	0.883	0.713
	n=50	92.55	90.25	94.4	93.25	93.25	93.8	95.05	93.7
		0.444	0.443	0.443	0.438	0.444	0.446	0.483	0.446
	n=100	93.3	91.8	93.05	92.7	92.45	92.7	93.7	92.55
		0.32	0.32	0.32	0.318	0.321	0.321	0.334	0.321
$\rho=0.75$	n=10	87.95	76.0	91.45	86.2	92.55	93.85	96.75	92.9
		0.707	0.686	0.686	0.699	0.769	0.811	1.497	0.811
	n=20	88.9	82.15	91.95	90.0	92.25	92.55	94.2	92.35
		0.435	0.43	0.43	0.427	0.447	0.46	0.542	0.46
	n=50	93.35	90.35	94.9	93.8	93.85	94.5	94.75	94.4
		0.264	0.263	0.263	0.264	0.267	0.269	0.284	0.269
	n=100	93.7	92.1	94.8	93.45	93.45	93.55	94.4	93.5
		0.187	0.187	0.187	0.187	0.188	0.188	0.194	0.189

# TECHNO-ECONOMIC ANALYSIS OF INFORMATION SECURITY EXPENDITURES

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## Abstract

*Information Security is considered to be an inextricable part of companies' expenditures and there are defined amounts that are invested for its accomplishment, although it is really difficult to determine the best Security Solution. The substantive problem of information security risk is value proportion of information properties or assets. Risk analysis can be approached from two evaluation models: the qualitative and the quantitative. Quantitative analysis refers to the use of numeric calculations and statistical techniques. Qualitative analysis describes methods that consider loss in a subjective form. Without measurement and metrics of information security we will not be able to estimate and process Information Security Strategies. The aims of this paper are to gain an understanding of Quantitative and Qualitative analysis and furthermore to both evaluate and improve the use of those methods.*

*Keywords: Risk, Information Security Economics, Quantitative analysis, Qualitative analysis*

## 1. Introduction to Security Process

As the world becomes more connected and an increasing amount of business is transacted electronically the computer and information security will continue to grow in importance (see Johnston et al. 2003). But before we step forward to the concept and means of security we need to understand that the most important characteristic of an object transacted electronically is its value. And that is because for failures to have consequences, electronic assets must have value. As Gaines and Shapiro (1978) designates, value to the potential violator may result from possession of the object (knowledge of the information), or because the violator can use the object. Value may be quantifiable, generally in monetary terms, or it may be determined subjectively and thus be difficult to quantify.

Security is an intricate property that is achieved by a combination of sufficiently strong cryptographic algorithms and protocols, correct implementation of hardware and software, and appropriate assumptions about trusted authorities (see Older and Chin, 2002). Security is a constant process that is strongly related to today's society evolution and not a solution (see Sandrini, 2003). Security properties describe the ability of principals to access information or resources. Key security properties include (see Peltier 2005; Suh and Han 2003):

- *privacy or confidentiality*: setting principal which information are and can be revealed to authorised people
- *integrity*: detection of whether the data has not been altered, manipulated or corrupted by unauthorized parties;
- *authentication*: providence of the identity of a principal or the source of information;
- *access control*: restricting or controlling the actions of a person or entity, based upon its identity
- *non-repudiation*: preventing person or entity from denying their actions;
- *availability of service*: guaranteeing authorized persons or entities to have continuously and uninterrupted access to services.

Canavan (2001) looks security as a trinity (figure 1) consisting of:

- **Prevention** – foundation, preventative measures over detection and response

- **Detection** – once measures implemented, procedures need to be placed in order to detect potential problems
- **Response** – identifies the appropriate response to a security breach

**The security trinity**

The determination of security requirements for a given system, and the selection of appropriate security mechanisms (including security policy) are a part of the risk management activity. The basic steps are value and criticality analysis, vulnerability analysis, threat identification, risk analysis, risk assessment, security safeguards selection and implementation, development of contingency plans, and effectiveness reviews (see Turn, 1999). The better the risk model, the better the security decisions that can be made using its forecasts (see Schechter, 2004). The only thing that security policy specifies (figure 2) is what should be protected, but does not impose any measures. In simply words policy necessitate certain process on who (person or entity) has specific permission and what he can do with information. From the moment the security policy has been employed the sequential stage is to enforce it (see Decker, 1998).

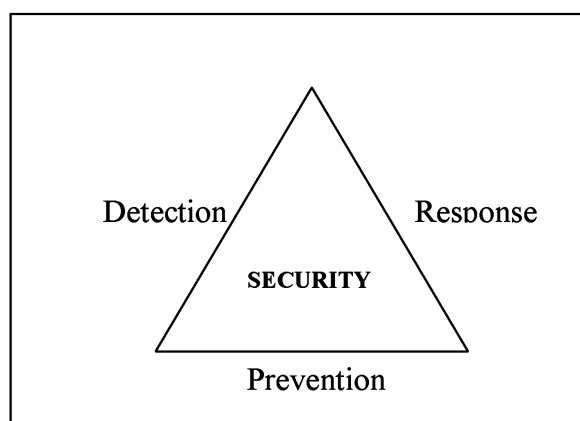


Figure 1. The security trinity

**Security policy and risk**

An *asset* is defined as any element of an information system that possess a value (see Loukis and Spinellis, 2001). It includes tangible (software, hardware, personnel) and intangible assets (plans, organization, external factors, technical factors). In risk process an object is called asset when there is an effect in objects value when risk emerges. A *threat* is defined as any possible harm to the system, including network failures and natural disasters. Vulnerability is a weak point where the system security is susceptible to attack (see Myerson, 1997; and Spinellis et al., 1999). Threats need to exploit certain vulnerability in order to cause a security incident. Therefore, threats, vulnerabilities, and impacts should be combined together to provide a measure of the risk. This is given in figure 3.

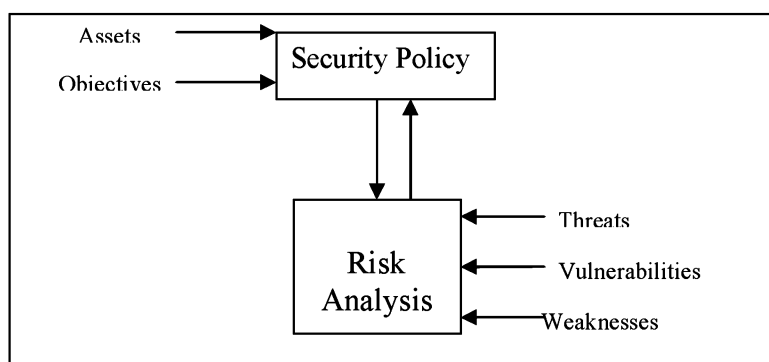


Figure 2. Security policy and risk

**The process of risk**

By Security Architecture we mean the consideration of how a company's systems (in the widest sense) should be designed to ensure that the company meets its security objectives (see Wright, 2001). A security Infrastructure is the practical realization of a security Architecture in a tangible and usable form. A security objective is the contribution to security that a system or a product is intended to achieve (see Röhrig and

Knorr, 2004). The term security objective must not be confused with security services that are defined as “a processing or communication service that is provided by a system to give a specific kind of protection to system resources” or — with more emphasis on communication in as “a service, provided by a layer of communicating open systems, which ensures adequate security of the system or of data transfer” (see Abrams et al., 1995). Therefore, security objectives are the goals that are to be achieved, while security services are means to achieve these goals.

We can picture this in the following ideogram as:

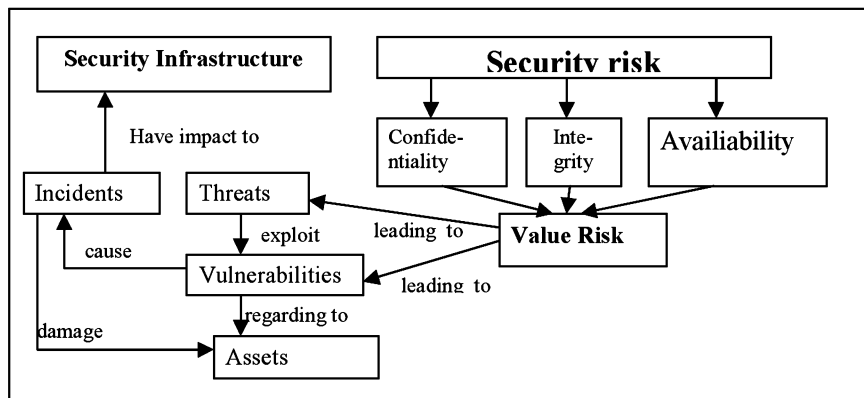


Figure. 3. The process of risk

### Implementing Security

Analyzing the security sceptic – logic we conclude in:

1. Identification of the system and its components
2. Identification of the system assets and their value to the system
3. Security objectives for the assets
4. The threats and vulnerabilities the assets face of will face
5. Valuation (financial) of security process through risk management
6. Design and establishment of security principals applicable to the organization system

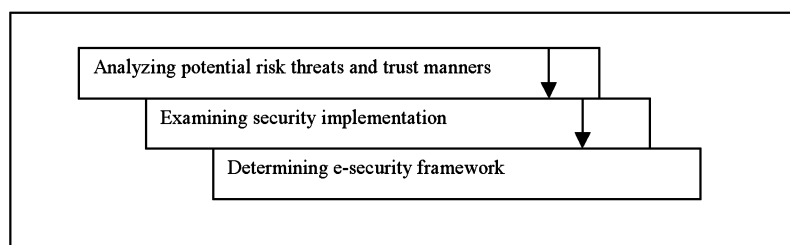


Figure. 4. Implementing Security

## 2. Risk Concept

Every human endeavour involves risk (see Chapman, 1998). The majority of people, think that risk constitutes something negative or bad. But Labuschagne and Eloff (2000), shows that we need to think of risk as mere opportunities, and the reason is that in most business environments, the number or size of the risks taken usually is equal to the number or size of the advantages to be gained. The reverse is also true. Risk has been studied from many perspectives. Kumar, (2002) studied risk in a detailed theoretical analysis of the anatomy of risk and risk and uncertainty in the context of the value of information.

Risk (R) in the simplest form is the product between event probability P(E) and the possible damage, mostly described as an Impact (I) (see Böhmer, 2006).

$$R(E) = P(E) \cdot I(E) \quad (2.1)$$

Where R(E) = risk of an event, E = Event, P = Probability and I = Impact.

The scope is to replace risk with acceptable risk as Jackson and Al-Hamdani (2008) formulate:

$$\text{Security Investment} \leq \text{Acceptable Risk} \geq 0 \quad (2.2)$$

### 3. Implementing Risk Evaluation methods (measurement)

Over the last five years there is a tremendous interest to implement - apply economic analysis to information security issues (see Anderson and Moore 2006; Lawrence and Loeb 2002; Huang et al. 2008; Campbell et al. 2003). And that is due to demand to define risk quantitatively so that information security can be addressed in a consistent, predictive and repeatable way (see Drake, 2004; Munteanu 2006; Shah and Murtaza 2006). Furthermore economic analysis often explains security failure better from technical analysis.

Measurement of risk of an organisation can be conducted by two different measurements, Quantitative or Qualitative (see Bornman, and Labuschagne, 2004). We use those measurement methods in order in one hand to understand and evaluate, problems and in the other to predict and improve processes, products and strategies.

**Quantitative** risk analysis or Quantitative measures is a mathematical approach to assign numerical value in order to measure the amount of damage done to an asset. Asset(s) values are expressed in monetary terms and threat(s) frequency in annualized expressions that represent actual expected frequency (e.g., 1/10 for once in 10 years, or 50/1 for 50 times per year) (see Ozier, 2003; McAfee, 2006).

**Qualitative** risk analysis or measure is the simplest form of relative value assigned to a risk, for estimating potential loss using subjective measurement such ordinal ranking (low risk or value, medium risk or value, and high risk or value) in a risk-to-value matrix. As everything there is positive and negative side. So looking qualitative versus quantitative we have the following tables:

Qualitative – Pros	Qualitative – Cons
Calculations are simple	Process and metrics are subjective
No need to assign monetary value or threat frequency	No value calculation
Cost of risk does not need to estimate threat and measures	No basis is provided for cost/benefit analysis
	Not objective way to management risk and analyze impact

Table 1. Qualitative Pros & Cons

Quantitative – Pros	Quantitative – Cons
Value of information in monetary terms is objective	Calculations are complex
Return on Investment on Security implementation can be measured	A great amount of information must be gathered
Risk management can be evaluated	Common Standards lack for risk/threat.

Table 2. Quantitative Pros & Cons

### 4. Establishing Quantitative Risk analysis

Information security management is closely related with financial decision making. The question whether we need more security (certain products), has turned to how much should we spend for added security. But spending more doesn't necessary means that we are more secure. It is true that good security costs a lot to implement (see Schneier, 2004) while on the other hand, the cost of actually detecting and responding to problems and security breaches is not as high (see Lampson, 2004).

The fact that security technology is advancing at a tremendous speed but the problem still remains indicates that the key solution to the problem is not with technology but with how people implement security technology (see Tabba, 2005).

This sceptic leads us to the reality that we need to educate people to risk management model that reducing cost without increasing risk

Information security investments concerning well established technologies such as firewalls and anti-virus software is easier because the economics of these technologies are already well understood. The problem emerges from new investments where the results are far less tangible (see Taylor, 2002). Specific, information security managers are confronted with great difficulties evaluating and justifying security technology investments because the technology benefits are difficult to estimate and these benefits depend on attack(s) frequency expectation, damage occurrence and effectiveness of security technology to mitigate the damage(s) from an attack(s) (Butler, 2002).

The first simple method is estimation of Annualized Loss Expectancy (ALE) (see Lin et al., 2007; Bistarelli et al., 2006 and Beachboard et al. 2008). We need to calculate:

**Asset Valuation (AV):** The process that distributes every information financial value.

**Exposure Factor (EF):** Is expressed within a range from 0 to 100 percent that an asset's value will be destroyed by risk.

**Single Loss Expectancy (SLE):** Is the calculation of expected monetary loss every time a risk occurs. The Single Loss Expectancy, Asset Value(AV), and exposure factor(EF) are related by the formula:

$$SLE = \text{asset value (AV)} \times \text{exposure factor (EF)} / SLE = AV * EF \quad (4.1)$$

Next we find **Annualized Rate of Occurrence (ARO):** The probability that a risk will occur in a particular year.

**Annualized Loss Expectancy (ALE):** is the annually expected monetary loss that can be expected for an asset due to a risk. It is determined by the two input values: the cost of the damage and the probability that the loss will occur. It is calculated as:

$$ALE = SLE * ARO \quad (4.2)$$

The second formula is **Return On Investment**. ROI as it names indicates simply defines how much will be received for what I have spent (Lucas, 2005). By spending we mean things such as equipment (Firewalls, Antivirus, etc), administration (Per hour cost of all security activities) etc. So ROSI, acronym of **Return on Security Investment**, as defined by (Davis, 2005) measures how much security investment reduces the risk. The calculation of the financial return from an investment in security is based on the financial benefits and costs of that investment. (Sonnenreich et al., 2006) calculated ROI, as the cost of a purchase is weighed against the expected returns over the life of the item (1).

$$ROI = \frac{\text{Expected Returns} - \text{Cost of Investment}}{\text{Cost of Investment}} \quad (4.3)$$

#### 4.1. Example

A simplified example of an ALE calculation that describes the above approach is to multiply the cost of a potential exposure, times the likelihood that it will occur. In a case that we have a server that costs (has an asset value of) 20000 €, an Antivirus 1500 € and Infrastructure 1000000 € we can produce the following results (table 3).

<i>Asset</i>	<i>Asset Value</i>	<i>Threat</i>	<i>EF</i>	<i>SLE</i>	<i>ARO</i>	<i>ALE</i>
Server	20000 €	Failure	100%	20000 €	0.35	7000 €
Antivirus	1500 €	Virus	20%	300 €	0.51	153 €
Infrastructure	1000000 €	Fire	40%	400000 €	0.07	28000 €

**Table 3.** Example of cost implementation

#### 5. Concluding remarks

The goal of security is to protect the distributed information, in Information Systems and Networks from any source and type of threat. The study of the literature impose that approaches for measurement of Information Security are relied on the measurement and analysis of risk. The cost of Information Security however, can't be calculated with precise as the information and substructures have subjective value and perception. The question that arises is twofold. Firstly when the information or system is considered secure and secondly what is its price for it. The higher price-cost doesn't mean that we have the higher level of security.

We proposed the risk analysis methodology that should be followed, also tried to investigate, if the adoption of security countermeasures constitutes operational cost, or value-added cost. This paper presented our results and introduced our approach to demonstrate that investments in Information Security can be measured (Qualitative and Quantitative) and analyzed with certain methods.



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# CITIZEN SATISFACTION FROM THE LOCAL GOVERNMENT AFTER THE ADMINISTRATION REFORM OF 1997 IN GREECE: THE CASE OF THE GREEK ISLAND THERA (SANTORINI)

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## Abstract

*Aims:* In 1997, Greece underwent a great reform in its public administration system, hugely reducing the number of local government organizations. The purpose of the present paper is to estimate citizen satisfaction from the local government in the Greek island Thera, after the enforcement of the law 2539/1997 "Ioannis Kapodistrias" and to discover possible associations with this satisfaction. Additionally, we intend to use citizen satisfaction as a measure of local administration performance (Kelly & Swindell, 2002). To our knowledge, this is the first study concerning citizen satisfaction in Greece.

*Methods:* Our sample consisted of 140 citizens from the Greek island Thera, belonging either to the Community of Oia or to the Municipality of Thera. Mean age: 40 years old and male/ female proportion was 47% / 63%. Our sample completed a questionnaire containing questions on demographics, knowledge of local government system and satisfaction from local government (standardized Cronbach's alpha = 0.758).

*Results:* Twenty four percent (24%) of the citizens claimed to be satisfied from local government. This was significantly correlated with the place of voting ( $p < 0.01$ ). The possibility somebody from Thera would be satisfied from the local government was significantly less than the same possibility from Oia (OR=0.24, 95% CI 0.09-0.64). Sixty one percent (61%) of the citizens knew what was the state of public administration in Thera and this knowledge was associated significantly with level of education ( $\chi^2 = 9.621$ ,  $df = 4$ ,  $p = 0.047$ ). The main complaint of the citizens from public administration concerned the low quality of health services (62%).

*Conclusions:* Citizens from Oia and Thera could be more satisfied from government than they are today. Generally, they must be informed about state of affairs by local councillors and this effort must be applied more strenuously in the greater municipality of Thera.

## Περίληψη

*Σκοπός:* Το 1997 ψηφίστηκε ο νόμος 2539/1997 «Ι. Καποδίστριας», μειώνοντας δραματικά τον αριθμό των ΟΤΑ σε όλη την ελληνική επικράτεια. Σκοπός της παρούσας εργασίας είναι να εκτιμήσουμε την ικανοποίηση των πολιτών από την τοπική αυτοδιοίκηση στη νήσο Θήρα (Σαντορίνη), μετά τον νόμο «Ι. Καποδίστρια» και να χρησιμοποιήσουμε την ικανοποίηση ως μέτρο αποδοτικότητας της τοπικής αυτοδιοίκησης (Kelly & Swindell, 2002).

*Μέθοδοι:* Το δείγμα μας αποτελείται από 140 κατοίκους από τη Θήρα, που ανοίκουν είτε στην Κοινότητα Οίας είτε στο Δήμο Θήρας. Μέση ηλικία δείγματος: 40 ετών και οι άντρες και οι γυναίκες συμμετείχαν σε περίπου ίσο ποσοστό στο δείγμα. Συμπληρώθηκε ερωτηματολόγιο με ερωτήσεις που αφορούσαν τα δημογραφικά, τη γνώση της τοπικής αυτοδιοίκησης και της ικανοποίησης από την τοπική αυτοδιοίκηση (συντελεστής εσωτερικής αξιοπιστίας Cronbach  $\alpha = 0.758$ )

*Αποτελέσματα:* Το 24% των πολιτών ανέφερε ότι ήταν ικανοποιημένο από τη διοίκηση. Η ικανοποίηση από τη διοίκηση ήταν συσχετισμένο σε στατιστικά σημαντικό βαθμό με την τοποθεσία των εκλογικών δικαιωμάτων των πολιτών. ( $p < 0.01$ ). Η πιθανότητα κάποιος πολίτης από το Δήμο Θήρας να ήταν ικανοποιημένος από τη διοίκηση ήταν σημαντικά μικρότερη από την ίδια πιθανότητα για κάποιον κάτοικο από την Κοινότητα Οίας (OR=0.24, 95% CI 0.09-0.64). Το 61% των πολιτών γνώριζε ποια ήταν η πρωτοβάθμια τοπική αυτοδιοίκηση (ΟΤΑ) στη Σαντορίνη και αυτό παρουσίαζε στατιστικώς σημαντική συσχέτιση με το επίπεδο της εκπαίδευσης

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(( $\chi^2 = 9.621$ ,  $df = 4$ ,  $p = 0.047$ ). Το κύριο παράπονο από τη την τοπική αυτοδιοίκηση αφορούσε τη χαμηλή ποιότητα των ιατρικών υπηρεσιών (62%).

*Συμπεράσματα:* Οι πολίτες της Κοινότητας Οίας και του Δήμου Θήρας θα μπορούσαν να ήταν περισσότερο ικανοποιημένοι από την τοπική αυτοδιοίκηση. Γενικά, οι δημοτικοί σύμβουλοι πρέπει να ενημερώνουν τους κατοίκους και τα θέματα διοίκησης, και αυτή η προσπάθεια πρέπει να εφαρμοσθεί περισσότερο έντονα σε όλη την έκταση της νήσου Θήρας.

## 1. Introduction

Thera (Santorini) is the southeast island of the Cyclades and is situated north of Crete. Santorini, Therasia and Aspronisi form a circle containing a caldera in the middle, which was shaped after the sinking of the island by the big volcanic eruption around 1500 BC. In the caldera, two new islands, Nea Kameni and Palaia Kameni, were shaped from underwater eruptions of the volcano of Santorini. Today 13.500 persons live permanently on the island and are divided in 16 smaller and bigger villages. The population of the island earns its living mainly from tourist occupations and less from traditional activities such as viniculture, tomatoculture, wineries and fishing (Kontaratos, 2007).

In 1997 the law 2539/1997 "Ioannis Kapodistrias" was voted and proposed decrease in the number of Communities and Municipalities (from 6000 to 1000) all over Greece by means of uniting the old Local governments (Spanou, 2008). In Thera, the law was enforced and applied in 1998 and created two local governments: Municipality of Thera and the Community of Oia.

The aims of the law "Ioannis Kapodistrias" were: a) the modernization of the administration system (because local governments are the base of public administration), b) the creation of first degree local governments with a statutory structure of contemporary open cities (in which, there will be oecistical units that are interdependent), the improvement of the local political system (since the administration of local transactions to the new local governments will form an important risking of power for the local societies), c) a managerial and economical state of being self-contained for local governments and the co-ordination of local public investments (with the creation of a "powerful administrative center acting at an extensive local scale" and the application of EAPTA) and, finally, d) to ensure satisfactory degree of legitimacy, transparency and social control of local authority.<sup>1</sup>

Today, ten years after the enforcement of the programme "Ioannis Kapodistrias", a new reform is in progress called "Ioannis Kapodistrias II", which discusses the decrease of local government even more: from 1033 to approximately 1/3 (that is about 400 new local governments). Those 400 local governments will become part of 16 prefectures and 6 bigger administrative regions. Recent newspaper articles discuss the "immobilization" of "Ioannis Kapodistrias II" indefinitely and possibly the abolition of this new reform attempt.

Possible reasons leading to the postponement of this new reform are suggested to be the world economic crisis and the contemporary social crisis in Greece (Chatziioanidou, 2008; Aegean Times, 2008).

In Thera, the creation of two local governments (the Municipality of Thera and the Community of Oia), appears to have brought forth a displeasure among citizens (Argyrou & Pelekis, 2002; ILG, 2008), mainly because citizens feel that they have been driven away from access to local government. This tendency of citizens is understandable and specifically in a small and peripheral local government, like Thera, where the personification of relationships play an important role in everyday activities.<sup>2</sup> Furthermore, a basic principle of public administration is that "the citizen wants the municipal authority close to him because this is the real essence of first degree local government" (ILG, 2008). So far, however, there has not been a study on citizens of Santorini examining the degree of knowledge and satisfaction by this legislative reform, as well as the knowledge of the aims of this reform. Research on this issue is in accordance with international bibliography (Kelly & Swindell, 2002; Sotirakou & Zeppou, 2006). Thus, the purpose of the present paper is to examine these issues, through a systematic attempt.

<sup>1</sup> See Chrysanthaki (1998), p. 237.

<sup>2</sup> In bigger cities, the phenomenon of personification of authority is not so intense. One reason is the bigger population of cities and the less interpersonal relationships of extensive scale.

## 2. Methods

In order to estimate the satisfaction of citizens from the local government in the island of Thera (Santorini)

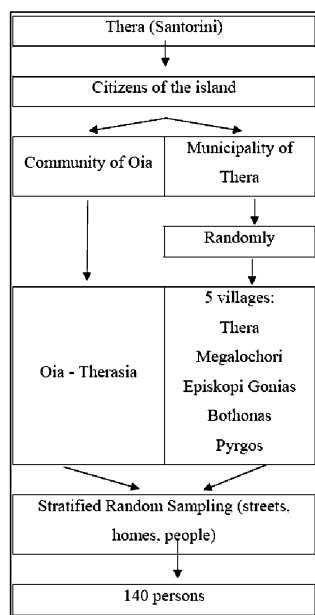


Figure 1. Sampling method in our survey

after the law “Ioanni Kapodistrias”, we used a structured questionnaire. Our sampling method was stratified random sampling (Figure 1) and the population of our research (sample) consisted of 140 citizens from Thera, belonging either to the Community of Oia or to the Municipality of Thera. The mean age of our sample was  $40 \pm 14,5$  (SD) years and the male / female proportion was 47% / 53%, meaning that the two sexes participated more or less equally in the sample. The questionnaire contained 13 questions and was divided into 4 sections: a) demographics, b) questions about the knowledge and the application of the law “I. Kapodistrias”, c) questions on the satisfaction of citizens the local government either from Municipality of Thera or the Community of Oia and d) questions on the general conception on behalf of citizens for the effectiveness of administration as well as suggestions for its improvement. Cronbach’s alpha coefficient of reliability was 0.758 and Spearman-Brown coefficient of split-half reliability was 0.765. Both coefficients show satisfactory internal reliability of the questionnaire.

Statistical techniques used were Pearson’s correlation coefficient for analysis of our data correlation analysis and hypothesis testing with  $\chi^2$ . The statistical processing of data was conducted the statistical package Social Package for the Social Sciences (SPSS) 15.0 (SPSS Inc., 2006) (Frangos, 2004).

## 3. Results

### 3.1 Descriptives

The educational level consisted of persons who were graduates from primary school to graduates of a university school, with the bigger percentage being graduates of senior high school (36%). The 58% of sample had its voting rights in the Municipality of Thera and the 19% in the Community of Oia. It is worth underlining that although the majority of (61%) citizens knows that Santorini is formed of one Municipality and one Community and the 46% knows that “I. Kapodistrias” refers to the unification of communities for developmental reasons, it appears that the application of the law hasn’t become noticeable to the citizens. Answering the question whether the application of the reform helped, the 58% of citizens believes that it didn’t help at the least. We note also, that the 76% of citizens mention that they aren’t satisfied from the administration (Figure 2) and the main reason of displeasure was the combination of the political leader with the unsuccessful management of administration (33%) (Figure 3). Finally, we observe that the 62% of citizens believe that the administration after the law “I. Kapodistrias” (reform law) doesn’t contribute to the maintenance of the good fame of island. The main reason is the scarcity of medical assistance (29%) and the second reason are the ineffectual facilities of everyday life (e.g. pavements, parking) (15%). As a solution to these problems, citizens consider (38%) that there should be a change in the people who lead public administration as well as in the mentality of administration; with dominance though in the perception that these should be a change in mentality.

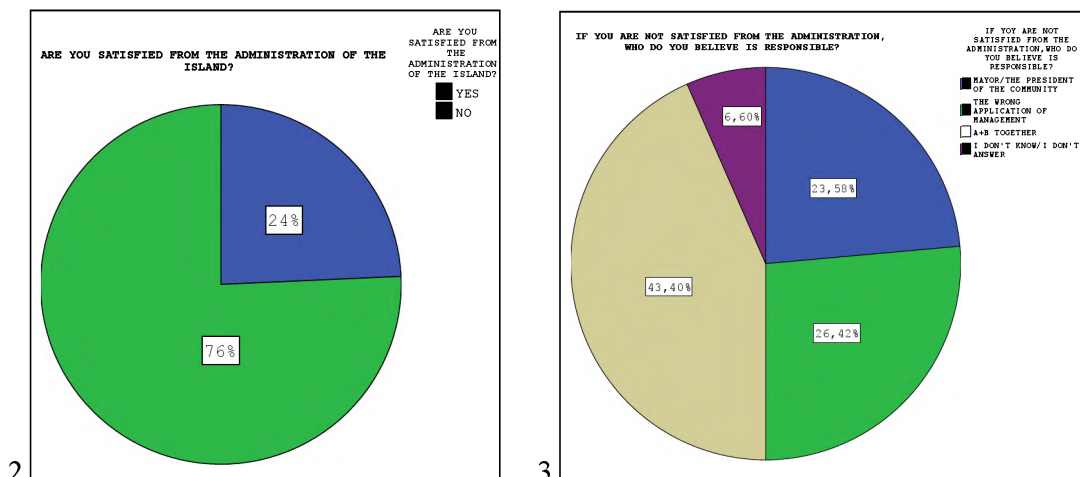


Figure 2. Presentation of the degree of satisfaction of citizens of the island Thera from the administration either of the Municipality or the Community. The 76% of citizens aren't satisfied from the administration, but the 24% are.  
 Figure 3. Presentation of the percentages of responsibility according to the not satisfied citizens.

### 3.2 Correlation Analysis

Pearson's correlation coefficients between the questions are shown in Table 1. A comment deserved being mentioned concerns the satisfaction of citizens from the Local government: where someone believed that he was satisfied from the way of administration of the island, he also believed that the party with the majority of votes was interested to face the problems of citizens (+0.383,  $p < 0.01$ ). The correlations between other positive perceptions relating to the administration are shown the Table 1, from where we briefly understand that one positive emotion to the administration is accompanied from another, such as the perception that the Kapodistrian Municipality contributes to the good fame of the island or that the legislation of the law "I. Kapodistrias" has had a positive impact.

Table 1. Pearson's correlation coefficients between questions from the citizens' questionnaire. The questions have been encoded from Q1 to Q17. The clarifications of Q1-Q17 are shown in Table 2.

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17
Q2	-0.196(*)																
Q3	0.163	-0.374(**)															
Q4	0.024	-0.083	0.321(**)														
Q5	0.095	0.049	0.145	0.079													
Q6	-0.012	0.164	-0.212(*)	-0.005	0.065												
Q7	0.257(**)	-0.144	-0.154	0.041	-0.233(**)	0.090											
Q8	0.138	-0.023	0.091	0.152	0.069	0.022	0.370(**)										
Q9	0.015	-0.121	0.213(*)	0.389(**)	-0.078	0.111	0.115	0.145									
Q10	0.008	-0.054	0.000	-0.627(**)	0.055	-0.150	-0.181	0.194	.(a)								
Q11	0.056	-0.204(*)	0.104	-0.177(*)	0.089	0.013	0.143	0.344(**)	0.027	0.100							
Q12	-0.015	0.185	0.068	-0.090	-0.037	-0.126	0.011	0.158	-0.015	0.113	.(a)						
Q13	-0.001	-0.213(*)	0.074	-0.113	0.096	0.008	0.031	0.221(**)	-0.076	0.134	0.383(**)	0.070					
Q14	0.094	0.017	-0.011	0.109	-0.028	-0.033	0.027	-0.063	0.121	0.294	-0.167	-0.087	.(a)				
Q15	0.030	-0.124	-0.032	0.032	-0.058	0.122	0.240(**)	0.406(**)	0.013	0.311	0.302(**)	0.182	0.348(**)	-0.002			
Q16	-0.295(**)	-0.097	0.124	-0.003	0.010	-0.061	-0.309(**)	-0.179	0.003	-0.275	-0.157	-0.273(*)	-0.137	-0.018	.(a)		
Q17	0.157	0.031	-0.088	0.085	-0.085	0.022	-0.041	-0.103	0.038	0.262	-0.137	-0.059	-0.139	0.181	-0.004	0.017	

\* Significant correlation at level 0.05

\*\* Significant correlation at level 0.01

a The correlation coefficient can not be estimated, because at least one variable is constant.

Table 2. Explanations to the questions Q1-Q17 of the citizen's questionnaire.

S1: DEMOGRAPHICS	Q1	GENDER
	Q2	AGE
	Q3	LEVEL OF EDUCATION
	Q4	WHERE DO YOU HAVE YOUR VOTING RIGHTS?
S2: KNOWLEDGE OF THE APPLICATION OF THE LAW "I. KAPODISTRIAS"	Q5	WHAT DOES THE ISLAND OF SANTORINI CONSIST OF?
	Q6	WHAT DO YOU KNOW ABOUT THE LAW "I. KAPODISTRIAS"?
	Q7	HAVE YOU REALISED THE LEGISLATION OF THE KAPODISTRIAN LAW?

	Q8	WHERE DO YOU BELIEVE THE APPLICATION OF KAPODISTRIAN LAW HAS HELPED?
S3: SATISFACTION	Q9	DO YOU VOTE AT YOUR MUNICIPAL ELECTIONS?
	Q10	WHY DON'T YOU VOTE AT YOUR MUNICIPAL ELECTIONS?
	Q11	IS THE MUNICIPAL OR COMMUNITY PARTY WHO WON THE ELECTIONS INTERESTED IN ASSISTING YOU TO SOLVE PUBLIC ISSUES, DURING THEIR 4-YEAR TENURE?
	Q12	WHY ISN'T THE PARTY INTERESTED IN POSSIBLE PROBLEMS?
	Q13	ARE YOU SATISFIED FROM THE ADMINISTRATION OF THE ISLAND?
	Q14	IF YOU ARE NOT SATISFIED FROM THE ADMINISTRATION, WHO DO YOU BELIEVE IS RESPONSIBLE?
	S4: GENERAL EFFICIENCY AS WELL AS SUGGESTIONS	Q15
Q16		WHERE DOES THE KAPODISTRIAN LOCAL GOVERNMENT LACK, IF IT DOESN'T CONTRIBUTE TO THE GOOD FAME OF THE ISLAND?
Q17		WHAT DO YOU SUGGEST FOR THE IMPROVEMENT OF THE ADMINISTRATION, IF THERE ARE BAD POINTS?

### 3.3 Hypothesis Testing

We examined the significance of the dependence between questions of the citizens' questionnaire. The most important result was the large percentage of the island's people who were not satisfied from the administration (76%). Additionally, we observed a statistically significant association between the satisfaction from administration and the location of voting rights ( $X^2 = 8,922$ ,  $df = 1$ ,  $p = 0.012$ ,  $OR=0.24$ ,  $95\% CI 0.09-0.64$ ) (Figure 4), the level of education ( $X^2 = 9.621$ ,  $df = 4$ ,  $p = 0.047$ ) (Figure 5), the interest of the political party who had won the elections in solving public issues [ $X^2 = 20.515$ ,  $df = 1$ ,  $p < 0.0001$  Odds Ratio = 7.7 (95% CI 2.9 – 20.216)], as well as the perception that the Kapodistrian local government contributes to the maintenance of the good fame of the island [ $X^2 = 16.940$ ,  $df = 1$ ,  $p < 0.0001$  Odds ratio = 5.3 (95% CI 2.3 – 12.2)].

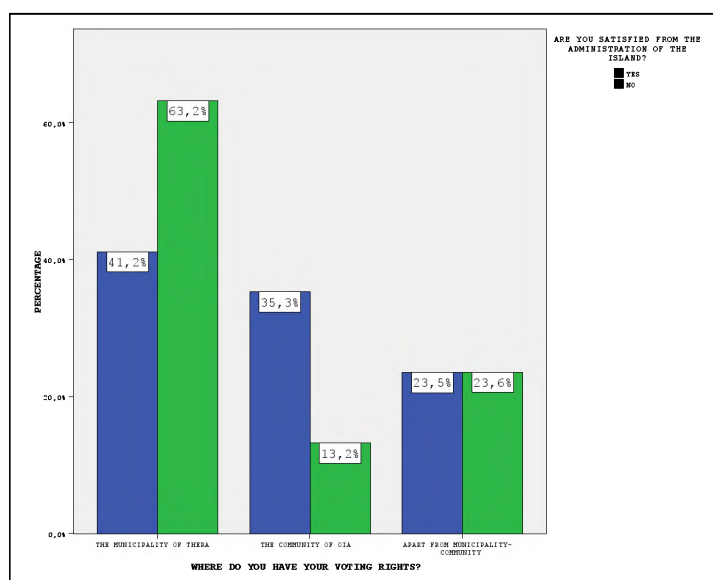


Figure 4. Statistically significant relation between satisfaction from administration and the place of voting rights. We observe that in Municipality of Thera, the satisfied citizens are less than the unsatisfied citizens in contrast to the Community of Oia.

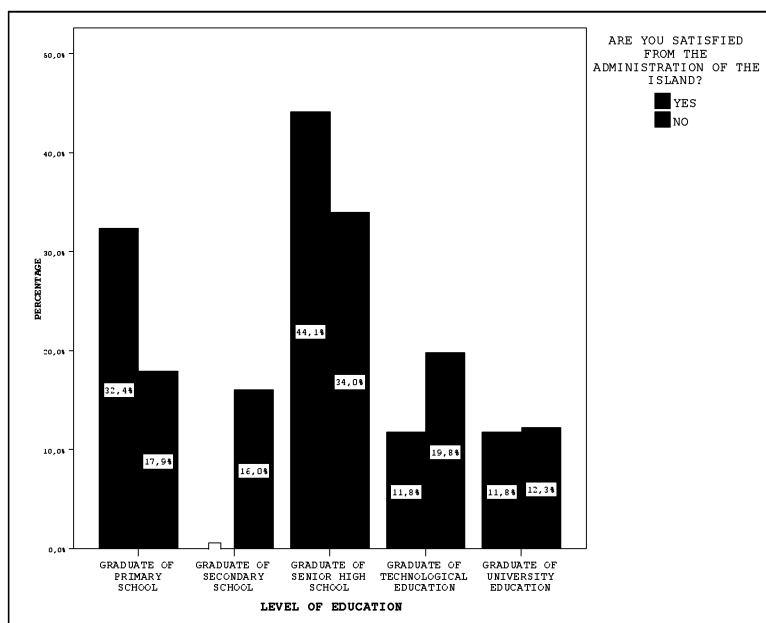


Figure 5. The statistically significant association between satisfaction from administration and the level of education. The figure shows the satisfaction from administration according to the level of education.

#### 4. Discussion

We conducted a sampling survey among the citizens of the Greek island Thera during October 2008 and we examined the satisfaction of citizens from the local government. Additionally, we examined the main factors associated with the satisfaction from administration. Our sample consisted of 140 citizens from the island of Thera and was selected randomly. To the best of our knowledge, there has not been a study examining local self-government's performance according to citizen's satisfaction in scientific literature. Spanou (1996) assessed the administrative reforms in Greece until 1996 and concluded that the two largest political parties had done redundant reforms and had lead to the re-emergence of clientelistic practices. The same author, studying this time the reforms in public administration until 2006 (Spanou, 2008), notes that these reforms consisted of actions aiming at solving burning issues: decentralization of economy at a local has been achieved, but citizens' rights and service delivery have been conceived rather as forms of democratisation and modernisation than as managerial reforms. Ongaro (2008) agrees with Spnaou's (2008) views. The observation by Spanou (2008), that economical management of local government has been decentralized is in contrast with our observation that decision making at a local level still maintains a central approval (Valvi et al, 2009). Chondroleou et al. (2005) also mention that decentralization of central governance does not stop Ministries from intervening at a local level, when something occurs that may not be desired.

The main results of our study are: first, although the 46% of citizens knows that the law "I. Kapodistrias" refers to the unification of communities for developmental reasons, yet its legislation hasn't become noticeable until today; on the contrary, many citizens claim things were better when there were only communities. Secondly, the law "I. Kapodistrias" helped carrying out important and large-scheme public constructions (e.g. waterworks, "Help at Home") in Thera, which in a different occasion, the existence of communities would be a setback in their completion. Despite this fact, 58% of citizens mentions that the application of the law "I. Kapodistrias" did not help at all. Moreover, 76% of citizens claim that they are not satisfied from the administration of the island, and they consider most responsible the Mayor/President of the Community and the wrong application of management. This is in accordance with the ILG (2008) and Chondroleou et al. (2005) which mentions that "the unification of local governments has brought a better economical management in them, but most of these local governments do not have the ability to supply their citizens with satisfactory services and are not able to benefit from National and European Schemes". Sixty two percent (62%) of citizens believes that the Kapodistrian local government does not contribute to the good fame of the island; the most important reasons for this belief are the inadequacy of health services (29%) and the lack of facilities in everyday life (e.g. sidewalks, parking slots) (15%). To these issues, the 38% of citizens suggests that a concurrent change in the people who are leaders and their notion of public administration is necessary.

Finally, we observed an association between the satisfaction from the administration and the place of voting rights: the possibility somebody from Thera would be satisfied from the local government was significantly



less than the same possibility from Oia (OR=0.24, 95% CI 0.09-0.64). This difference most possibly is due to the large number of persons and villages under its jurisdiction, which creates the feeling of dissatisfaction from a certain portion of citizens. In Oia though, citizens feel more satisfied, because under the jurisdiction of the Community of Oia are only two villages: Oia and Therasia; as a result, citizens feel that there is a more immediate confrontation of their problems. For this reason, it is understandable that the people of Oia prefer remaining an independent Community, which will not unite with the Municipality of Thera – as suggested by the law “I. Kapodistrias II”. This will lead to a less immediate dealing with their personal problems and to the better services provided. These observations agree with the basic principle of public administration which claims that the citizen wants its municipal authority close to him, because this is the real essence of 1<sup>st</sup> degree local governance. (ILG, 2008; Kelly & Swindell, 2002). We do not observe a correlation between satisfaction from administration and age or gender, as noted by Dimitriades & Maroudas (2007), but only with the level of education.

Thus, from our survey we point out several points that citizens consider could be improved in their public administration. We suggest that citizens should be more informed about the happenings in local governance. This can be achieved by informing citizens through bi-monthly speeches or seminars on behalf of the public councilors. Additionally, the internet can be utilized through blogs, special web pages etc., as well as informing notices in the streets and other public places, in order to inform citizens on the public administration and its works. Lastly, it is worth noting that a more humanized approach should be applied by the local governors, because citizens mentioned more than once that they wanted their local government close to them and their problems. Kelly & Swindell (2002) claim that if local leadership would listen more to what citizens said through satisfaction surveys, instead of fearing the fact that their actions are disapproved by them as inefficient, it is very likely that they would become more effective and they could achieve a greater satisfaction from their voters.

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# TOWARDS THE IMPROVEMENT OF LOCAL GOVERNMENT IN GREECE: A MINI-QUALITATIVE SURVEY

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## Abstract

*In 1997, a reform in the local government of Greece took place (Law 2539/1997 "I. Kapodistrias"). However, this reform did not manage to fulfil its original ambitions. We sought to report possible reasons for this using a qualitative research method. We used an in-depth structured interview of 6 questions, concerning the problems of the reform and possible points for improvement. Our interviewees were the Mayor of the Municipality of Thera, Aggelos Roussos, and the President of the Community of Oia, George Chalaris.*

*The results of our interview can be summarised in the following statements:*

- The reform in local government was something very important and necessary. It allowed doing many large-scale works (e.g. roads).*
- Its big disadvantage was that it did not manage to enforce local government essentially. For most decisions today (e.g. hiring personnel), a ministerial sign is required.*
- The new reform under consideration by the Greek Government (Kapodistrias II) is a revolutionary thought. It gives more importance to local government and decentralisation and should not be hampered by political fear of loss of power.*

*In conclusion, both local government officers, share the same opinion that a more realistic meaning to local government and decentralisation must be given.*

## Περίληψη

Ο νόμος 2539/1997 «I. Καποδίστριας» ψηφίστηκε το 1997 και αφορούσε τη διοικητική μεταρρύθμιση της τοπικής αυτοδιοίκησης στην Ελλάδα. Παρ' όλες τις αρχικές φιλοδοξίες του προγράμματος, δεν κατάφερε να τις εκπληρώσει εξ' ολοκλήρου. Σκοπός της παρούσας έρευνας ήταν να εντοπίσουμε πιθανούς λόγους γι' αυτό χρησιμοποιώντας ποιοτική μεθοδολογία. Χρησιμοποιήσαμε ερωτηματολόγια 6 ερωτήσεων σε δομημένες «εις βάθος» συνεντεύξεις προ τους: Δήμαρχος Θήρας, Άγγελος Ρούσσος, και Κοινοτάρχη Οίας, Γεώργιος Χάλαρης.

Τα αποτελέσματα της έρευνά μας μπορούν να συνοψισθούν στις παρακάτω απόψεις:

- Η διοικητική μεταρρύθμιση της τοπικής αυτοδιοίκησης ήταν σημαντική και απαραίτητη. Επέτρεψε τη διενέργεια πολλών μεγάλων έργων (π.χ. ύδρευση, αυτοκινητόδρομοι).
- Το μεγάλο του μειονέκτημα αφορά την έλλειψη ουσίας στη λέξη «αυτοδιοίκηση». Για όλες τις αποφάσεις της τοπικής αυτοδιοίκησης (π.χ. πρόσληψη προσωπικού) απαιτείται υπουργική έγκριση, υποβαθμίζοντας το ρόλο της αυτοδιοίκησης.
- Ο προαναγγελθείς «I. Καποδίστριας II» είναι μια επαναστατική μεταρρύθμιση. Δίνει περισσότερη σημασία στη λέξη «αυτοδιοίκηση» και ευνοεί την περαιτέρω αποκέντρωση. Εντούτοις, δεν πρέπει να καταπολεμείται από παραδοσιακές πολιτικές δυνάμεις.

Συμπερασματικά, οι δύο διοικητικοί ηγέτες της τοπικής αυτοδιοίκησης της Νήσου Θήρας, υποστηρίζουν ότι πρέπει να γίνει μια πιο ουσιαστική εφαρμογή στην αυτοδιοίκηση, που θα ευνοεί την αποκέντρωση.

*Key words: local government, self-government, Thera, Greece, modernization*

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## 1. Introduction

The law 2539/1997 “I. Kapodistrias” was voted in 1997 and concerned the administrative reform of local government in Greece (Spanou, 2008). Under the plan for reconstruction of primary government organization, specific targets and principles had been chosen and adopted that should govern the new legal regime and a particular time schedule was set for the execution of the reform plan (up to 2001 it should have been fully applied, with a possibility of extension) as well a special budget along with the analogous funding sources. Despite the initial aspirations of the program, it failed to meet up to its goals (Chrysanthaki, 1998).

A key point of criticism for the reform “I. Kapodistrias” referred to the fact that it was not accompanied by a radical change in the political and administrative system of the new enlarged municipalities, so that the elected political actors would obtain the executive and programmatic role in their operation (ILG, 2008). Hence, municipalities were deprived by the elements which, together with the necessary staff services, would assist them to shift towards strong planning and promotion of local development. Additionally, the way in which the political and administrative system of the new enlarged municipality was conceived, resulted in the reduction of accessibility of citizens to decision-making (Chondroleou et al., 2005; Hlepas, 1999).

Moreover, it was noted that Kapodistrian Municipalities were created without ensuring the structures and procedures for internal decentralization. The provision of the law for the creation of “Local Councils” remained unfruitful: they remained inert bodies without powers and resources, without a local action plan, with no real institutional function, that, even at this level, would be able to ensure the participation and expression of citizens. If we add to these characteristics, deficit maturity, a sense of regionalism/localism and narrow-minded political perceptions on behalf of many elected actors of the Kapodistrian Municipalities; who failed to overcome the logic of the “Superiority of Municipalities”, which conceives Municipalities as politically stronger (because of many voters) and marginalizes smaller communities of the Kapodistrian Law, both administratively and in the activities of the larger Municipality. The few exceptions confirm the rule (Makridimitris & Hlepas, 1997).

Thus, the plan of “Kapodistrian Municipalities”, without actually succeeding in the objectives it put, led to a reaction from the citizens of the former municipalities and communities, who suddenly felt that the umbilical cord that joined them – albeit rudimentary – with the State was cut off; that now there was no possibility of collective expression and participation, without a proper representation of their village or town. For this reason, a new reform effort is being formulated for the near future, law “I. Kapodistrias II”. However, recent publications in the newspapers, discuss the “hang” of “I. Kapodistrias II” indefinitely and perhaps abolition of this legislative reform (Siakaris, 2008). Reasons causing the suspension of this reform are mentioned to be the global economic crisis and the current social crisis in Greece (Aegean times, 2008; Chatziioannidou, 2008; Rousos, 2008).

Thus, the purpose of this paper is to identify possible reasons for the unfulfilled aspects of the law 2539/1997 “I. Kapodistrias”, using qualitative methodology.

## 2. Methods

In order to determine factors leading to the improvement of local government we used a 6-questions structured questionnaire, during in-depth interviews with the Mayor of Thera (Santorini), Angelos Roussos, and the President of the Community Oia, George Halaris. WE selected these two local elites, because they belong to a common geographical region (Thera) but have under their jurisdiction the two different forms of primary government defined by the reform law 2539/1997 “I. Kapodistrias”: the Municipality of Thera and the Community of Oia. Because of the upcoming “I. Kapodistrias II”, personal conversations with several residents of Thera suggested that there was a difference in views by the two local elites of the island concerning the reform law of 1997 as well as the new reform under plan. A reason proposed was the redistribution of power caused by these reforms among local elites as well as the opportunities to pursue managerial positions. As a result, we believe it was interesting to examine the differences and similarities of their views, in order to identify the advantages and disadvantages of the administrative reform of 1997.

The questions addressed to the local elites referred to law “I. Kapodistrias” and the impending “I. Kapodistrias II”. The questions were the same for the Mayor and the President of the Community, so as to allow comparison of their responses (Kefis, 1998; Frangos, 2005; Liamputtong & Ezzy, 2005; Kvale, 2006). The interview questions are shown in Table 1.

**Table 1. Interview questions for the two administrative leaders of Thera.**

Questions
1. What do you know about the law "I. Kapodistrias"?
2. How did the state support the Kapodistrian Municipality of Thera/ and the community of Oia?
3. Do you think that there should be some administrative changes in the law "I. Kapodistrias"?
4. As an administrative leader (the Mayor – the President of the Community), what do you think are the benefits and what the drawbacks of this legislation?
5. We are currently giving out questionnaires on a similar topic with our interview. If it turns out that people are not aware of the benefits of the Kapodistrian Municipality/ Community, why do you think this happens? How can we reverse the ignorance of the inhabitants of the island?
6. What is your opinion on roomers concerning "I. Kapodistrias II"? Do you believe that a new administration reform in the island's local government will contribute to its development?

### 3. Results

The results obtained from the answers of the Mayor of Thera and the President of the Community of Oia are:

a) The two local representatives know that the law was formulated in order to integrate former Municipalities and Communities in to new larger Municipalities. Particularly, they say:

Mayor: The meaning of the law "I. Kapodistrias" is the upgrading of primary and secondary local government; it is a law which Greece required, because there were too many small communities and municipalities. Through this law, municipalities and communities were integrated into new local governments.

President of the Community: The law "I. Kapodistrias" is a matter of public offer towards the citizen. In practice, it was proven very difficult to be firmly applied. It was a very innovative movement in self-government.

b) The Mayor stressed that there wasn't strong support from the state to the Kapodistrian Municipality of Thera saying that

During the two 4-year tenures that I am a Mayor, there was not some particular support; we had the same with whatever the law provides for all local self-governments,

The President of the Community shares similar view and says

The support of the state was to upgrade the educational level of employees. That means hiring more technical and administrative officials, either of Highest Education (AEI) or Technological (TEI). Of course, this was not accomplished to a large extent, because unfortunately, with the way the system worked, everyone became interested in returning quickly to municipalities near to their first home, on the ground of family or friend reasons. Particularly in peripheral regions. As a result, where there many employees even more went. So again the local authorities were left without the appropriate scientific personnel. The original goal was not completely achieved!

c) The Mayor argues that there must be some administrative changes in the Law "I. Kapodistrias" and especially points out the need to modernize the Municipal and Communal Code because there is no self-government in essence. More specifically he states

The code should be modernized. We cannot call ourselves Self-government Authorities if we do not have the opportunity to self-govern ourselves. Self-government is a misinterpreted word; in fact we are not those who are managing municipalities. Others are managing... The General Secretaries of Ministries, the Region Office, and the Commissioner of the Court of Audit are in fact really in charge. Thus, there is no self-government in effect. The Municipal and Communal Code should be voted and modernized; hence, truly creating self-governments.

The President of the Community mentions the importance of the role of the elected local elite, who should possess a sense of responsibility rather than a leisure attitude and indifference. The President of the Community says

Men are rewarded for their work and not passive inactivity. Unfortunately, we can observe from this, that the act of offering is in a crisis. Indifference and passivity are rewarded.

Because of this indifference, the President of the Community states that there was not a proper application of the Law “I. Kapodistrias”, mentioning that not only is the Central Government responsible for this situation, but also the mentality that prevails in Greece.

d) Both the Mayor, Angelos Roussos, and the President of the Community, George Halaris, argued that the law “I. Kapodistrias” has only advantages. Specifically, the mayor emphasizes that thanks to this law major projects were conducted on the island and supports this opinion by saying that:

The law “I. Kapodistrias” does not have disadvantages, only benefits. You see, in Thera there were 14 fragmented communities and no large project, no great expenditure and no great projection of the island could be made, because who would take the responsibility of the costs. Nothing in fact could be done, just an administration-management existed.

On the other hand, the President of the Community underlines the importance of the Law “I. Kapodistrias” and how much it helped Therasia (an island much separated from the other islands of the Cyclades), to absorb a big amount of the money; hence, causing Therasia to rise from the position of the most undermined community in Greece to a stronger and more functional self-government unit. The President of the Community says

The Community of Oia joined with the island Therasia. The island Therasia was the most deprived community in Greece, the most isolated part of the country and the community of Oia was the most famous and publicized, possibly, island in the world. This assembly [of Oia with Therasia] was therefore my own personal bet to prove that the elected local elite can rest the weaknesses and rigidities of the system, if he wants; and I believe that this was accomplished, because the former community and now community district of Therasia, absorbed most of the money among all the small islands of the country from the 3rd Community Support Framework. So, this shows how a weaker region was aided by a stronger and more functional unit level, thanks to the law “I. Kapodistrias”.

e) The Mayor argues that the citizens of the island do not know what the law “I. Kapodistrias” is about, because there is misinformation. More specifically, he states:

There is misinformation, because the presidents of the former communities misinformed the society (eg they used to say that we will lose our community, the municipality and our secretary, and all these along with complaints and disputes); it was in their interest of saying so.

Instead, the President of the Community emphasizes the need to improve the mentality of self-government, from the central ministries to the municipal and communal departments. Further he states:

The idea behind self-government was that it believed that the citizen, the Greek person requires from his local representatives to evidently resolve the problems that, unfortunately, the central government cannot. Hence, self-governors have agreed many times on a new administrative reform (and not only on the new law “I. Kapodistrias II”), going one step ahead of the central government; which means that when we speak of a proper administrative reform, decisions that should be taken at local level, cannot be obtained centrally.

f) Finally, regarding the law “I. Kapodistrias II”, both local leaders believe that an administrative re-transformation of the island can contribute to its development. The Mayor says:

I think that is a great reform tool, “I. Kapodistrias II” should not be hampered, and, I repeat, more jurisdictions should be given, more financial incentives to municipalities and, above all, the element of true self-governance.

The President of the Community points out that “I. Kapodistrias II” is a promising suggestion, because it introduces a more substantial sense of self-government, with more authorities in local government. More specifically he states:

The law “I. Kapodistrias II” has a new mentality. It is what we demand today, after we decided to ask how to change the mentality by which the system works until now... When we speak of a proper administrative reform, decisions that should be taken at local level, cannot be obtained centrally.

#### 4. Discussion

From the interviews with the Mayor of Thera and the President of the Community of Oia, we can draw the following main conclusions (Table 2).

**Table 2. Basic concepts obtained from our interviews with the local elite.**

<b>Mayor of Thera, Angelos Roussos</b>	<b>President of the Community, George Halaris</b>
<i>1. The law "I. Kapodistrias" refers to the unification of communities, Greece needed it and the second law "I.Kaopdistrias" is necessary</i>	<i>1. The law "I. Kapodistrias" concerned the assembly of communities, with the goal of upgrading its scientific personnel, but the original objective was not achieved</i>
<i>2. The Municipality of Thera did not have the expected financial support from the law "I. Kapodistrias"</i>	<i>2. The law "I. Kapodistrias" allowed major projects (like water supply). It helped especially Oia and Therasia</i>
<i>3. The law "I. Kapodistrias" did not have disadvantages, only benefits. There were major projects executed through the law "I. Kapodistrias"</i>	<i>3. The elected local leader must be interested in offering services with a sense of responsibility, without inaction and indifference</i>
<i>4. The word self-government is not applied essentially because central command headquarters are in charge. Self-government should be applied more meaningfully and effectively</i>	<i>4. Self-government is not fully expressed, compare to what it means. Many local authorities requires higher ministerial approval</i>
<i>5. The presidents of the former communities misinformed citizens about the law "I. Kapodistrias"</i>	<i>5. The mentality of self-government must be improved; from central ministries to the municipal and communal districts</i>
<i>6. The law "I. Kapodistrias II" is a great reform tool</i>	<i>6. The law "I. Kapodistrias II" is promising, because it introduces a more substantial meaning to self-government, and grants local government authorities with more powers</i>

It is worth commenting our findings in relation to our other papers. Chondroleou et al. (2005) indicate that the present Constitution of Greece (1975/1986/2001, article 102) protects the jurisdiction of local governments and creates the environment that allows their smooth and progressive development. The reform of 1997 "I. Kapodistrias" promised decentralization and greater control over decisions for local authorities. In practice, however, only political leadership has not been diminished at the local level; essential social and economic decisions concerning the management of local authorities require central approval. Our findings are in agreement with the lack of essential local *self-government*. However, this observed suspension of applying *self-government* thoroughly possibly has an explanation: local elites of local self-governments are described as been able to build relatively strong political powers in their jurisdiction, thus promoting the development of clientelistic relationships and corruption (Gkekas, 2000; Hlepas, 2000; Mavrogordatos, 1998; Spanou, 1996). The presence of clientelistic relationships are also noted by Valvi (2009). The role (or the absent) of honesty among local elites is essential in this discussion. Local elites appear to be honest only when they this honesty is not followed by any political or other casualty. For an interesting discussion on honesty among local leaders, see de Vries (2000). Thus, the non-entire implementation of "I. Kapodistrias", and the suspension of "I. Kapodistrias II" for the present (Rousos, 2008), possibly prevent corruption at the local level of self-government. However, the development of clientelistic relations at the central level is not prevented (Spanou, 2008).

The importance of decentralization to local government is also discussed by de Vries (2000). He argues that decentralization of public administration depends on the size of the country and the satisfaction of citizens from the existing legislative structure. In small countries, decentralization reforms are not necessary to be carried out so rigorously as in larger ones. Greece might possibly be adequate in accomplishing decentralization on a smaller scale, since it is a small country compared to other European countries, such as the United Kingdom, France, Germany, Spain etc. This is in contrast with the desire of the local elites of Thera, who indicated that more effective implementation of self-government should be set. There is a question concerning these statements: Who wants more power: central or local authorities? This question appears often in discussions of decentralization; the final formulation of an administrative reform, however, is determined by the collision of desire for political power and resistance to the redistribution of them from both sides (de Vries, 2000; 2002). Finally, de Vries (2002) suggests that the answer to the debate on the true reason of decentralization is more likely to be found on the ground of providing solutions to the social problems of citizens, rather than shifting responsibility and redistributing authorities at the various levels of public administration.

## Conclusion

We conducted a qualitative survey among the local elites of the island Thera, Greece. The main result is their desire for essential implementation of local self-government. Although this view appears more democratic and effective for local governments, we are sceptical for its entire implementation, because strong clientelistic relationships have been reported to develop at the local level (Spanou, 1996). The complete control by central agencies or the observed “ping-pong” phenomenon of shifting responsibility between various administration levels is no the solution; on the contrary, the creation of an administrative structure that will provide solutions to citizens’ problems appears to be more rational.

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# COMMON PERFORMANCE INDICATORS FOR PUBLIC SERVICES' TRAINING CENTRES

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## Abstract

*Rapid changes in life-long training and Performance Measurement (PM) in public services literature are posing serious questions from both theory and practice. A proposed synthesis of the most Common Performance Indicators (CPIs) aim to promote and support the PM into the public sector training programs provides the benchmarking of the selected frameworks and creates two proposed set of tables. These set of tables include:*

*-The first set describes, through the tables 1 to 5, each source of reference (theoretical or practical) the number of selected frameworks that supports CPIs in this paper and,*

*-The second set describes, through the tables 6 to 9, the CPIs selected by each referred framework. Both sets reveal the lack of PM into the public sector training programs.*

*The CPIs offers practical help to increase the value of taxpayers' money and provide accountability of public services decision makers' contribution.*

**Keywords** – Common Performance Indicators (CPIs), Performance Measurement (PM), public sector life-long training programs

*JEL Classification: M53*

## Introduction

The rational of this review is to reduce the knowledge gap if performance dips below target, the Common Performance Indicators (CPIs) control system will register an expanded “performance gap”, which is then acted upon to produce a reduction in resource allocation of training programmes. Getting a better insight into the appropriateness of this paper’s objectives, life-long training is one of the central elements of performance improvement, into public organizations in general and public training organizations more specifically (Mwita, 2000, Kettunen J., 2005). CPIs could create flexibility in order to re-allocate resources within training programs (especially concerning staff). Furthermore, CPIs could create new reporting terms of public service employment in order to enable better internal management, including the ability to move staff from low value areas and to recruit and promote capable staff (Johanson, 1999; Vasilakis, A., 2008). Each public organization needs flexibility to redeploy expenditure within these budgets so as to maximize performance of each Public Services Unit (Holzer, M. and Kloby, K., 2005; Papadeas, P. 2006). CPIs could also contribute to another dimension of public accountability to the taxpayers and stakeholders in general and to the public sector more specifically (Johanson, 1999; Chang, 2004). The Performance Measurement (PM) can be used as a report card from which taxpayers and stakeholders can gauge operational efficiency (inputs-outputs) of each state training center and measure the ‘value for these spending funding’ (Johnes, N., and Connolly, M., 2001; Cutler, T. and Waine, B., 2003; Boyne, G. and Enticott, G., 2004).

## Performance Measurement Frameworks and Initiatives Applied in Education and Training

To start with the literature review reveals four-performance measurement’s theoretical frameworks that could be applied in life long training of public services. These frameworks are presented in the following table 1.

**Table 1: Theoretical Frameworks**

Theoretical Frameworks	Country	Year
Balanced Scorecard (B.S.C.),	U.S.A.	1992
The Model of European Foundation of Quality Management (E.F.Q.M.),	Europe	1996
New Public Management (N.P.M.)	U.K.	1984
Data Envelopment Analysis (D.E.A.)	Europe	1978



Secondly, the general review of international practice reveals assessment frameworks that could be applied in life long training of public services. The sum of methods and processes used to evaluate the attainments (knowledge, know-how, skills and competences) of an individual, and typically leading to certification is called an “Assessment” (European Commission, 2005b). The selected assessment frameworks are illustrated in the following Table 2.

**Table 2: Assessment Frameworks**

Assessment Framework	Country	Year
Center European Pour Le Developpement De La Formation Professionnelle (CEDEFOP)	Europe	1975
European Training Foundation (ETF)	Europe	1995
Malcolm Baldrige National Quality Award (MBNQA), Educational Criteria	U.S.A.	1999
European Universities Association (EUA)	Europe	2001
U.S. General Accounting Office (GAO)	U.S.A.	1980
Comprehensive Performance Assessment (CPA) of Audit Committee	U.K.	2002
Higher Education Funding Council For England (HEFCE)	U.K.	1992
U.S. Government Accounting Standards Board (G.A.S.B.)	U.S.A.	1987
Common Assessment Framework (C.A.F.)	Europe	2000
The Danish Evaluation Institute (DEI)	Denmark	1999
Office For Standards in Education (OFSTED)	U.K.	2001
The Quality Assurance Agency for Higher Education (QAA)	U.K.	1997
Internal Revenue Service’s (IRS’s)	U.S.A.	1913
European Social Fund (ESF)	Europe	1957
U.S. The Nation’s Report Card	U.S.A.	1988

Thirdly, the general review of international practice has indicated different accreditation frameworks concerning of programmes and institutions. These frameworks have adapted processes and procedures for performance measurement of training programmes. Some of them are selected and illustrated in table 3. Furthermore, the process of accrediting an institution of education or training, a programme of study, or a service, shows that it has been approved by the relevant legislative and professional authorities by having met predetermined standards (European Commission, 2005b).

**Table 3: Accreditation Frameworks**

Accreditation Framework	Country	Year
Investors in People (IiP)	U.K.	1990
Association of Masters of Business Administration (A.M.B.As).	U.K.	1967
European Quality Improvement System (E.Q.U.I.S).	Europe	1998
Council for Higher Education Accreditation (C.H.E.A), including: Association to Advance Collegiate Business Schools of Business (A.A.C.S.B), and Association of Collegiate Business Schools and Programs (A.C.B.S.P).	U.S.A.	1996
The Teacher Training Agency (T.T.A)	U.K.	1994

Fourthly, the general review of international practice has revealed legislation frameworks that encourage the performance measurement in life long training. Some of them are illustrated in table 4.

**Table 4: Legislation Frameworks**

Legislation Framework	Country	Year
The National Center For Vocational Educational Research (NCVER)	Australia	2002
The Australian Department of Education, Science and Training (DEST)	Australia	2001
National Forum on Educational Statistics (NFES)	U.S.A.	2001
Qualifications and Curriculum Authority (QCA)	U.K.	1985
Sector Skills Development Agency (SSDA)	U.K.	2002
The Canadian Education Statistics Council (CESC)	Canada	1989
Government’s Public Service Agreement (PSA)	U.K.	1997
Department of Education & Employment	U.K.	1999

Department of Labor (DOL)	U.S.A.	2003
National Performance Review	U.S.A.	1993
Governing with Accountability	U.S.A.	1993
The Government Performance and Results Act	U.S.A.	1993
Higher Education Statistics Agency (HESA)	U.K.	1993
National Skills Framework (NSF)	Australia	2002
National Governance and Accountability Framework (NGAF)	Australia	2005

Lastly, the general review of international practice has indicated general initiatives of European Union and International Organisations for the development performance measurement systems and the application of CPIs. Some initiatives are referred as following in Table 5.

**Table 5: Initiatives of European Union and International Organizations for performance measurement metrics in Education and Training**

Initiatives for performance measurement metrics in Education and Training	Country	Year
Eurostat (Education and Training)	Europe	1952
European Union initiatives for life long learning	Europe	1976
European Employment Strategy (EES)	Europe	2002
EQUAL Initiative of European Union	Europe	2001
The Organisation for Economic Cooperation and Development (OECD)	International	1996
International Federation of Training & Development Organisations (IFTDO)	International	1972
European Association for Quality Assurance in Higher Education (ENQA)	Europe	2000
International Labour Organisation (ILO)	International	1944
Ministerial Council for Vocational and Technical Education (MCVTE)	Australia	2005

Overall, the above initiatives and frameworks have been tested empirically and applied practically as a performance measurement process and procedure in education and training. Some of the above empirical papers or practical applications have been tested or applied for different purposes. All of them use different performance indicators in order to measure the performance of a training programme or an organization. The benchmarking of them leads to summarization of most CPIs that could be appropriate for performance measurement of life long training into public services.

### The Proposed Common Performance Indicators (CPIs)

This study selects CPIs in four sets. These sets are grouped into input, output, results and outcome indicators (see: the following tables 6, 7, 8, 9) and are identified during the synthesis of usability approach for the International and European reality (see: the above tables 1, 2, 3, 4, 5). Data on these indicators could be quantified and collected among the consideration of parity in the public services units that participate in life long training and the PM of the variable could ensure uniqueness in the representation. The final choice except the benchmarking of the highest referred indicators from different frameworks was based on adaptability to the European public life-long training centers. These tables illustrate a PM system, where each target consists of a relevant group of indicators on the right (CEDEFOP, 1997; European Commission, 2002a, 2002b; Forrier A. and Sels L., 2003).

1. In fact, the consumption of some inputs such as financial, human capital, technical material etc. is necessary for the training system (Smith et al., 2002; Vasilakis, A., 2008). The selected input indicators refer to some resources that need to be consumed in order to cover all needs that are necessary for target accomplishment (GASB, 1990, 1997; Hood, 1991; GAO, 1998, 2003; Petridou E. and Chatzipanagiotou, P., 2004). The most common of them are selected and presented in the following table 6.

**Table 6: Set of Input Indicators**

Objective	Measure
1.1 Valid training budget	The valid budget illustrates the training cost of Civil Servants.
1.2 Training programme conditions for trainees	-Lecture rooms -Timetable
1.3 Teaching methods for trainees.	Instructor efficiency or inefficiency
1.4 Instructors' sufficiency in training programmes for trainees' opinion.	-Sufficiency in instruction -Sufficiency in answering questions.
1.5 Homogeneity of trainees (as knowledge level of the subject) in the group of participants.	<b>Level of knowledge of the subject</b>
1.6 Estimation of instructors for homogeneity of trainees (as knowledge level of the subject).	Level of knowledge of the subject (for instructors' opinion)
1.7 Average cost per trainee.	1. Expenditures divided by the number of trained civil servants. 2. Comparison between the costs of different training programmes. 3. Different time period and different instructors and trainees
1.8 Sufficient absorption costs (expenditures) as part of the budget.	Available resources
1.9 Trainees estimation for teaching materials quality.	Coverage needs of trained civil servants.

The consumption of the inputs produces outputs in order to fulfill the training progress (GASB, 1990, 1997; GAO, 1998, 2003). These outputs could be referred to as actual training programmes, number of participants, training timeframe, etc. (Behrman, J.N. and Levin, R.I., 1984; Agocs C., 2002; Eurostat 2002e, 2002f; Tablib, A., 2001; Baruch, Y. and Leeming, A., 2001). The most common of them are selected and presented in the following table 7.

**Table 7: Set of Output Indicators**

Objective	Measure
2.1 Average training cost per human hour	Total expenditures divided by time period of training programme.
2.2 Number of civil servants that take advantage of the training action	Number of completed training programmes related to trained target group each year.
2.3 Percentage of trainees who abandon the training programme per the total number of trainees	Percentage of trainee failure or abundance in total trained civil servants each year.
2.4 Timeframe adequacy of training programmes	Difference between planned and applied time trained hours each year.
2.5 Absorption cost - Difference of actual and budgeted cost	Difference between actual and budgeted cost.
2.6 Average timeframe suitability per number of trained civil servants	Number of trained civil servants divided by training time each year.
2.7 Sufficient percentage of trained civil servants per total number of public services	Percentage of trained civil servants per total number of civil servants in public organization.
2.8 Satisfactory absorption of costs (expenditures) as part of the budget	Expenditures per outputs of a project.
2.9 Number of materialism's training programmes	Completed training programmes per planned training programmes.

The following result indicators pay attention to trainee civil servants and they measure the direct impact of training to civil servant skills, employment behaviour into the public services. The simplification of working activities could increase outputs in order to improve the results that concern direct benefits. For instance, the

value added of learning in the trainee civil servant unit, the trainees civil servant performance in their units, the efficiency and effectiveness of training programme and the target accomplishment of training programmes (Terry, F., et al, 1992; CEDEFOP, 1997; Taylor, J. and Parkinson, S.T., 1998; Bell, E. et al, 2001, 2002; Smith, A. et al, 2002; Smith, A. and Collins, L., 2004). In most cases the results are illustrated immediately after the completion of training programmes period. The most common of them are selected and presented in the following table 8.

**Table 8: Set of Results Indicators**

Objective	Measure
3.1 Learning Utilization (Value added of life-long learning).	Average of trainees and trainees' managers' opinion that trainees could utilization the learning knowledge into their administration unit.
3.2 Applicability and utilization of knowledge	Percentage of received knowledge applicability into administrative unit. This measure is calculated by the average of trainees and their manager's opinion.
3.3 Training Programmes Effectiveness	Outputs divided by the targets in general. In this case training outputs divided by annual planning targets.
3.4 Training Programmes Efficiency	Relationship of Inputs – Outputs of training programmes
3.5 Training programmes targets accomplishment	Complete rate of annual Training programme targets.
3.6 Trainee rate of success	Percentage of trainees that received the degree of successful attendance.
3.7 Civil servant's performance	Percentage that recognizes the performance improvement of civil servant is a result of training. This measure is calculated by the average of trainees and their managers' opinion.
3.8 Relevance training programme curriculum and job tasks	This measure is calculated by the average of trainees and their managers' opinion.
3.9 Recognition of Training programme's practical utilization	<b>Link between Trainees targets and leadership could be calculated by the percentage of expression of interest in the duration of training course.</b>

The selected outcome indicators concern the public services in general and the indirect results of training programmes. In fact, it paid extra attention to the external relationship of the public services with citizens-customers. Furthermore, the results and outputs could lead to outcomes when they accomplish the annual targets. This is an essential issue for the success or failure of training programmes (Reddy, P.S., et al., 2000; Cutler, T. and Waine, B., 2003; HM Treasury, 2005). Outcomes could appear late or with different results for public services after long time (Hood 1991; GAO 1998, 2003; Agoes C., 2002; Freer, S., 2002; Broadbent, J., 2003; EU Directors general for Public administration, 2002). The most common of them are selected and presented in following table 9.

**Table 9: Set of Outcomes Indicators**

Objective	Measure
4.1 Cost Reduction	This measure is calculated by the average of trainees and their managers' opinion that the training programme led to cost reduction.
4.2. Public service effectiveness	The training programmes leads to effectiveness improvement of trainee's public service. This measure is calculated by the percentage of trainees' managers opinion that the training programme leads to effectiveness improvement to public service.
4.3 Public Service targets' accomplishment	The planning and the implementation of training programme should satisfy the targets of public services. This measure counts the percentage of public service manager who estimates that the training programme elaborate public service accomplishments.
4.4 Diffusion of Learning	The diffusion of learning add value in life long learning. This measure is estimated by the percentage of trainees and their managers who believe that the attended training programme elaborate to the diffusion of learning. This measure is calculated by the average of trainees and their managers' opinion.

4.5 Modernization of public services	The contribution level of training programme to modernization of public services. This measure is calculated by the average of trainees and their managers' opinion that the training programme contributes to public service modernization.
4.6 Better management of tasks in public services	This measure is the percentage calculated by the average of trainees and their managers' opinion that training programme contributes to management of public services tasks.
4.7 Servicing customer-citizens	This indicator assures the service improvement to citizens and measures by the percentage of managers who estimates that the training programme contributes to better service of citizens.
4.8 Time- saving methods in public services	The training programme could save working hours for civil servants. This percentage is calculated by the average of trainees and their managers' opinion that training programme contributes to saving working hours by improving civil servants' working methods.
4.9 Assimilation of legislation changes for servicing the citizens	Public services' managers who believe that the training programme contributes in assimilation of legislation changes calculate this indicator.

The synthesis of the above CPIs is constructed in a more simplistic way in order to be convenient to the Public Services' Decision Makers. The proposed metrics are quantifiable, complete and controllable. If we look at the use of CPIs, and at their integration in more elaborate systems of monitoring, evaluation or benchmarking, we will often observe that the practice at the different levels is not integrated (Kouzmin A. et al, 1999). Moreover, there may be conflicts or contradictions between the actors at different levels concerning the use of CPIs or concerning the aforesaid systems.

## Conclusions

This literature review paper has hopefully made a convincing argument that PM's priority on CPIs mechanisms and studies is substantial in relation to the size of the public training institutes or organisations. The purpose of PM's system is to guarantee that in terms of credibility and consistency PM meets the high expectations and demands of the government, stakeholders, educational institutions, and other users of PM's reports (Kouzmin A. et al, 1999). The PM system is a mean to better services and products and to a higher uniform quality standard (Mwita, J., 2000). Thus, the PM system is not an end in itself, but one mean to achieve the end of a quality standard second to none. Therefore, the public training organizations could set priorities through the proposed CPIs in order to keep the costs down and improve performance for public services. The benchmarking of CPIs according to referred frameworks offers credibility of CPIs selection. Therefore, these proposed sets of CPIs could force the public training organizations to cover the public services needs through their training programmes in a more efficient way. Consequently, these proposed sets could increase the value of stakeholders' money and provide accountability to the public services decision makers' contribution.

The proposed CPIs were constructed in a short version that consists of inputs, outputs, results and outcome sets. This version has illustrated the minimum necessary indicators for PM in order to keep the monitoring in control (Mwita, J., 2000), thus includes 36 indicators (see tables 6-9). These indicators that refer to the most frameworks are the only criterion of credibility and selection in this presented short version. The selected CPIs are synthesized, renamed or modified properly in order to be able to compare to each other. The majority of indicators are referred differently in different theoretical and institutional practical frameworks. Finally, the proposed CPIs aim to close the knowledge gap of performance measurement between public services and public life-long training centers.

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# APPLICATIONS OF MARKOV CHAINS TO BUSINESS PROBLEMS

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## Abstract

We present characteristic examples of applications of finite Markov chains to Business problems, which can be solved - as most of the problems concerning applications of Markov chains in general do - by distinguishing between two types of such chains, the ergodic and the absorbing ones.

## Περίληψη

Στο άρθρο αυτό παρουσιάζουμε χαρακτηριστικά παραδείγματα εφαρμογών των πεπερασμένων αλυσίδων Markov σε εμπορικά προβλήματα, τα οποία μπορούν να επιλυθούν - όπως συμβαίνει γενικά με τα περισσότερα προβλήματα, που αφορούν εφαρμογές των αλυσίδων Markov - κάνοντας διάκριση μεταξύ δύο τύπων τέτοιων αλυσίδων, των εργοδικών και των απορροφητικών.

AMS Subject Classification (2000): 60J20

Some key words: Finite Markov chains, ergodic chains, absorbing chains.

## 1. Introduction

One of the most interesting approaches for the nature and position of mathematics into the whole body of the human knowledge is the one that determines it as an activity whose target is to interpret and (or) describe in a satisfactory way the various phenomena of the real world, as well as the real situations of our everyday life. This approach, combined with the recent waves of social, economical, and technological changes and evolutions of our world, transubstantiates mathematics to an essential factor of the formation of the future of our society.

The above target is succeeded through the use of *mathematical models*, which are simplified representations of the corresponding real phenomena and situations, achieved through the use of mathematical terms and symbols, i.e. functions, equations, inequalities, etc. A mathematical model excels compared with the other types of models, e.g. simulation, analogical, iconic, etc (Taha, 1967), used for the same purposes, because it gives accurate and general solutions to the corresponding problems. It is of worth to notice at this point the words of Davis and Hersh (1981) about it: "The usefulness of a mathematical model is exactly its success to foresee, or (and) to imitate accurately the behaviour of the real world".

A very important theory that offers ideal conditions for the study and mathematical modelling of a certain kind of phenomena depending upon random variables is the theory of Markov processes. Roughly speaking a *Markov chain* is a stochastic process that moves in a sequence of steps (phases) through a set of states and has 'no memory', i.e. the probability of entering a certain state in a certain step, although it is not necessarily independent of previous steps, depends at most on the state occupied in the previous step. This is known as the *Markov property*.

When the set of its states is a finite set, then we speak about a *finite Markov chain*. For special facts on such type of chains we refer freely to Kemeny & Snell (1976).

The basic concepts of Markov chains were introduced by A. Markov in 1907 on coding literary texts. Since that time the Markov chain theory was developed by a number of leading mathematicians such as A. Kolmogorov, W. Feller etc, but only from the 60's the importance of this theory to the Natural, Social and most of the other Applied Sciences has been recognized, e.g. Suppes and Atkinson (1960), Kemeny & Snell (1963), Bartholomew (1973) etc.

Most of the problems concerning applications of Markov chains can be solved by distinguishing between two types of such chains, the ergodic and the absorbing ones.

The purpose of this paper is to present characteristic applications of finite Markov chains to Business problems.

## 2. The basic form of the Markov model - Ergodic Markov chains

The basic form of the Markov model is used to make short run forecasts for the evolution of various phenomena. On the contrary, through the equilibrium situation of an ergodic chain, one obtains a long run forecast for the evolution of the corresponding phenomenon. Towards this direction important is also the role of the mean first passage matrix of the ergodic chain. We may recall that a Markov chain is said to be an *ergodic chain*, if it is possible to go between any two states, not necessarily in one step.

In this section we shall illustrate all the above through the following two examples on business problems:

**Problem 1:** A company circulates for first time in the market a new product, say K. The market's research has shown that the consumers buy on average one such product per week, either K, or a competitive one. It is also expected that 70% of those who buy K they will prefer it again next week, while 20% of those who buy another competitive product they will turn to K next week.

i) Find the market's share for K two weeks after its first circulation, provided that the market's conditions remain unchanged.

ii) Find the market's share for K in the long run, i.e. when the consumers' preferences will be stabilized.

iii) Find how many times on average a consumer buys for first time competitive products between two purchases of K and vice versa. Find also how many times the consumer buys on average K for first time before buying a competitive product and vice versa.

**Solution:** i) We form a Markov chain having the following two states:  $s_1$  = the consumer buys K, and  $s_2$  = the consumer buys another competitive product (obviously this process has the Markov property).

Denote by  $p_{ij}$  the transition probability from  $s_i$  to  $s_j$ ,  $i, j=1, 2$ , then the matrix

$$A = [p_{ij}] = \begin{matrix} & \begin{matrix} s_1 & s_2 \end{matrix} \\ \begin{matrix} s_1 \\ s_2 \end{matrix} & \begin{bmatrix} 0,7 & 0,3 \\ 0,2 & 0,8 \end{bmatrix} \end{matrix}$$

is called the *transition matrix* of the chain. Since the transition from a state to some other state (including itself) is the certain event, we have that  $p_{i1} + p_{i2} = 1$ , for  $i=1, 2$ .

Consider also the row-matrix  $P_k = [p_1^{(k)} \ p_2^{(k)}]$ , known as the *probability vector* of the chain, which gives the probabilities  $p_i^{(k)}$  for the chain to be in state  $i$  at step  $k$ , for  $i=1, 2$  and  $k=0, 1, 2, \dots$ , where we obviously have that  $p_1^{(k)} + p_2^{(k)} = 1$ .

It is well known then that  $P_{k+1} = P_k A$ , therefore  $P_k = P_0 A^k$ .

In our case, since K circulates for first time in the market, we have that  $P_0 = [0 \ 1]$ , therefore  $P_2 = P_0 A^2 = [0,3 \ 0,7]$ .

Thus the market's share for K two weeks after its first circulation will be 30%.

ii) Obviously the above chain is an ergodic one. It is well known that, for an ergodic  $n$ -state chain,  $n \geq 2$ , as the number of its steps tends to infinity (long run), the chain tends to an equilibrium situation, where the probability vector  $P_k$  takes a constant price, say  $P = [p_1 \ p_2 \ \dots \ p_n]$ , called the *limiting probability vector* of the chain. Thus the equilibrium situation is characterized by the equality  $P = PA$ , with

$$p_1 + p_2 + \dots + p_n = 1.$$

For the present 2-state chain the above equality gives that  $p_1 = 0,7p_1 + 0,2p_2$  and  $p_2 = 0,3p_1 + 0,8p_2$ , or equivalently  $0,3p_1 - 0,2p_2 = 0$ .

Solving the linear system of the above equation and of  $p_1 + p_2 = 1$  one finds that  $p_1 = 0,4$ , i.e. the market's share for K in the long run will be 40%.

iii) For this case we must calculate the *mean first passage matrix*  $M = [m_{ij}]$  of the chain, whose entry  $m_{ij}$  gives the mean number of steps needed to go from state  $s_i$  to  $s_j$  for first time,  $i, j=1, 2$ .

To do so we must calculate first the matrix  $N = (I_2 - A + JP)^{-1}$ , where  $I_2$  is the  $2 \times 2$  unitary matrix,  $A$  is the transition matrix of the chain,  $P$  is its limiting probability vector and  $J = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ . A straightforward calculation

gives that

$$N = \begin{bmatrix} 0,4 & -0,15 \\ -0,1 & 0,35 \end{bmatrix}.$$



Then  $M = (I_2 - N + EN_{dg})D$ , where  $E = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$ ,  $N_{dg}$  is the 2X2 diagonal matrix whose diagonal elements are equal to the corresponding elements of  $N$  and  $D = [d_{ij}]$  is the 2X2 diagonal matrix with  $d_{ii} = \frac{1}{p_i}$ ,  $i=1,2$ .

Therefore a straightforward calculation gives that

$$M = \begin{bmatrix} \frac{10}{4} & \frac{5}{6} \\ \frac{5}{4} & \frac{10}{6} \end{bmatrix}.$$

Inspecting  $M$  we observe that a consumer buys on average  $m_{11} = 2,5$  competitive products for first time between two purchases of  $K$ . Vice versa he (she) buys on average  $m_{22} \approx 1,67$  times  $K$  for first time between two purchases of competitive products. Notice that the diagonal elements of  $M$  are (in all cases) equal to  $m_{ii} = \frac{1}{p_i}$ .

We also observe that a consumer buys on average  $m_{12} \approx 0,83$  times  $K$  for first time before buying a competitive product, and vice versa he buys on average  $m_{21} = 1,25$  times a competitive product for first time before buying  $K$ .

The next example concerns the application of a 3-state ergodic Markov chain to the production process of an industry:

**Problem2:** In an industry the production of a certain product is regulated according to the existing stock of it at the end of each day. Namely, if at the end of the day there exist unsatisfied orders or the stock is zero, then the production of the next day covers the unsatisfied orders plus two more metric units (m.u.). On the contrary, if there exists a non zero stock, there is no production for the next day.

We further know that the consumers' demand for the product is either 1 m.u. per day with probability 60%, or 2 m. u. per day with probability 40%.

Under the above conditions determine the probability to have unsatisfied orders in the long run and in how many days on average this will be repeated for first time.

**Solution:** Since the maximum product's demand is 2 m. u., the production of the factory at the first day must be 2 m. u. and therefore at the end of the day the stock is either zero or 1 m. u. .

In the former case the process is repeated in the same way. In the latter case the production of the next day is zero and therefore at the end of this day the stock is either zero (in this case the process is repeated in the same way), or there are unsatisfied orders of 1 m. u. .

In the latter case the production of the next day is 3 m. u., i.e. 1 m. u. to cover the unsatisfied orders of the previous day plus 2 m. u., and so on.

It becomes therefore evident that according to the above rhythm of production there are three possible situations at the end of each day:  $s_1$  = unsatisfied orders of 1 m.u.,  $s_2$  = zero stock and  $s_3$  = stock of 1 m.u. .

Evidently our problem can be described with an ergodic Markov chain having as states the above possible situations  $s_i$ ,  $i=1,2,3$ .

Using the given data it is easy to observe that the transition matrix of the chain is

$$A = \begin{matrix} & \begin{matrix} s_1 & s_2 & s_3 \end{matrix} \\ \begin{matrix} s_1 \\ s_2 \\ s_3 \end{matrix} & \begin{bmatrix} 0 & 0,4 & 0,6 \\ 0 & 0,4 & 0,6 \\ 0,4 & 0,6 & 0 \end{bmatrix} \end{matrix}.$$

Let  $P = [p_1 \ p_2 \ p_3]$  be the limiting probability vector of the chain, then the equation

$P = PA$  gives that  $p_1 = 0,4p_3$ ,  $p_2 = 0,4p_1 + 0,4p_2 + 0,6p_3$ , and  $p_3 = 0,6p_1 + 0,6p_2$  .

Adding the first two of the above equations we find the third one. Solving the linear system of the first two equations and of  $p_1 + p_2 + p_3 = 1$  one finds that  $p_1 = 0,15$ .

Therefore the probability to have unsatisfied orders in the long run is 15% and this will be repeated on average after  $m_{11} = \frac{1}{0,15} \approx 6,67$  days for first time..

### 3. Absorbing Markov chains

A state of a chain is called absorbing if, once entered, it cannot be left. Further a Markov chain is called an *absorbing chain* if it has at least one absorbing state and if from every state it is possible to reach an absorbing state, not necessarily in one step.

In order to illustrate the use of absorbing Markov chains in business applications we consider the following problems:

**Problem 3:** The following process is applied in an agricultural cooperative for the collection and shelling of a product:

$s_1$ =collection,  $s_2$ =sorting - refining,  $s_3$ =packing and  $s_4$ =shelling.

The past data show that, being in stage  $s_2$ , there is a 20% probability that the quality of the product is not satisfactory. In this case the corresponding quantity is thrown away and a new collection is attempted.

(i) Find the probability for the completion of the above process in seven at most steps after its start, as well as the probabilities to be in each of the stages  $s_1, s_2$  and  $s_3$  at the 7<sup>th</sup> step of the above process

(ii) Assuming further that the duration of each of the stages  $s_i, i=1,2,3,4$ , is on average 10, 4, 3 and 45 days respectively find the mean time needed for the completion of the whole process.

**Solution:** i) We form a 4-state chain having as states the corresponding stages  $s_i$  of the above process,  $i=1,2,3,4$  (obviously the Markov property holds in this case too). Obviously this chain is an absorbing one, with  $s_4$  its unique absorbing state. According to the given data it is straightforward to check that the transition matrix of the chain is

$$A = \begin{matrix} & \begin{matrix} s_1 & s_2 & s_3 & s_4 \end{matrix} \\ \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix} & \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0,2 & 0 & 0,8 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \end{matrix} .$$

Further, since the above process starts always from  $s_1$ , we have that  $P_0 = [1 \ 0 \ 0 \ 0]$  and therefore  $P_6 = P_0 A^6 = [0,008 \ 0 \ 0,032 \ 0,96]$ .

Thus the probability for the completion of the process in seven at most steps is 96%. Actually in this case the process is completed either in 4 steps if no quantity of the product is thrown away, or in 6 steps, if the quantity of the product is thrown away once, because its quality was found to be unsatisfactory. We observe also that the probability to be at stage  $s_3$  in the 7<sup>th</sup> step is 3,2% and this will happen if the corresponding quantities of the product are thrown away for two successive times. There is also a small probability 0,8% to be at stage  $s_1$  in the 7<sup>th</sup> step. This will happen if the corresponding quantities of the product are thrown away for three successive times. Finally it is impossible to be at stage  $s_2$  in the 7<sup>th</sup> step

ii) We bring the transition matrix  $A$  of the chain to its canonical form  $A^*$  by listing the absorbing state first and then we make a partition of  $A^*$  as follows:

$$A^* = \begin{matrix} & \begin{matrix} s_4 & s_1 & s_2 & s_3 \end{matrix} \\ \begin{matrix} s_4 \\ s_1 \\ s_2 \\ s_3 \end{matrix} & \begin{bmatrix} 1 & | & 0 & 0 & 0 \\ - & | & - & - & - \\ 0 & | & 0 & 1 & 0 \\ 0 & | & 0,2 & 0 & 0,8 \\ 1 & | & 0 & 0 & 0 \end{bmatrix} = \begin{bmatrix} I & | & 0 \\ - & | & - \\ R & | & Q \end{bmatrix} . \end{matrix}$$

Then the *fundamental matrix* of the chain is given by  $N = (I_3 - Q)^{-1}$ , where

$I_3$  is the 3X3 unitary matrix and  $Q = \begin{matrix} & s_1 & s_2 & s_3 \\ s_1 & \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \\ s_2 & \begin{bmatrix} 0,2 & 0 & 0,8 \end{bmatrix} \\ s_3 & \begin{bmatrix} 0 & 0 & 0 \end{bmatrix} \end{matrix}$  is the transition matrix of the

non absorbing states of the chain resulting from the above partition of  $A^*$ .  
A straightforward calculation gives that

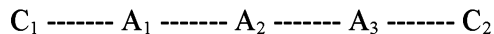
$$N = \begin{matrix} & s_1 & s_2 & s_3 \\ s_1 & \begin{bmatrix} 1,25 & 1,25 & 1 \end{bmatrix} \\ s_2 & \begin{bmatrix} 0,25 & 1,25 & 1 \end{bmatrix} \\ s_3 & \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} \end{matrix}.$$

It is well known that the entries of  $N$  give the mean number of times in each non absorbing state before absorption for each possible non absorbing starting state.

Therefore, since in our case the chain starts always from  $s_1$ , the mean number of times in state  $s_1$  is 1,25, in  $s_2$  is also 1,25, and in  $s_3$  is 1. Thus the mean time needed for the completion of the whole process is  $1,25(10+4)+3+45 = 65,5$  days.-

When an absorbing Markov chain has more than one absorbing states, then the transition matrix  $R$  from the non absorbing to the absorbing states enables us to calculate the probabilities for the chain to reach a certain absorbing state, when it starts from a certain non absorbing state. The above situation is illustrated with the following example, which concerns the application of an absorbing Markov chain with two absorbing states to a “random – walk” problem:

**Problem 4:** A supermarket has three storehouses, say  $A_1, A_2$  and  $A_3$  between two cities, say  $C_1$  and  $C_2$ , as it is shown in the below diagram:



For the delivery of the goods a truck starts its route every day from one of the storehouses and terminates it to one of the cities. The truck moves each time one place to the right or to the left with the same probability. Find the mean number of stops of the truck to each storehouse during its route and the probability to terminate its route to the city  $C_1$ , when it starts it from storehouse  $A_2$ .

**Solution:** We form a 5-state Markov chain having the following states:

$s_1$  (or  $s_5$ ) = the truck arrives to the city  $C_1$  (or  $C_2$ ),

$s_2$  (or  $s_3$ , or  $s_4$ ) = the truck arrives to the storehouse  $A_1$  (or  $A_2$ , or  $A_3$ ).

Obviously the above chain is an absorbing one and  $s_1, s_5$  are its absorbing states. Therefore the canonical form of its transition matrix is

$$A^* = \begin{matrix} & s_1 & s_5 & s_2 & s_3 & s_4 \\ s_1 & \begin{bmatrix} 1 & 0 & | & 0 & 0 & 0 \end{bmatrix} \\ s_5 & \begin{bmatrix} 0 & 1 & | & 0 & 0 & 0 \end{bmatrix} \\ s_2 & \begin{bmatrix} - & - & | & - & - & - \end{bmatrix} \\ s_3 & \begin{bmatrix} 0,5 & 0 & | & 0 & 0,5 & 0 \end{bmatrix} \\ s_4 & \begin{bmatrix} 0 & 0 & | & 0,5 & 0 & 0,5 \end{bmatrix} \\ s_4 & \begin{bmatrix} 0 & 0,5 & | & 0 & 0,5 & 0 \end{bmatrix} \end{matrix} = \begin{bmatrix} I & | & 0 \\ R & | & Q \end{bmatrix}.$$

It is straightforward then to check that the fundamental matrix of the chain is

$$N = (I_3 - Q)^{-1} = \begin{matrix} & s_2 & s_3 & s_4 \\ \begin{matrix} s_2 \\ s_3 \\ s_4 \end{matrix} & \begin{bmatrix} 1,5 & 1 & 0,5 \\ 1 & 2 & 1 \\ 0,5 & 1 & 1,5 \end{bmatrix} \end{matrix}.$$

Thus, since the truck starts its route from the storehouse  $A_2$  (state  $s_3$ ), the mean number of its stops to the storehouse  $A_1$  (state  $s_2$ ) is 1, to the storehouse  $A_2$  (state  $s_3$ ) is 2 and to the storehouse  $A_3$  (state  $s_4$ ) is 1. Further, the transition matrix from the non absorbing to the absorbing states resulting from the above partition of  $A^*$  is

$$R = \begin{matrix} & s_1 & s_5 \\ \begin{matrix} s_2 \\ s_3 \\ s_4 \end{matrix} & \begin{bmatrix} 0,5 & 0 \\ 0 & 0 \\ 0 & 0,5 \end{bmatrix} \end{matrix}.$$

It is well known that the entries of the matrix  $B = NR$  give the probabilities for the chain to be absorbed in each absorbing state for each possible non absorbing starting state. It is straightforward to check that

$$B = \begin{matrix} & s_1 & s_2 \\ \begin{matrix} s_2 \\ s_3 \\ s_4 \end{matrix} & \begin{bmatrix} 0,75 & 0,75 \\ 0,5 & 0,5 \\ 0,25 & 0,25 \end{bmatrix} \end{matrix}.$$

Thus the probability for the truck to terminate its route to the city  $C_1$  (state  $s_1$ ), when it starts it from store  $A_2$  (state  $s_3$ ) is 50%. -

Our last example illustrates the fact that a great care is needed in certain cases in order to “translate” correctly the mathematical results of the Markov chain model in terms of the corresponding real situation.

**Problem 5:** In a college, where the duration of studies is four years, it has been estimated that for each student there is a 20% probability to be withdrawn due to unsatisfactory performance and a 30% probability to repeat the same year of studies. Find the probability for a student to graduate, the mean time needed for the graduation and the mean time of attendance in each year of studies.

**Solution:** The corresponding process can be described with the following states:  $s_i$  = attendance of the  $i$  – th year of studies,  $i=1,2,3,4$ ,  $s_5$  = withdrawal from the college and  $s_6$ =graduation.

Obviously we can form an absorbing Markov chain, where  $s_5$  and  $s_6$  are its absorbing states. The canonical form of its transition matrix is

$$A^* = \begin{matrix} & s_5 & s_6 & & s_1 & s_2 & s_3 & s_4 \\ \begin{matrix} s_5 \\ s_6 \\ s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix} & \begin{bmatrix} 1 & 0 & | & 0 & 0 & 0 & 0 \\ 0 & 1 & | & 0 & 0 & 0 & 0 \\ - & - & | & - & - & - & - \\ 0,2 & 0 & | & 0,3 & 0,5 & 0 & 0 \\ 0,2 & 0 & | & 0 & 0,3 & 0,5 & 0 \\ 0,2 & 0 & | & 0 & 0 & 0,3 & 0,5 \\ 0,2 & 0 & | & 0 & 0 & 0 & 0,3 \end{bmatrix} \end{matrix} = \begin{bmatrix} I & | & 0 \\ - & | & - \\ R & | & Q \end{bmatrix}$$

Further, using probably a proper PC mathematical package in order to make the necessary calculations quicker, it is straightforward to check that the fundamental matrix of the chain is

$$N = (I_4 - Q)^{-1} = \begin{matrix} & \begin{matrix} s_1 & s_2 & s_3 & s_4 \end{matrix} \\ \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix} & \begin{bmatrix} 1,429 & 1,02 & 0,729 & 0,521 \\ 0 & 1,429 & 1,02 & 0,729 \\ 0 & 0 & 1,429 & 1,02 \\ 0 & 0 & 0 & 1,429 \end{bmatrix} \end{matrix},$$

and therefore to find that

$$B=NR = \begin{matrix} & \begin{matrix} s_5 & s_6 \end{matrix} \\ \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix} & \begin{bmatrix} 0,74 & 0,261 \\ 0,636 & 0,365 \\ 0,49 & 0,51 \\ 0,286 & 0,715 \end{bmatrix} \end{matrix}.$$

Observe that from the fundamental matrix N of the chain, one finds that  $n_{13}=0,729$  and  $n_{14}=0,521$ , i.e. for a first year student of the college the mean time of attendance to the third and fourth year of studies is less than one year! However this is not embarrassing, because there is always a possibility for a student to be withdrawn from the college due to unsatisfactory performance before entering the third, or fourth, year of studies.

Since  $n_{11} = n_{22} = n_{33} = n_{44} = 1,429$ , we find that the mean time of attendance of a student in each year of studies is 1,429 years, while the mean time needed for graduation is  $1,429 \times 4 = 5,716$  years.

Further from B one finds that  $b_{15} = 0,74$ , i.e. the probability of a student to graduate is 74%.

#### 4. Some other applications of Markov chains to real world problems

There are very many applications of Markov chains known in the literature for the solution of real world problems in almost every sector of the human activity, but a complete reference to all, or even to the most representative of them, is out of the scope of the present paper. Therefore we shall restrict here only to a brief presentation of some of our personal research results concerning applications of Markov chains to the sectors of management and economics and of mathematical education

In fact, in Voskoglou and Perdikaris (1991, 1993), and in Perdikaris and Voskoglou(1994) the problem-solving process is described through the introduction of an absorbing Markov chain to its main steps. Also in Voskoglou (1996 a) an ergodic chain is introduced for the study of the analogical problem-solving process in the classroom, while in Voskoglou (1996 b) an absorbing Markov chain is used for the description of the process of learning a subject matter by a group of students in the classroom

Further, in Voskoglou (1994) an absorbing Markov chain is introduced to the major steps through which one would proceed in order to effect the study of a real system (modelling process). The stochastic model obtained gives an important theoretical framework for the study of the modelling process. An alternative form of the above model is introduced in Voskoglou (2007) for the description of the mathematical modelling process in the classroom, when the teacher gives such kind of problems for solution to students. In this case it is assumed that after the completion of the solution process of each problem a new problem is given from the teacher to the class and therefore the process starts from the beginning again. Thus the resulting Markov chain is an ergodic one.

In Voskoglou (2000) an absorbing Markov chain is introduced to the main steps of the decision making process performed in order to choose the best among the existing solutions of a given problem, and examples are presented to illustrate the applicability of the constructed model to “real” decision making situations.

Finally in a recent paper (Voskoglou, 2009) the theory of Markov chains is used for the description of the Case -Based Reasoning (CBR) process, which is applied for the solution of a new problem in terms of already known from the past solutions of similar problems, and a measure is obtained for testing the efficiency of a CBR system.

## 5. Final conclusions

- The theory of Markov chains is a successful combination of Linear Algebra and Probability theory, which enables one to make short and long run forecasts for the evolution of various phenomena of the real world. In this paper we mainly presented characteristic applications of finite Markov chains to Business problems
- The short run forecasts are obtained, regardless the type of the chain, through the calculation of its transition matrix and the probability vector of the proper phase of the chain (basic form of the Markov model). On the contrary, the long run forecasts (equilibrium situation of the chain) are obtained, for the case of an ergodic chain only, by calculating its limiting probability vector. In this case the mean first passage matrix of the chain gives also some important information about the evolution of the corresponding phenomenon.
- In the case of absorbing Markov chains we proceed by forming the canonical form of its transition matrix and calculating the fundamental matrix of the chain, the entries of which give the mean number of times in each non absorbing state before absorption, for each possible non absorbing starting state. When an absorbing chain has more than one absorbing states, then the transition matrix from the non absorbing to the absorbing states enables us to calculate the probabilities for the chain to reach a certain absorbing state, when it starts from a certain non absorbing state.

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# COMBINING CASE-BASED WITH FUZZY REASONING IN COMMERCIAL PROBLEMS

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## Abstract

*Case-Based Reasoning (CBR) and Fuzzy Systems are intended as cognitively more plausible approaches to problem-solving and learning. The two corresponding fields have emphasized different aspects that complement each other in a reasonable way. In the present paper we introduce a fuzzy model for the representation of a CBR system, which is based on the formalization of CBR as a four steps process (retrieve, reuse, revise, retain), and we use the total possibilistic uncertainty as a measurement tool for the effectiveness of the model in solving new related commercial problems. An example is also presented to illustrate our results in practice.*

## Περίληψη

*Ο Συλλογισμός δια της Μελέτης Περιπτώσεων (ΣΜΠ) και τα Ασαφή Συστήματα αποτελούν ευλογοφανείς προσεγγίσεις για την επίλυση προβλημάτων και τη μάθηση. Τα δύο αυτά γνωστικά αντικείμενα έχουν δώσει έμφαση σε διαφορετικές απόψεις, που συμπληρώνουν αρμονικά η μία την άλλη. Στο άρθρο αυτό εισάγουμε ένα ασαφές πρότυπο για την αναπαράσταση ενός συστήματος ΣΜΠ, το οποίο βασίζεται πάνω στην τυποποίηση του ΣΜΠ ως μιας διαδικασίας τεσσάρων βημάτων (ανιχνεύω, επαναχρησιμοποιώ, αναθεωρώ, διατηρώ) και χρησιμοποιούμε τη συνολική δυναμική αβεβαιότητα ως εργαλείο μέτρησης της αποτελεσματικότητας του προτύπου για την επίλυση σχετιζομένων εμπορικών προβλημάτων. Δίδουμε επίσης ένα παράδειγμα, που απεικονίζει τα αποτελέσματα μας στην πράξη.*

AMS Subject Classification (2000): 03E72, Secondary 70E05

**Keywords:** Case- Based Reasoning, Fuzzy sets, Uncertainty

## 1. Introduction

**Case-Based Reasoning (CBR)** is a general paradigm for problem-solving and learning from expertise, which is not only a psychological theory of human cognition, but it also provides a foundation for a new technology of intelligent computer systems that can solve problems and adapt to new situations.

A lawyer, who advocates a particular outcome in a trial based on legal precedents, or an auto mechanic, who fixes an engine by recalling another car that exhibited similar symptoms, or even a physician, who considers the diagnosis and treatment of a previous patient having similar symptoms to determine the disease and treatment for the patient in front of him, are using CBR; in other words CBR is a prominent kind of analogy making.

As a general problem-solving methodology intended to cover a wide range of real-world applications, CBR must face the challenge to deal with uncertain, incomplete and vague information. In fact, uncertainty is already inherent in the basic CBR hypothesis demanding that similar problems have similar solutions. Correspondingly recent years have witnessed an increased interest in formalizing parts of the CBR methodology within different frameworks of reasoning under uncertainty, and in building hybrid approaches by combining CBR with methods of uncertain and approximate reasoning.

**Fuzzy sets theory** (Voskoglou, 2003; section 1) can be mentioned as a particularly interesting example. In fact, even though both CBR and fuzzy systems are intended as cognitively more plausible approaches to reasoning and problem-solving, the two corresponding fields have emphasized different aspects that complement each other in a reasonable way. Thus fuzzy set-based concepts and methods can support various aspects of CBR including case and knowledge representation, acquisition and modeling, maintenance and management of CBR systems, case indexing and retrieval, similarity assessment and adaptation, instance-based and case-based learning, solution explanation and confidence, and representation of context. On the other way round ideas and techniques for CBR can contribute to fuzzy set-based approximate reasoning. For special facts on fuzzy sets and on uncertainty theory we refer freely to Klir and Folger (1988).

In the present paper we shall construct a fuzzy model for the description of the CBR process and we shall also present an example to illustrate our results. For this, and in order to help the non experts on the field to have a better understanding of the paper, we shall refer first to some foundational issues of the CBR process.

## 2. Case- Based Reasoning

Broadly construed CBR is the process of solving new problems based on the solutions of similar past problems. The term problem-solving is used here in a wide sense, which means that it is not necessarily the finding of a concrete solution to an application problem, it may be any problem put forth by the user. For example, to justify or criticize a proposed solution, to interpret a problem situation, to generate a set of possible solutions, or generate explanations in observable data, are also problem-solving situations.

CBR has recently been developed to a theory of problem-solving and learning for computers and people. Its coupling to learning occurs as a natural byproduct of problem solving. When a problem is successfully solved, the experience is retained in order to solve similar problems in future. When an attempt to solve a problem fails, the reason for the failure is identified and remembered in order to avoid the same mistake in future. Thus CBR is a cyclic and integrated process of solving a problem, learning from this experience, solving a new problem, etc.

In CBR terminology, a case denotes a problem situation. A previously experienced situation, which has been captured and learned in a way that it can be reused in the solving of future problems, is referred as a past case, previous case, stored case, or retained case. Correspondingly, a new case, or unsolved case, is the description of a new problem to be solved. The CBR systems expertise is embodied in a collection (library) of past cases rather, than being encoded in classical rules. Each case typically contains a description of the problem plus a solution and/or the outcomes. The knowledge and reasoning process used by an expert to solve the problem is not recorded, but is implicit in the solution. A case-library can be a powerful corporate resource allowing everyone in an organization to tap in the corporate library, when handling a new problem. CBR allows the case-library to be developed incrementally, while its maintenance is relatively easy and can be carried out by domain experts.

Effective learning in CBR, sometimes referred as *case-based learning*, requires a well worked out set of methods in order to extract relevant knowledge from the experience, integrate a case into an existing knowledge structure (known, in terms of the cognitive science, as schema, or script, or frame), and index the case for later matching with similar cases.

CBR is often used where experts find it hard to articulate their thought processes when solving problems. This is because knowledge acquisition for a classical knowledge-based system would be extremely difficult in such domains, and is likely to produce incomplete or inaccurate results. When using CBR the need for knowledge acquisition can be limited to establishing how to characterize cases.

Some of the characteristics of a domain that indicate that a CBR approach might be suitable include:

- Records of previously solved problems exist
- Historical cases are viewed as an asset which ought to be preserved.
- Remembering previous experiences is useful; experience is at least as valuable as textbook knowledge.
- Specialists talk about the domain by giving examples.

CBR traces its roots in Artificial Intelligence to the work of Roger Schank and his students at Yale University, U.S.A. in early 1980's. The model of dynamic memory (Schank, 1982) was the basis of the earliest computer intelligent systems that can be viewed as prototypes for CBR systems: CYRUS (Kolodner, 1983) and IPP (Lebowitz, 1983). An alternative approach is the category and exemplar model applied first to the PROTOS system of Porter and Bareiss (1986), while some other types of memory models developed later on.

As an intelligent-systems method CBR has got a lot of attention over the last few years, because it enables the information managers to increase efficiency and reduce cost by substantially automating processes. CBR first appeared in commercial systems in the early 1990's and since then has been used to create numerous applications in a wide range of domains including diagnosis, help-desk, assessment, decision support, design, etc. Organizations as diverse as IBM, VISA International, Volkswagen, British Airways and NASA have already made use of CBR in applications such as customer support, quality assurance, aircraft maintenance, process planning and many more applications that are easily imaginable.

CBR has been formalized for purposes of computer and human reasoning as a four steps process. These steps involve:

**R<sub>1</sub>:** *Retrieve* the most similar to the new problem past case.

**R<sub>2</sub>:** *Reuse* the information and knowledge of the retrieved case for the solution of the new problem.

**R<sub>3</sub>:** *Revise* the proposed solution.

**R<sub>4</sub>:** *Retain* the part of this experience likely to be useful for future problem-solving.



More specifically, the retrieve task starts with the description of the new problem, and ends when a best matching previous case has been found. The subtasks of the retrieving procedure involve identifying a set of relevant problem descriptors, matching the case and returning a set of sufficiently similar cases given a similarity threshold of some kind, and selecting the best case from the set of cases returned. Some systems retrieve cases based largely on superficial syntactic similarities among problem descriptors, while advanced systems use semantic similarities.

The reuse of the solution of the retrieved case in the context of the new problem focuses on two aspects: The differences between the past and the current case, and what part of the retrieved case can be transferred to the new case. Usually in non trivial situations part of the solution of the retrieved case cannot be directly transferred to the new case, but requires an adaptation process that takes into account the above differences.

Through the revision the solution generated by reuse is tested for success – e.g. by being applied to the real world environment, or to a simulation of it, or evaluated by a specialist – and repaired, if failed. When a failure is encountered, the system can then get a reminding of a previous similar failure and use the failure case in order to improve its understanding of the present failure, and correct it. The revised task can then be retained directly (if the revision process assures its correctness), or it can be evaluated and repaired again.

The final step involves selecting which information from the new case to retain, in what form to retain it, how to index the case for better retrieval in future for similar problems, and how to integrate the new case in the memory structure.

Detailed flowcharts illustrating the basic steps of the CBR process and detailed analyses of the CBR methodologies have been presented by Slade (1991), Aamodt and Plaza (1994), Lei et al (2001), Voskoglou (2008 a) and others.

### 3. The fuzzy model

Let us consider a CBR system whose library contains  $n$  past cases,  $n \geq 2$ . We denote by  $R_i$ ,  $i=1,2,3$ , the steps of retrieval, reuse and revision and by  $a, b, c, d$ , and  $e$  the linguistic labels of negligible, low, intermediate, high and complete degree of success respectively for each of the  $R_i$ 's. Set

$$U = \{a, b, c, d, e\}$$

We are going to represent  $R_i$ 's as fuzzy sets in  $U$ . For this, if  $n_{ia}, n_{ib}, n_{ic}, n_{id}$  and  $n_{ie}$  respectively denote the number of cases where it has been achieved negligible, low, intermediate, high and complete degree of success for the state  $R_i$   $i=1,2,3$ , we define the membership function  $m_{R_i}$  in terms of the frequencies, i.e. by

$$m_{R_i}(x) = \frac{n_{ix}}{n}$$

for each  $x$  in  $U$ . Thus we can write

$$R_i = \left\{ \left( x, \frac{n_{ix}}{n} \right) : x \in U \right\}, i=1,2,3$$

The reason, for which we didn't include the last step  $R_4$  of the CBR process in our fuzzy representation, is that all past cases, either successful, or not, are retained in the system's library and therefore there is no fuzziness in this case. In other words keeping the same notation we have that  $n_{4a}=n_{4b}=n_{4c}=n_{4d}=0$  and  $n_{4e}=1$ .

In order to represent all possible profiles (overall states) of a case during the CBR process, we consider a *fuzzy relation*, say  $R$ , in  $U^3$  of the form

$$R = \{ (s, m_R(s)) : s = (x, y, z) \in U^3 \}$$

To determine properly the membership function  $m_R$  we give the following definition:

**DEFINITION:** A profile  $s=(x, y, z)$ , with  $x, y, z$  in  $U$ , is said to be well ordered if  $x$  corresponds to a degree of success equal or greater than  $y$ , and  $y$  corresponds to a degree of success equal or greater than  $z$ .

For example, profile  $(c, c, a)$  is well ordered, while  $(b, a, c)$  is not.

We define now the membership degree of  $s$  to be

$$m_R(s) = m_{R_1}(x) m_{R_2}(y) m_{R_3}(z)$$

if  $s$  is a well ordered profile, and zero otherwise. In fact, if for example  $(b, a, c)$  possessed a nonzero membership degree, given that the degree of success at the step of reuse is negligible, how the proposed solution could be revised?

In order to simplify our notation we shall write  $m_s$  instead of  $m_R(s)$ . Then the *possibility*  $r_s$  of the profile  $s$  is given by

$$r_s = \frac{m_s}{\max\{m_s\}}$$

where  $\max\{m_s\}$  denotes the maximal value of  $m_s$ , for all  $s$  in  $U^3$ . In other words  $r_s$  is the “relative probability” of  $s$  with respect to the other profiles.

During the CBR process it might be used reasoning that involves amplified inferences, whose content is beyond the available evidence and hence obtain conclusions not entailed in the given premises. The appearance of conflict in the conclusions requires that the conclusions be appropriately adjusted so that the resulting generalization is free of conflict. The value of total conflict during the CBR process can be measured by the strife function  $S(r)$  on the ordered possibility distribution

$$r : r_1 = 1 \geq r_2 \geq \dots \geq r_n \geq r_{n+1}$$

of the profiles defined by:

$$S(r) = \frac{1}{\log 2} \left[ \sum_{i=2}^n (r_i - r_{i+1}) \log \frac{i}{\sum_{j=1}^i r_j} \right]$$

In general, the amount of information obtained by an action can be measured by the reduction of uncertainty that results from the action. Thus the total possibilistic uncertainty  $T(r)$  during the CBR process can be used as a measure for the system’s effectiveness in solving new related problems. The value of  $T(r)$  is measured by the sum of the strife  $S(r)$  and non specificity  $N(r)$  (Klir, 1995; p.28), defined by:

$$N(r) = \frac{1}{\log 2} \left[ \sum_{i=2}^n (r_i - r_{i+1}) \log i \right]$$

In contrast to strife, which, as we have already seen, expresses conflicts among the various sets of alternatives, non specificity is connected with the sizes (cardinalities) of relevant sets of alternatives. The lower is the value of  $T(r)$ , the higher is the effectiveness of the CBR system in solving new related problems. Assume now that one wants to study the combined results of the behaviour of  $k$  different systems,  $k \geq 2$ , designed for the solution of the same type of problems via the CBR process. Then it becomes necessary to introduce the fuzzy variables  $R_i(t)$ , with  $i=1,2,3$  and  $t=1,2,\dots,k$ , and determine the possibilities  $r(s)$  of the profiles  $s(t)$  through the pseudo-frequencies

$$f(s) = \sum_{t=1}^k m_s(t)$$

Namely

$$r(s) = \frac{f(s)}{\max\{f(s)\}}$$

where  $\max\{f(s)\}$  denotes the maximal pseudo-frequency. The possibilities  $r(s)$  of all the profiles  $s(t)$  measure the degree of evidence of the combined results of the  $k$  different CBR systems..

#### 4. An application

Let us consider a medical diagnostic CBR system that tries to retrieve past cases, whose symptom lists are similar in nature to that of the new case, and suggest diagnoses based on the best matching retrieved cases. Assume that in the system there exists a library of 105 past cases, where in no case there was a failure at the step of retrieval of a previous similar case for making a diagnosis. In fact, assume that in 51 cases we had an intermediate success in retrieving a suitable past case, in 24 cases high, and in 30 cases we had a complete success respectively. Thus the state of retrieval is represented as a fuzzy set in U as

$$R_1 = \{(a,0), (b,0), (c, \frac{51}{105}), (d, \frac{24}{105}), (e, \frac{30}{105})\}$$

In the same way we find that

$$R_2 = \{(a, \frac{18}{105}), (b, \frac{18}{105}), (c, \frac{48}{105}), (d, \frac{21}{105}), (e,0)\}$$

and

$$R_3 = \{(a, \frac{36}{105}), (b, \frac{30}{105}), (c, \frac{39}{105}), (d,0), (e,0)\}$$

It is a straightforward process then to calculate the membership degrees of all the possible profiles (see column of  $m_s(1)$  in Table 1). For example, if

$$s=(c, b, a)$$

then

$$m_s = m^{R_1}(c) \cdot m^{R_2}(b) \cdot m^{R_3}(a) = \frac{51}{105} \cdot \frac{18}{105} \cdot \frac{36}{105} \approx 0,029.$$

It turns out that (c, c, c) is the profile with the maximal membership degree 0,082 and therefore the possibility of each s in  $U^3$  is given by

$$r_s = \frac{m_s}{0,082}$$

For example the possibility of (c, b, a) is

$$\frac{0,029}{0,082} \approx 0,353$$

while the possibility of (c, c, c) is of course equal to 1.

Calculating the possibilities of the 53=125 in total profiles (see column of  $r_s(1)$  in Table 1) one finds that the ordered possibility distribution r of the profiles is:

$r_1=1, r_2=0,92, r_3=0,768, r_4=0,512, r_5=0,476, r_6=0,415, r_7=0,402, r_8=0,378, r_9=r_{10}=0,341, r_{11}=0,329, r_{12}=0,317, r_{13}=0,305, r_{14}=0,293, r_{15}=r_{16}=0,256, r_{17}=0,20, r_{18}=0,195, r_{19}=0,171, r_{20}=r_{21}=r_{22}=0,159, r_{23}=0,134, r_{24}=r_{25}= \dots \dots =r_{125}=0$

Therefore the total possibilistic uncertainty is

$$T(r)=S(r)+N(r)=0,565+2,405= =2,97$$

Next we shall study the combined results of the behaviour of the above system and of another system, designed for the solution of the same type of problems via the CBR process, with an existing library of 90 past cases. Working as before we find for the second system that

$$R_1 = \{(a,0), (b, \frac{18}{90}), (c, \frac{45}{90}), (d, \frac{27}{90}), (e,0)\}$$

$$R_2 = \{(a, \frac{18}{90}), (b, \frac{24}{90}), (c, \frac{48}{90}), (d, 0), (e, 0)\}$$

and

$$R_3 = \{(a, \frac{36}{90}), (b, \frac{27}{90}), (c, \frac{27}{90}), (d, 0), (e, 0)\}$$

The calculation of all possible profiles gives the results shown in column of  $m_s(2)$  in Table 1. It turns out that (c, c, a) is the profile possessing the maximal membership degree 0,107 and therefore the possibility of each is given by

$$r_s = \frac{m_s}{0,107}$$

(see column of  $r_s(2)$  in Table 1).

Finally, in the same way as above, one finds that

$$T(r) = S(r) + N(r) = 0,452 + 1,87 = 2,322$$

Thus, since  $2,322 < 2,97$ , the effectiveness of the second system in solving new related problems is better than that of the first one. This happens despite the fact that the profile (c, c, c) with the maximal possibility of appearance in the first system is a more satisfactory profile than the corresponding profile (c, c, a) of the second system.

Table 1: Profiles with non zero pseudo-frequencies

$A_1$	$A_2$	$A_3$	$m_s(1)$	$r_s(1)$	$m_s(2)$	$r_s(2)$	$f(s)$	$r(s)$
b	b	b	0	0	0,016	0,150	0,016	0,087
b	b	a	0	0	0,021	0,196	0,021	0,115
b	a	a	0	0	0,016	0,150	0,016	0,087
c	c	c	0,082	1	0,080	0,748	0,162	0,885
c	c	a	<b>0,076</b>	<b>0,927</b>	<b>0,107</b>	<b>1</b>	<b>0,183</b>	<b>1</b>
c	c	b	0,063	0,768	0,008	0,075	0,071	0,388
c	a	a	0,028	0,341	0,040	0,374	0,068	0,372
c	b	a	0,028	0,341	0,053	0,495	0,081	0,443
c	b	b	0,024	0,293	0,040	0,374	0,064	0,350
d	d	a	0,016	0,495	0	0	0,016	0,087
d	d	b	0,013	0,159	0	0	0,013	0,074
d	d	c	0,021	0,256	0	0	0,021	0,115
d	a	a	0,013	0,159	0,024	0,224	0,037	0,202
d	b	a	0,013	0,159	0,032	0,299	0,045	0,246
d	b	b	0,011	0,134	0,024	0,224	0,035	0,191
d	c	a	0,031	0,378	0,064	0,598	0,095	0,519
d	c	b	0,026	0,317	0,048	0,449	0,074	0,404
d	c	c	0,034	0,415	0,048	0,449	0,082	0,448
e	a	a	0,017	0,207	0	0	0,017	0,093
e	b	b	0,014	0,171	0	0	0,014	0,077
e	c	a	0,039	0,476	0	0	0,039	0,213
e	c	b	0,033	0,402	0	0	0,033	0,180
e	c	c	0,042	0,512	0	0	0,042	0,230
e	d	a	0,025	0,305	0	0	0,025	0,137
e	d	b	0,021	0,256	0	0	0,021	0,115
e	d	c	0,027	0,329	0	0	0,027	0,148

Note: The outcomes of Table 1 are with accuracy up to the third decimal point.

Notice that in general, the more are the stored past cases in the system's library, the greater is expected to be its effectiveness in solving new related problems. In fact, the more are the past cases, the greater is the probability for a new problem to fit satisfactorily to one of them. Therefore the fact that the second system was found to be more effective than the first one, although not impossible to happen, it is rather unexpected in general.

We introduce now the fuzzy variables  $R_i(t)$ ,  $i=1,2,3$  and  $t=1,2$ . Then the pseudo-frequency of each profile  $s$  is given by

$$f(s) = m_s(1) + m_s(2)$$

(see the corresponding column of Table 1). It turns out that (c, c, a) is the profile with the highest pseudo-frequency 0,183 and therefore the possibility of each profile is given by

$$r(s) = \frac{f(s)}{0,183}$$

The possibilities of all profiles having nonzero pseudo-frequencies are given in the last column of Table 1

## 5. Conclusions and discussion

The following conclusions can be drawn from the discussion presented in the paper:

- Although both CBR and fuzzy systems are intended as cognitively more plausible approaches to reasoning and problem-solving, the two corresponding fields have emphasized different aspects that complement each other in a reasonable way.
- Our fuzzy representation of a CBR system is based on the formalization of CBR as a four steps process (retrieve, reuse, revise, retain)
- Our fuzzy model is not restricted only to quantitative information (possibilities, value of  $T(r)$ , etc), but it also gives a qualitative view of the behaviour of a CBR system. In fact, through it one studies all the possible profiles of the stored cases, and gets – in terms of the linguistic labels – a comprehensive idea about the degree of success of each step of the CBR process.
- Another advantage of our model is that it gives the possibility to study the combined results of behaviour of two, or more, CBR systems designed for the solution of the same type of problems.

An analogous to the above model has been constructed for a fuzzy representation of the process of learning a subject matter by a group of students in the classroom (Voskoglou, 2008 b). Analogous efforts, with different in general methodologies, to use the fuzzy sets logic in the area of student modelling and student diagnosis in particular and in education in general have been attempted by other researchers as well, e.g. Perikaris (1996), Espin and Oliveras (1997), Ma and Zhou (2000), Spagnolo and Gras (2004) etc.

We must finally underline the importance of use of *stochastic methods (Markov chain models)* as an alternative approach for the same purposes, e.g. Voskoglou and Perdikaris (1991), Voskoglou (1996 a, 1996 b, 2000, 2007) etc. However Markov models, although easier sometimes to be applied in practice by a non expert, are self-restricted to provide quantitative information only for the corresponding situations, e.g. measures for the problem-solving, or model-building abilities of a group of students, short and long-run forecasts (probabilities) for the evolution of various phenomena, etc. Therefore, one could claim that a fuzzy model, like the one presented in this paper, is more useful for the deeper study of a real situation, because, apart from the quantitative information, it gives also the possibility of a qualitative analysis of the corresponding phenomena.

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# HOUSEHOLD ENERGY FOOTPRINT: RESEARCH OUTCOMES FROM THE REGION OF ATTICA

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## Abstract

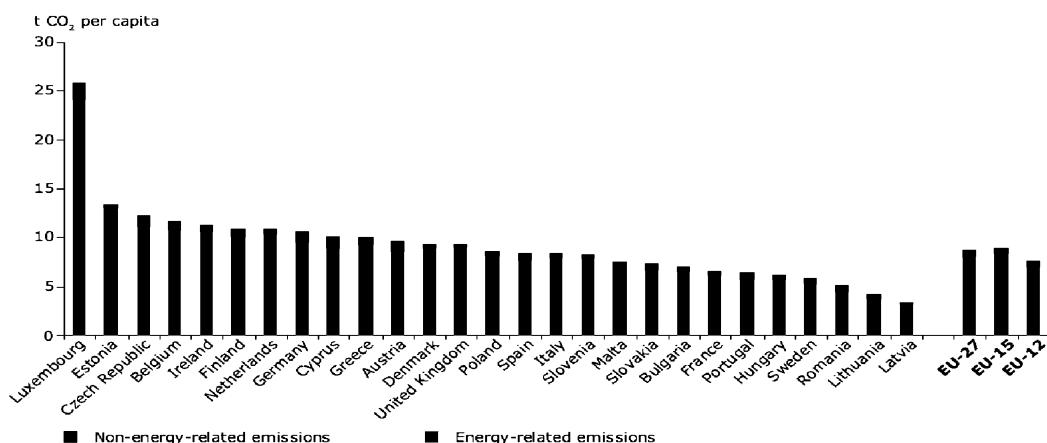
*Global climate change is one of humanity's greatest challenges and one of the most important indicators that we are in ecological overshoot. Human activities result in greenhouse gas emissions, with Carbon Dioxide (CO<sub>2</sub>) emissions to be the most threatening. The household component (house environment) is considered as an important factor in energy consumption, emitting in the atmosphere remarkable CO<sub>2</sub> quantities.*

*Aim of this paper, is to present the research results from a random sample of 477 households from the region of Attica. For our research, (conducted in the frame of the research activities of the "Environmental Economics" course in the Economics Department of University Piraeus), we used a structured questionnaire, referring to household patterns and energy consumption practices in the house (internal environment and water heating and electric appliances). Basic objective of our research was the calculation and the analysis of household energy footprint (the total consumption of electric energy and the resultant CO<sub>2</sub> emissions). For the data input and the footprint calculation, we used the WWF Greece web-based tool and therefore we applied simple statistical analysis techniques using the SPSS software. Our research results show, that a remarkable percentage of the households in the region of Attica declare ignorance regarding the energy characteristics of their electric appliances and the majority have low ecological awareness regarding to the management of these appliances. Nevertheless, the household energy consumption in the region of Attica, it's not remarkably differentiated from the medium Greek and European household energy consumption and Carbon Dioxide (CO<sub>2</sub>) emissions, as have been shown by other official studies. Finally, we propose simple interventions for energy saving in the house, in the context of energy footprint reduction and protection of the environment.*

*Keywords: Energy consumption, Household, Greenhouse gases, Greece, CO<sub>2</sub> emissions*

## 1. Introduction

According to the recent World Energy Outlook (IEA, 2007), if governments around the world continue with current policies, the world's energy needs would be 55% higher in 2030 than in 2005. Energy production and use, particularly of fossil fuels, have a number of environmental impacts including air pollution, greenhouse gas emissions and adverse impacts on ecosystems. According to the latest report from the International Panel for Climate Change (IPCC, 2007), to avoid significant impacts of climate change, global CO<sub>2</sub> emissions should peak before the year 2015 and then decrease by 50 to 85% by 2050 (compared to the year 2000). Key trends observed in Europe include the facts that energy-related greenhouse gas (GHG) emissions remain dominant, accounting for 80% of the total emissions, with the largest emitting sector being electricity and heat production, followed by transport. The intensity of carbon dioxide emissions from public conventional thermal power plants in the EU-27 decreased by about 27% during the period from 1990 to 2005, due to improvements introduced in all Member States. Per capita CO<sub>2</sub> emissions in Greece is estimated to 12 t for 2005 (EEA, 2005 & Eurostat, 2005) (see Graph 1).

**Graph 1. CO<sub>2</sub> emissions per capita by country (split by energy and non-energy related emissions), 2005**

Source: EEA; Eurostat.

## 2. Household energy consumption and emissions in E.U and Greece

### 2.1 Household energy consumption

Household consumption forms an important part of the production-consumption chain as it is consumers who make the final choice of which goods and services to consume. European households affect the environment through their day-to-day choices of which goods and services to buy and how to use them (EC, 2003). Even though the environmental pressures caused by each household are small, compared with those caused by production activities, the combination of millions of European households is a major contributor to environmental problems such as climate change, air pollution, water pollution, land use and waste generation (OECD, 2002 & EC, 2001). Households are one of the largest final energy users in the EU, accounting for 26.2 % of total energy consumption in 2001 (compared with 27.7 % for industrial use) (Eurostat, 2005). Space heating is by far the largest energy end-use in households in the EU-15 (70 %), followed by water heating (14 %) and electric appliances and lighting (12 %) (Enerdata, 2004 & PRIMES, 1999). Space heating absorbs the biggest amount of energy in the residential sector with 71.5% of the total energy consumption in 2004. Consequently, space heating and appliances lightning are highly energy intensive for the examined period and thereupon responsible for the high increasing trend in energy consumption of the residential sector (IEA, 1996).

### 2.1 Household CO<sub>2</sub>-emissions and energy efficiency

The CO<sub>2</sub> emissions per dwelling from the direct use of fuels in households slowly decreased in both the EU-15 and EU-27 over the period to 2005 (by 17% and 23% respectively). The decrease in CO<sub>2</sub> emissions resulted from improvements in the carbon intensity of electricity generation, although the decrease in overall emissions has been lessened by the increase in the number of dwellings in Europe (EC, 2004). The per capita CO<sub>2</sub> emissions from household energy consumption (internal environment and water heating and electric appliances) represent about 10% of the total per capita CO<sub>2</sub> emissions in E.U-27. During the period 1997-2004 total CO<sub>2</sub> emissions -including electricity- have been increased by 20.7% in Greece. In 2004, the most CO<sub>2</sub> intensive sector was households which generate 34.3% of the total CO<sub>2</sub> emissions. The corresponding CO<sub>2</sub> share in 2004 for transport was 23.2%, industry 21.5% and tertiary & agriculture 21%. The total CO<sub>2</sub> emissions (including electricity) per dwelling have increased from 4.87 to 8.43 tonnes of CO<sub>2</sub> / dwelling, namely a growth of almost 73%. The per capita CO<sub>2</sub> emissions from household energy consumption (internal environment and water heating and electric appliances) in Greece represent about 8% of the total per capita CO<sub>2</sub> emissions (CRES, 2006).

## 3. Household energy consumption and emissions in the region of Attica: Research rationale, content, methodology and results

Aim of this paper, is to present the research results from a random sample of 477 households from the region of Attica. For our research, (contacted in 2008 in the frame of the research activities of the "Environmental Economics" course in the Economics Department of University Piraeus), we used a structured questionnaire,



referring to household patterns and energy consumption practices in the house (internal environment and water heating and electric appliances). Basic objective of our research was the calculation and the analysis of household energy footprint (the total consumption of electric energy and the resultant CO<sub>2</sub> Emissions). For the data input and the footprint calculation, we used the WWF Greece web-based tool (<http://climate.wwf.gr/>) and therefore we applied simple statistical analysis techniques using the SPSS software.

Descriptive statistics from the data for selective variables of interest is shown in Table 1.

**Table 1: Household energy consumption and CO<sub>2</sub> emissions statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
Household members	477	1	6	<b>3,13</b>	1,280
Household Energy consumption KWh/year	477	719	14027	<b>4503,82</b>	1616,156
Household CO <sub>2</sub> /year emissions (kg)	477	585	11418	<b>3671,06</b>	1311,247
Per capita CO <sub>2</sub> /year emissions (kg)				<b>1172,86</b>	
Valid N (listwise)	477				

For the above results, we can draw out the following remarks:

- The household members (**3,13**) differ from those of the 2001 census (**2,8**) and might be quite different for the year 2008 estimations (**2,4**)
- The per household (dwelling) CO<sub>2</sub> emissions (**3,67 t**), are higher than those estimated for the year 2005 in Greece (**2,73 t**), but are less to the EU-27 measures (**4,4 t**)
- The per capita CO<sub>2</sub> emissions (**1,17 t**) are very close to those measured in Greece for the year 2005 (**1 t**) and to the measurements in EU-27 (**1,14 t**)
- The per capita energy consumption (**1.439 KWh**) is almost identical to those measured in Greece for the year 2005 (**1.554 KWh**)

**Table 2: Summary of Household and per capita energy consumption and CO<sub>2</sub> emissions statistics**

	Greece 2005	EU-27 2005	Our research 2008
Household members	<b>2,8</b>		<b>3,13</b>
Household Energy consumption KWh/year	<b>4351</b>	<b>5700</b>	<b>4503,82</b>
Per capita Energy consumption KWh/year	<b>1554</b>		<b>1439</b>
Household CO <sub>2</sub> /year emissions (t)	<b>2,73</b>	<b>4,4</b>	<b>3,67</b>
Per capita CO <sub>2</sub> /year emissions (t)	<b>0,98</b>	<b>1,14</b>	<b>1,17</b>

The number of powered appliances in homes has increased rapidly in recent decades in Greece. Examples include washing machines, dishwashers, microwaves, refrigerators and freezers, and audio-visual appliances such as televisions, DVD players, mobile phones and personal computers. In 2004 energy consumption of electrical appliances & lighting represented 17.8% of the total energy consumed in the residential sector.

The analysis of our data shows that almost half of the households aren't aware of the energy class of their powered appliances and only a small fraction state that are labelled as energy class "A" (see Table 3).

**Table3: Household powered appliances energy characteristics**

		Class A refrigerator	Class A plate washing machine	Class A cooling air-conditioners	Class A washing machine
		Valid Percent	Valid Percent	Valid Percent	Valid Percent
Valid	Yes	28,9	33,2	29.0	25.0
	No	25,8	22,1	19.4	25.6
	I don't know	45,3	44.7	51.6	49.4
	Total	100,0	100,0	100,0	100,0

Moreover, only 40% switches off the powered appliances disconnecting the power cord. Also, only 21% of the total household lamps are efficient fluorescent lamps (CFLs).

#### 4. Conclusions and proposals

Our research results show, that a remarkable percentage of the households in the region of Attica declare ignorance regarding the energy characteristics of their electric appliances and the majority have low ecological awareness regarding to the management of these appliances. Nevertheless, the household energy consumption in the region of Attica, it's not remarkably differentiated from the medium Greek and European household energy consumption and Carbon Dioxide (CO<sub>2</sub>) emissions, as have been shown by other official studies.

According to the EU Directive in energy end-use efficiency and energy services (EEESD), the Member States shall adopt and aim to achieve an overall national indicative energy savings target of 9 % for the ninth year of application of the Directive starting from 2008 until 2017. Consequently Greece must take cost-effective, practicable and reasonable measures designed to contribute towards achieving this target. In Greece the Ministry of Development is responsible for the implementation of the EEES Directive.

Below, there is a series of proposed policies and measures in the household sector, so as to align Greek environmental strategy to the European strategy for the energy and the environment:

**Table 4: Proposed National Policies and Measures in the household sector**

Measure Title	Measure Type	Subsector	Target Audience	Expected Impact
Energy labelling of domestic electrical appliances	Legislative/Informative	Appliances	general public, landlords, tenants, retailers	High
Inspection standards for central heating boilers	Legislative/Normative	Hot Water, Heating	owner-occupiers, building professions, landlords, tenants	High
Building Energy Efficiency Code	Legislative/Normative	Appliances, Hot water, Heating	owner-occupiers, housing associations, building professions, landlords, manufacturers, retailers	Low
Standards for the thermal insulation for new buildings	Legislative/Normative	Heating	building professions	High
Tax exemption for using natural gas and RES appliances	Fiscal/Tariffs	Appliances, Hot water, Heating	owner-occupiers, housing associations, building professions, landlords, general public, tenants	Low

Measure Title	Measure Type	Subsector	Target Audience	Expected Impact
Efficiency standards for new hot water boilers	Legislative/Normative	Hot Water, Heating	owner-occupiers, building professions, landlords, tenants, manufacturers, retailers	High

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# THE FOLLIES OF FINANCIAL LIBERALIZATION: SOME STATISTICAL EVIDENCE FROM MALAYSIA

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## Abstract

*The link between financial liberalization and the performance of the banking sector is assessed here by employing two techniques. Firstly, using firm level data of Malaysian domestic banks to assess the allocative efficiency of the banking sector. Results revealed that all save one of the banks analyzed have not become more efficient after the banking sector is liberalized. Secondly, the link between financial liberalization and the banking sector crisis is assessed by mobilizing macroeconomic data and multivariate logistic regression technique. Results suggest that financial liberalization, bank's lending rates and the ratio of M2 to foreign exchange reserves do contribute significantly to the 1997 banking crisis in Malaysia.*

*Keywords: Financial liberalization, Banking Crisis, Logistic Regression.*

## 1. Introduction

The current financial meltdown that swept across the globe jolt to memory the importance of a sound and efficient banking system. News of a fire-sale of Bears Stearns Inc. on March 2008 stunned Wall Street and pummelled global financial stocks. This was just the beginning of the global financial storm. By now (March 2009) in USA alone, there are already 14 banks that are declared insolvent while the exports of several Asian countries (namely, Japan, Taiwan and South Korea and Singapore) have plunged. The trail of destruction caused reminisces the 1997 East Asian financial crisis (EAFC). Malaysia was one of the countries that was severely affected then.

Besides Malaysia, Thailand, Korea, Indonesia and the Philippines were also badly hit. The toll of the crisis was enormous as it persisted and spread to the real sector. On average, these five economies shrank about 7.7%, with many millions of people sustaining livelihood losses. (Yellen, 2007). The East Asian financial crisis of 1997 highlighted the link between financial liberalization and instability of the banking sector. All five countries had deregulated their banking systems some time before the onslaught of that banking debacle. Malaysia, went through two banking crises. The first crisis was in the mid 1980's and the second being the 1997 EAFC. The crisis of 1980s was short and less severe compared to the 1997 crisis. The ringgit (Malaysian currency) depreciated against the US dollar by nearly 50%, while the stock market contracted by more than 60%. Real output declined by 6.7% after 12 years of uninterrupted expansion, averaging 7.8% per annum before the onslaught of the EAFC. Per capita income in nominal terms declined by about 30% from US\$4284 in 1997 to US\$3018 in 1998. This had a bearing on the real sector of the economy. Significant numbers of people were being retrenched. This resulted in immense human suffering due to lack of social safety nets.

This paper aims to contribute to the literature on the link between financial liberalization and the performance of the banking sector by: a) using firm level data of Malaysian domestic banks to assess the allocative efficiency of the banking sector. Specifically, it tries to determine whether financial liberalization in Malaysia was able to promote a competitive environment that could boost the efficiency of banks in terms of reduction in intermediation spreads; and b) mobilizing macroeconomic data to assess the contribution of financial liberalization to the banking crisis of 1997.

## 2. Banking Institutions and Financial liberalization in Malaysia

The banking system in Malaysia consists of the central bank (Bank Negara Malaysia), banking institutions and other financial institutions as shown in Table 1. The banking system is the largest component, accounting for about 70 per cent of the total assets of the Malaysian financial system (Bank Negara Malaysia, 1999). The banking institutions are traditionally the largest mobilizers of deposits. Recent statistics show that they still are: in 2005, for example, the banking institutions mobilized around 83% of the total deposits of the financial system and held about 67% of the financial system's total assets.

The 1997 financial crisis revealed the structural weakness of the Malaysian financial system. Strong loan growth between 1994 – 1997, which averaged about 25% per annum, had led to the high loan exposure of the banking system. In addition the underdeveloped bond market also resulted in the banking system providing a significant portion of the private sector financing, thereby increasing the concentration of risk in the banking sector. The crisis also exposed the vulnerability of the finance companies, whose business was mainly hire purchase financing and consumption credit. Thus the industry became highly vulnerable amidst rising interest rates and a slowdown in the economic activity. Hence a merger programme for the finance companies was initiated in January 1998 to consolidate and rationalize the industry. In 1999, the domestic banking banks were given the flexibility to form their own merger groups and to choose their own leader in each group to lead the merger process. By 2001, the domestic banking sector was subsequently merged into 10 banking groups as shown in Appendix 1.

Malaysia began financial liberalization on October 1978, however, on several occasions, the deregulation process had to be put on hold or reversed when the economy faced adverse shocks. Malaysia's banking sector is considered fully liberalized on February 1991.

**Table 1: The Malaysian Financial System**

Financial Institutions	Financial Markets
Banking System <ul style="list-style-type: none"> <li>• Bank Negara Malaysia</li> <li>• Banking institutions               <ul style="list-style-type: none"> <li>- Commercial banks (including Islamic Banks)</li> <li>- Finance companies</li> <li>- Merchant banks</li> </ul> </li> <li>• Others               <ul style="list-style-type: none"> <li>- Discount houses</li> <li>- Representative office of Foreign banks</li> <li>- Offshore banks in Labuan</li> </ul> </li> </ul> Non-Bank Financial Intermediaries (NBFI) <ul style="list-style-type: none"> <li>• Provident and pension funds</li> <li>• Insurance companies (including Takaful)</li> <li>• Development finance institutions</li> <li>• Saving institutions               <ul style="list-style-type: none"> <li>- National savings bank</li> <li>- Co-operative societies</li> </ul> </li> <li>• Other NBFI               <ul style="list-style-type: none"> <li>- Unit trusts</li> <li>- Pilgrims fund board</li> <li>- Housing credit institutions</li> <li>- Cagamas Bhd.</li> <li>- Credit guarantee corp.</li> <li>- Leasing companies</li> <li>- Factoring</li> <li>- Venture capital</li> </ul> </li> </ul>	Money & Foreign Exchange Markets <ul style="list-style-type: none"> <li>• Money market</li> <li>• Foreign exchange market</li> </ul> Capital market <ul style="list-style-type: none"> <li>• Equity market</li> <li>• Bond market               <ul style="list-style-type: none"> <li>- Public debt securities</li> <li>- Private debt securities</li> </ul> </li> </ul> Derivative markets <ul style="list-style-type: none"> <li>• Commodity Futures</li> <li>• KLIBOR Futures</li> </ul> Offshore market <ul style="list-style-type: none"> <li>• Labuan International Offshore Financial Centre</li> </ul>

Source: Bank Negara Malaysia, *The Central Bank and the Financial System in Malaysia, A Decade of Change, 1999*

### 3. Allocative Efficiency of Malaysian Banks : A Cost Ratio Analysis

The banking system of a country in its role as an intermediary, performs the crucial task of channeling resources from savings to investment. With financial liberalization, banks are expected to be more efficient in their operations. This implies narrowing the margin between what they pay for financial resources (the deposit rate) and what they earn on them (the loan rate). The difference between the deposit rate and the loan rate is referred to as the interest spread (or margin). For the Malaysian banks, margin is the main source of their profits (Cheah, 1994). In a fully liberalized environment, competition should reduce spreads and enhance bank performance and efficiency. According to Lin (1990), the ability of the banks to reduce their lending margins without crippling the system's financial health is an indicator of the efficiency of the banking system. Hence margin can be regarded as an indicator of the banks' efficiency in financial intermediation.

Revell (1980) conducted a comprehensive survey on the cost of intermediation and interest-rate margin. The main objective was to investigate an assumed increase in the cost of intermediation in the OECD countries. In this paper, the cost-ratio analysis procedure established by Revell is adopted to evaluate the efficiency of the banking system. By comparing two series (pre-liberalization and post-liberalization) of cost data of the banks, we would be able to ascertain whether the banking system's cost of intermediation has increased or decreased over time. This in turn allows us to infer about banks' efficiency following financial liberalization. In computing the cost ratio, the gross earning margin being a proxy for the cost of intermediation would appear in the numerator. While the total assets of the banking institutions would be the denominator.

The items that are extracted from the income statements of banks to calculate the gross earning margin figures are: 1. Interest received 2. Interest paid 3. Other income. Items 1 and 2 include only interest received and paid on loans and deposits. Interest and income from other sources such as investment in securities, foreign exchange operation and other fees and commission are found in item 3. The sum of 1,2 and 3 gives the broadly defined margin received by banks in their financial operations. This sum is referred to as the gross earning margin (G.E.M), which is also referred to as the "banker's spread". Hence, the required cost ratio is GEM divided by the bank's total assets. Related data of selected banks in Malaysia are compiled from 1987 to 1997. These years are chosen based upon data constraints. 1987 is the earliest year that has data in the form of aggregation described above, or in a form, from which the required data can be extracted from the published sources. While, 1997 is the last year in the series due to the banking merger exercise that followed after the financial crisis of 1997. The crisis had affected a number of banks adversely. There is also the issue of the bank entity itself. Banks that are chosen are those that have been established long enough (at least from 1987 to 1997) and have not encountered significant changes in management or mergers during the period under study. A number of banks in the Malaysian banking system have gone through mergers during the 1990's. Mergers give rise to considerable consolidation in banks' accounts making it very difficult to compare the banks' accounts from one period to another, especially if previous period is before the merger. Owing to the above constraints, only seven of the Malaysian domestic banks are selected for a cost ratio analysis. The main sources of statistical information are the Balance Sheets and Profit and Loss Accounts of the banking institutions. The cost ratio series from these banks provide an indication of the banking institutions' efficiency over the years, especially before and after financial liberalization.

The mean (or average) intermediation spread is calculated for both the pre liberalization years (1987 – 1991) and for the post liberalization years (1992 – 1997). From these mean values (as seen in Table 2), it would seem that most of the banks (five out of seven) showed an increase in the spread in the post liberalization period. Only banks F and D had a reduced G.E.M/Total Assets ratio in the post liberalization period. In order to investigate if there were indeed significant changes in the mean ratios between the pre and post-liberalization periods, statistical analysis using the non parametric method is employed here. Non parametric test is used when the distribution of the data is not normal. From Table 3, the test reveals no significant difference in the GEM ratio between pre and post liberalization periods for all banks except for Bank D. This implies that the intermediation spread of all the banks sampled did not change materially with financial liberalization except for one, i.e. Bank D. Hence, the results generally indicate that a more liberalized environment in Malaysia did not seem to have enhanced bank efficiency in terms of reducing the bankers' spread. Out of seven, only one bank had a lower average intermediation spread in the post-liberalization period.

**Table 2: Mean GEM/Total Assets Ratio for Both Periods**

Bank	Pre ( $\bar{x}_{pre}$ )	Post ( $\bar{x}_{post}$ )	Difference ( $\bar{x}_{pre} - \bar{x}_{post}$ )	Change
A	4.6654	5.2742	-0.6087	Increase
B	4.2819	4.6962	-0.4142	Increase
C	3.0960	3.4383	-0.3423	Increase
D	3.4375	2.9766	0.4609	Decrease
E	3.3941	3.5260	-0.1319	Increase
F	3.3054	3.0860	0.2194	Decrease
G	3.1883	3.6083	-0.4200	Increase

**Table 3: Mann-Whitney U Test Results**

Bank	Pre ( $\bar{x}_{pre}$ )	Post ( $\bar{x}_{post}$ )	Difference ( $\bar{x}_{pre} - \bar{x}_{post}$ )	p-values	Results
A	4.6654	5.2742	-0.6087	0.361	Not significant
B	4.2819	4.6962	-0.4142	0.144	Not significant
C	3.0960	3.4383	-0.3423	0.068	Not significant
D	3.4375	2.9766	0.4609	0.028*	Significant
E	3.3941	3.5260	-0.1319	0.361	Not significant
F	3.3054	3.0860	0.2194	0.361	Not significant
G	3.1883	3.6083	-0.4200	0.068	Not significant

\* p-value &lt; 0.05

#### 4. Financial Liberalization and Banking Sector Stability

Agrawal (1992) pointed out that liberalized financial markets have been associated with certain undesirable outcomes that may offset the benefits of financial liberalization. Amongst them include increased use of credit to purchase assets and finance consumption, asset price inflation and volatility, and financial fragility. It was noted also that financial liberalization often leads to the prices of shares, real estate first rising sharply, inducing many people to invest or speculate in these markets with some funds borrowed from banks at very high real interest rates. The prices later decline, causing many people who had earlier borrowed at high real interest rates to become insolvent and this leaves the banks with a large portfolio of non-performing loans which eventually causes their insolvency.

Demirguc-Kunt and Detragiache (1998) and also Cole and Slade (1998) stressed that financial liberalization is a contributing factor to the banking crises that had occurred. Demirguc-Kunt and Detragiache explored empirically the relationship between banking crises and financial liberalization in 53 countries (including Malaysia) during 1980 – 1995 using a multivariate logit framework and found that banking crisis are more likely to occur in liberalized financial systems. The results derived showed a number of factors including adverse macroeconomic developments, bad economic policies as being the other potential explanatory variables. When these factors are controlled for, financial liberalization exerts a significantly, negative effect on the stability of the banking system. Zhuang (2002) also tested empirically the link between financial liberalization and bank instability. The factors considered in these studies included both bank specific and macroeconomic variables. The ratio of M2 to foreign exchange reserves, total bank loans divided by the country's GDP and the current account balance have been found to affect bank stability. Akyuz (2004) stressed that in developing countries, domestic financial cycles are often associated with sharp swings in external capital flows and exchange rates. Further, the great susceptibility of domestic financial condition in developing countries to currency instability is due primarily to the existence of large stocks of public and private debt denominated in foreign currencies. In his opinion, this is the main reason why currency crises in emerging markets spill over to domestic financial markets, not bad macroeconomic policies, as he felt that the large majority of the countries in East Asia have track records of sustainable development and macroeconomic discipline.

## 5. The Logistic Regression Model

The logistic regression model can be expressed as follows:

$$P(Y_i = 1) = \frac{1}{1 + e^{-Z}} \quad , \quad i = 1, \dots, N \quad \text{----- (1)}$$

Where

$$Z = b_0 + b_1X_1 + b_2X_2 + \dots + b_MX_M$$

P = the probability that the observed value Y takes the value 1

N = the number of observations

X = the explanatory variables

M = the number of explanatory variables

Y = the dependent variable ; Y = 1 for bank crisis period and Y = 0 for non crisis period.

It is a cumulative logistic distribution function with P representing the probability of a bank crisis which can be estimated. Logistic regression is appropriate when the dependent variable is grouped into discrete states. The explanatory variables include the financial liberalization variable and other control variables. Like most studies on financial liberalization, the removal of interest rate controls is considered the centerpiece of financial liberalization. For Malaysia, it is only on February 1, 1991 that the BLR (base lending rate) was freed from the administrative control of the central bank.

In this study the control variables that capture the characteristics of the banking system namely, ratio of M2 to foreign exchange reserves (an indicator of vulnerability to sudden capital outflows) and lending rate are included. The ratio of M2 to foreign exchange reserves is a measure of the country's ability to withstand the pressure of substituting foreign currency for domestic currency by investors. A rise in the M2/ foreign exchange reserves ratio implies a decline in the foreign currency backing of the short-term domestic currency liabilities of the banking system. Hence this would make the banking system vulnerable to sudden capital outflow. Malaysia opened its capital account as part of its ongoing financial liberalization program. With this development, there was a massive inflow of foreign capital, in particular portfolio investment. When the crisis precipitated, these funds took flight easily. As noted by Chan-Lau (1998), the private capital flows to the five economies most affected by the EAFC, reversed from a net inflow of US\$93 billion in 1996 to a net outflow of US\$12 billion in 1997.

Lending-deposit rate spreads were used by both Zhuang (2002) and Chenard (1997) as an indicator of distress and problems in the banking sector. The rationale being, after financial liberalization, banks are free to set the rates charged on borrowing. Hence, banks could be motivated to profit from the new found freedom of setting interest rates, as long as interest gains are larger than the loss from the increased risk. The same has been expressed by Akyuz (1993). In essence, this means that unregulated financial markets can lead to higher interest rates and greater risk-taking. Hence, both the lending-deposit spread and the lending rates will be used here for the analysis. Apart from these variables, the rate of real GDP growth as a macroeconomic variable (Rgdpgrow) is also included, given that adverse shifts in the macroeconomic condition of a country could weaken its financial sector.

Based on the criteria of goodness of fit, predictive efficiency of the model and statistical significance of individual predictor variables as given by Menard (2001), the following model is considered the most appropriate to address the banking crisis hypothesis of this study. Three of the predictor variables; financial liberalization (Fin Lib), ratio of M2 to foreign exchange reserves (M2tofor) and bank lending rates (Lend) are statistically significant. The following two tables furnish the results of the model used.

**Table 4: Logistic Regression Results**

Predictors	B	S.E	Wald	Df	Sig.	Exp (B)
Fin. lib.	5.34	2.50	4.52	1	0.033**	208.26
M2tofor	1.58	0.72	4.43	1	0.030**	4.85
Lend	2.20	1.00	4.69	1	0.030**	8.73
Rgdpgrow	0.33	0.25	1.84	1	0.180	1.39
Constant	-38.00	15.70	5.85	1	0.016**	0.0000



## Notes:

- i) B = the logistic regression coefficient
- ii) S.E. = standard error of the coefficient
- iii) Wald = Wald statistic to test the significance of the individual coefficient
- iv) df = degree of freedom
- v) Sig. = the p-value for the Wald statistic
- vi) Exp(B) = the odds ratio of the independent variable
- vii) \*\* Indicates significance level of 0.05

The odds ratio for the financial liberalization variable is 208. This implies that when all the other variables are held constant, the liberalization of the banking sector increases the odds of a banking crisis occurring. Specifically, with financial liberalization the banking sector is 208 times more likely to encounter a banking crisis. The other two variables, namely ratio of M2 to foreign exchange reserves (m2tofor) and lending rates of the commercial banks (lend) could also raise albeit to a much smaller extent the odds of a banking crisis happening, as they grow. The odds ratio of the lending rates is 8.7. This implies that with a one unit increase in the lending rates, the banking sector is 9 times more likely to encounter a banking crisis. The classification table below suggest that this model predicted the outcome (banking crisis) very well. The percentage of the non-occurrence of the crisis correctly predicted is 100 per cent, while the percentage of occurrence of the crisis correctly predicted is 87.5 per cent, giving an overall success rate of 98.4 per cent.

**Table 5 : Classification Table for Prediction of Banking Crisis**

Observed		Predicted		
		Crisis		Percentage Correct
		0	1	
Crisis	0	54	0	100.0
	1	1	7	87.5
Overall percentage				98.4

**6. Conclusion**

The impact of financial liberalization on the performance and stability of Malaysian banks has been assessed based upon cost ratio analysis and logistic regression analysis. The cost ratio analysis has revealed that all save one of the banks analyzed, have not become more efficient (in terms of having a lower intermediation spread) after the banking sector is liberalized. This indicates that a liberalized environment alone was not sufficient to promote keen competition among the banks, conversely, the banks seem to be able to keep a larger spread.

The logistic regression analysis showed that financial liberalization could independently exert a negative effect on the stability of the banking sector when other factors (macroeconomic variables and bank specific factors) are controlled for. Besides financial liberalization, the factors that could contribute significantly to a banking sector crisis were the M2 to foreign exchange reserves ratio and the banks' lending rates. This implies that financial liberalization encouraged higher interest rates and greater risk taking, while capital account liberalization attracted mobile capital that caused damaging effects to the economy for the period studied.

Hence, for Malaysia, the results suggest that financial liberalization had contributed to the 1997 banking crisis. The crisis also has a lot to do with the banking sector's performance but not much with the country's macroeconomic condition. This is plausibly due to financial liberalization without adequate financial regulation. In a liberalized environment and in the absence of adequate monitoring, banks are likely to take greater risks. The process of financial deregulation should be accompanied by an adequate system of laws and regulations. Supervision of banking institutions is just as important if not more important than for non-financial public listed firms. Regulatory agencies should ensure that financial institutions are transparent, responsible and accountable in their operations. With half the world in recession now, in no small part due to unfettered financial liberalization, the case for greater prudential financial regulation is crystal clear.

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## Appendix 1: Merger Programme for Malaysian Domestic Banking Institutions

Source: Bank Negara Annual Report, 2001

Original Anchor Banking Group	Merged with	Resultant Entity after Merger
<b>1. Affin Bank Berhad Group</b> Perwira Affin Bank Bhd Asia Commercial Finance Bhd Perwira Affin Merchant Bank Bhd.	BSN Commercial Bank (M) Bhd BSN Finance Bhd BSN Merchant Bankers Berhad	Affin Bank Berhad Affin ACF Finance Berhad Affin Merchant Bank Berhad
<b>2. Alliance Bank Berhad Group</b> Multi-Purpose Bank Berhad	International Bank Malaysia Bhd Sabah Bank Berhad Sabah Finance Berhad Bolton Finance Berhad Amanah Merchant Bank Berhad Bumiputra Merchant Bankers Bhd	Alliance Bank Berhad Alliance Finance Berhad Alliance Merchant Bank Berhad
<b>3. Arab-Malaysian Bank Bhd. Group</b> Arab-Malaysian Bank Berhad Arab-Malaysian Finance Bhd Arab-Malaysian Merchant Bhd	MBf Finance Berhad	Arab-Malaysian Bank Berhad Arab-Malaysian Finance Berhad Arab-Malaysian Merchant Bank Berhad
<b>4. Bumiputra Commerce Bank Berhad Group</b> Bumiputra Commerce Bank Berhad Bumiputra Commerce Finance Berhad Commerce International Merchant Bankers Berhad		Bumiputra Commerce Bank Berhad Bumiputra Commerce Finance Berhad Commerce International Merchant Bankers Berhad
<b>5. EON Bank Berhad Group</b> EON Bank Berhad EON Finance Berhad	Oriental Bank Berhad City Finance Berhad Perkasa Finance Berhad Malaysian International Merchant Bankers Berhad	EON Bank Berhad EON Finance Berhad Malaysian International Merchant Bankers Berhad
<b>6. Hong Leong Bank Berhad Group</b> Hong Leong Bank Berhad Hong Leong Finance Berhad	Wah Tat Bank Berhad Credit Corporation (Malaysia) Berhad	Hong Leong Bank Berhad Hong Leong Finance Berhad
<b>7. Malayan Banking Berhad Group</b> Malayan Banking Berhad Mayban Finance Berhad Aseambankers Malaysia Bhd	The Pacific Bank Berhad PhileoAllied Bank (M) Berhad Sime Finance Berhad Kewangan Bersatu Berhad	Malayan Banking Berhad Mayban Finance Berhad Aseambankers Malaysia Berhad
<b>8. Public Bank Berhad Group</b> Public Bank Berhad Public Finance Berhad	Hock Hua Bank Berhad Advance Finance Berhad Sime Merchant Bankers Berhad	Public Bank Berhad Public Finance Berhad Public Merchant Bank Bhd
<b>9. RHB Bank Berhad Group</b> RHB Bank Berhad RHB Sakura Merchant Bankers Bhd	Delta Finance Berhad Interfinance Berhad	RHB Bank Berhad RHB Delta Finance Berhad RHB Sakura Merchant Bankers Berhad
<b>10. Southern Bank Berhad Group</b> Southern Bank Berhad	Bah Hin Lee Bank Berhad United Merchant Finance Berhad Perdana Finance Berhad Cempaka Finance Berhad Perdana Merchant Bankers Bhd	Southern Bank Berhad Southern Finance Berhad Southern Investment Bank Berhad

# THE VALIDITY OF PPP IN THE DAIRY SECTOR AND THE ROLE OF MACROECONOMIC VARIABLES: CASE OF GREECE

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## Abstract

*The present paper investigates the validity of PPP (Taylor and Taylor, 2004; Zafeiriou et al, 2006) and the role of the macroeconomic variables in the formation of prices in dairy products in the Greek market. The macroeconomic variables used in the present paper are the differences between the inflation rates of Greece and U.S.A., as well as the differences in the short – term interest rates between the two countries. In addition we employed another variable representing the openness of the dairy market in Greece, while the role of CAP was examined with the use of a dummy variable. In the first step we surveyed the validity of PPP for the case of Greece and then we examined the role of the macroeconomic variables in the validity or to the non validity of PPP for the commodity price index studied. The method applied for the study of the long – run relationship is the Johansen cointegration technique (1988, 1991). According to the results of our survey, one and sole relationship was validated, between the real exchange rates and the macroeconomic variables used. This result implies that in the long run there is a relationship among these variables, while only the real exchange rates and the interest rates difference affect the inflation rates differential in the long run as confirmed with the estimation of VECM*

*Keywords: PPP, Cointegration, Macroeconomic Variables, VECM.*

## 1. Introduction

In European Union, the market of dairy products has been strongly affected by CAP. The CAP is characterized by complexity, while it is expressed by price support programs or subsidies. What must be mentioned is the realization of three major reforms leading to remarkable changes in the subsidy policy of dairy production. The first reform (the MacSharry reform), took place in 1992 that led to a movement from price support to direct farm payments which is based on the area farmed and livestock kept. As a result the intervention prices for dairy reduced products by 7.5% (Former et al, 1995). The second reform, Agenda 2000, expanded the shifts towards direct payments. Intervention prices for butter and milk powder were reduced by 15%, starting in 2005 (Benjamin et al, 1999). The cuts were compensated by the introduction of yearly direct payments in the form of a dairy premium and additional payments such as "top-up" premium and area payment. In 2003, the Fischler reform further weakened the link between subsidies and production. Relative to Agenda 2000, the intervention price cuts were brought forward one year, and the intervention price for butter was further reduced by 10%. In exchange, the compensation payments were increased. In short, the various CAP reforms have undergone a long process from price support, to the production-related subsidies, and eventually to the decoupled payments (Swinbank and Daugberg, 2006).

The market of dairy products in Greece has been thoroughly studied in the past. In particular, the formation of the prices in the dairy sector has been interpreted with the PPP theory and other models. According to the PPP theory the prices of similar products expressed in the domestic currency are the same. The prices of dairy products are formed within an economic environment affected by the Common Agricultural Policy. The present paper studies the validity of PPP in the long run and also surveys the relationship between the real exchange rate based on the prices of the dairy products in Greece, the difference of the interest rates between domestic and the foreign country, the difference of the inflation rates between the two countries and finally an index that expresses the openness of the market of the dairy products in the economy, under preview.

## 2. Data – Methodology

The time period used in the present study extends from 1.1996-12-2006 while it involves monthly data. The first step in the methodology employed is the application of stationarity test for every variable used. In particular, the KPSS test was applied, and the results of this test are given in Table 1. According to the

results all the variables employed in our study are integrated of order 1 (I(1)) with exception the nominal exchange rates that is integrated of order zero (I(0)).

**Table 1** Results of KPSS stationarity test for all the variables used

Μεταβλητή	Έλεγχος KPSS
dp	1.096546
D(dp)	0.0243
dr	0.993264
D(dr)	0.424790
nxd	1.013846
D(nxd)	0.182812
pd	1.365434
D(pd)	0.090950
Pd*	0.486418
D(pd*)	0.35570
S	0.317513
D(S)	

Note: The critical values of the test are 0.739000, 0.463000, 0.347000 for 1, 5 και 10% significance levels in levels and 0.739000, 0.463000, 0.347000 for the first differences respectively.

$Dp = p-p^*$ ; denotes the inflation rates difference between the two countries used.

$Dr = r-r^*$ ; denotes the difference in the interest rates between the two countries used

$nxd$ ; denotes an index describing the openness of the dairy Greek market

$pd$ ; denotes the consumer domestic price index for the dairy products.

$Pd^*$ ; denotes the consumer foreign price index for the dairy products

$S$ ; denotes the nominal exchange rates

The next step in our study involves the estimation of the cointegration rank with the application of the Johansen technique (1988). The results of this application are given in the next Table 2.

**Table 2.1** Results of Johansen cointegration technique (trace test)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.211038	38.34258	29.79707	0.0041
At most 1	0.093274	13.45364	15.49471	0.0992
At most 2	0.029763	3.172578	3.841466	0.0749

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

**Table 2.2** Results of Johansen cointegration technique (maximum likelihood test)

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.211038	24.88894	21.13162	0.0141
At most 1	0.093274	10.28107	14.26460	0.1941
At most 2	0.029763	3.172578	3.841466	0.0749

Maximum likelihood indicates 1 cointegrating eqn(s) at the 0.05 level

According to the results both tests indicate the existence of a sole relationship and consequently indicating the validity of PPP in the long run. In this test we used as exogenous variables the macroeconomic variables mentioned above.

The next step in our study includes finding the rank of cointegration.

**Table 3.1** Results of Johansen cointegration technique (trace test)

Hypothesized		Trace	5 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value
None **	0.416551	72.00247	29.68

At most 1 *	0.100306	15.96746	15.41
At most 2 *	0.046707	4.974643	3.76

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

**Table 3.2** Results of Johansen cointegration technique (maximum likelihood test)

Hypothesized		Max-Eigen	5 Percent
No. of CE(s)	Eigenvalue	Statistic	Critical Value
None **	0.416551	56.03501	20.97
At most 1	0.100306	10.99282	14.07
At most 2 *	0.046707	4.974643	3.76

Maximum likelihood indicates 1 cointegrating eqn(s) at the 0.05 level

According to the results given above one relationship is confirmed for all the variables used, and consequently a sole relationship is valid in the long run. The macroeconomic variables affect the real exchange rate that is based on the consumer prices of the dairy products.

The relationship is given by the following cointegrating vector after normalizing the coefficient of the real exchange rate;

$$\text{QGREED} - 1.332222 \text{ DP} + 0.062465 \text{ DR} \\ (0.16032) \quad (0.03684)$$

According to the estimated vector the sign of the inflation rate differential is reverse related to the real exchange rate and consequently an increase in the domestic inflation rate implies a decrease in the real exchange rate. A positive sign is confirmed for the coefficient of the interest rates. An increase in the interest rates differential is positively related to the real exchange rates.

The next steps involve the estimation of the Vector Error Correction Models, and are given in the next Table 4;

**Table 4** The estimated vector error correction model

Error Correction:	D(QGREED)	D(DP)	D(DR)
CointEq1	0.000624	-0.223439	0.004519
	(0.00082)	(0.02838)	(0.01293)
	[ 0.75934]	[ -7.87231]	[ 0.34953]
D(QGREED(-1))	0.377070	1.676366	-3.645689
	(0.09943)	(3.43380)	(1.56401)
	[ 3.79225]	[ 0.48819]	[-2.33099]
D(QGREED(-2))	-0.177883	3.382378	0.042601
	(0.10217)	(3.52825)	(1.60703)
	[-1.74111]	[ 0.95866]	[ 0.02651]
D(DP(-1))	0.001387	0.507656	0.037366
	(0.00370)	(0.12786)	(0.05823)
	[ 0.37456]	[ 3.97054]	[ 0.64165]
D(QGREED(-1))	0.377070	1.676366	-3.645689
	(0.09943)	(3.43380)	(1.56401)
	[ 3.79225]	[ 0.48819]	[-2.33099]
D(QGREED(-2))	-0.177883	3.382378	0.042601
	(0.10217)	(3.52825)	(1.60703)
	[-1.74111]	[ 0.95866]	[ 0.02651]
D(DP(-1))	0.001387	0.507656	0.037366
	(0.00370)	(0.12786)	(0.05823)
	[ 0.37456]	[ 3.97054]	[ 0.64165]
D(DP(-2))	0.001824	0.091936	-0.011448
	(0.00290)	(0.10008)	(0.04558)
	[ 0.62946]	[ 0.91865]	[-0.25114]
D(DR(-1))	-0.004977	-0.221960	0.333244
	(0.00656)	(0.22662)	(0.10322)
	[-0.75845]	[-0.97943]	[ 3.22848]

D(DR(-2))	-0.013525	0.167959	-0.039613
	(0.00630)	(0.21748)	(0.09906)
	[-2.14764]	[ 0.77228]	[-0.39990]
C	-0.001705	0.002663	-0.058132
	(0.00270)	(0.09314)	(0.04242)
	[-0.63202]	[ 0.02859]	[-1.37029]
R-squared	0.208586	0.596649	0.172648
Adj. R-squared	0.150879	0.567238	0.112321
Sum sq. resids	0.068494	81.68692	16.94649
S.E. equation	0.026711	0.922445	0.420150
F-statistic	3.614562	20.28656	2.861843
Log likelihood	233.3515	-135.0118	-53.22444
Akaike AIC	-4.333682	2.750226	1.177393
Schwarz SC	-4.130268	2.953641	1.380808
Mean dependent	-0.000140	-0.002115	-0.083077
S.D. dependent	0.028987	1.402219	0.445940

According to the results given above, the error correction term is significant and negative only in the case the first differences of the inflation rate difference is the dependent variable, implying that the other two variables affect only the inflation rate difference while the opposite is not confirmed. Consequently, the real exchange rate based on the consumer price index of the dairy products is not Granger caused by the other two variables. This result means that the deviation from PPP as expressed by the real exchange rate cannot be attributed to the differences in the macroeconomic variables of the two countries studied.

### 3. Impulse – Response analysis

The next step in our study involves an impulse response analysis for the three endogenous variables used. The time reference used for this analysis is ten periods time (ten months, given that our data are monthly). According to the results presented in figure 1, we can conclude the following;

An innovation in the real exchange rate based on dairy products does not affect the inflation rate differential between the two countries. On the other hand, in the long term such a change does affect significantly after six period's time the interest rates differential. Furthermore, a one s.d. innovation in the inflation rates differential also affects slightly both the other variables. To be more specific, the real exchange rates are increasing within ten periods' time, while the interest rates differentials appear an sharp decrease within a two periods' time and then balancing change are observed. Finally, a change in the interest rate differential implies a similar decreasing trend for both the other variables that is the real exchange rates, and the inflation rates differential.

### 4. Conclusion

The particular study presents an effort to examine the role of macroeconomic variables to the deviation from PPP as expressed by the real exchange rates. The macroeconomic variables are the inflation rates differential, as well as the interest rate differential. We tried by choosing those two variables to embody the uncovered interest parity as well as the quantity theory of money to the deviation from PPP. According to the results of the particular analysis and with the application of the Johansen cointegration technique we confirmed the existence of a sole relationship in the long run between the real exchange rates and the macroeconomic variables employed. Furthermore, according to the estimated VECM, the error correction term is statistically significant and with negative sign in the case where the first difference of the inflation rates differential is the dependent variable implying a one way relationship from the other two variables to the one under preview. Finally, the impulse response analysis has shown that a one standard deviation innovation of DP leads to opposite reactions of the other two variables within a ten periods' time, while a similar response was observed to a one s.d. innovation of DR to the other two variables.

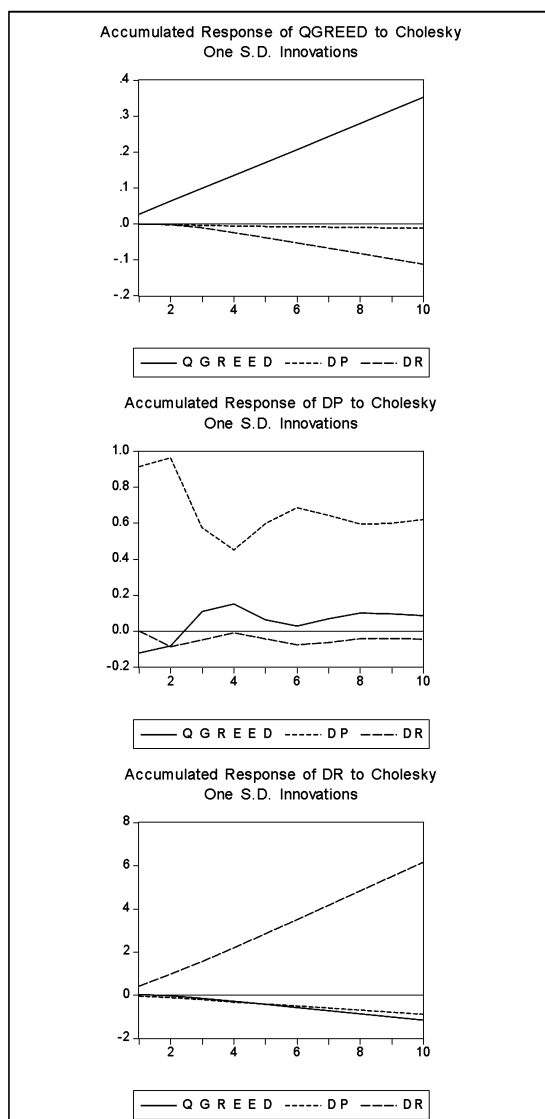


Figure 1: Impulse – Responses for a medium – run period of the three endogenous variables used (q, dp, dr).

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# BRAND EQUITY REVISITED: AN INSTITUTIONAL THEORY APPROACH TO AIRLINE CUSTOMER SUPPORT

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## Abstract

*Following the Yoo et al (2000) conceptualisation of brand equity this paper empirically explores its relationship with practical support for the brand, through the opinions of 244 British and Greek easyJet customers. Despite the very high level of practical support the brand equity reported through the attitude scales was mediocre. The reasons for the high practical support consumers show to easyJet were explored using the constructs of performative and social legitimation (Handelman & Arnold, 1999) and the degree to which brand values have been fully espoused by the customers. The paper argues that existing brand equity measures failed to convey what really matters – practical consumer support for the brand. It also demonstrates that brand equity as well as perceptions of brand performance are positively influenced by social legitimation whilst performative legitimation has a stronger impact on brand awareness but none on brand equity. It concludes that successfully communicating and upholding brand values that reflect societal expectations of firm conduct as well as consistently delivering the promised benefits that reflect what customers really need and are prepared to pay for is a strategy that delivers increasing market share and turnover even in a recession.*

**KEYWORDS:** consumer based brand equity, practical support, legitimation, airline industry.

## Introduction

The airline industry has experienced consistently decreasing profitability despite unbroken traffic growth as a result of intense competition and rising costs (Oum & Yu, 1997). Currently it “is undergoing one of the major transitions in its history” caused, primarily, by a “change in market power constellations in favor of the customers who are now becoming more conscious of their needs” (Teichert, Shehu, & von Wartburg, 2008, p. 227) and are redefining their values in order to control the recession effects on their finances (Baltas, 2008), a situation that makes branding “a question of survival” (David Davis of the FutureBrand agency quoted in Spaeth, 2001). Earlier econometric analyses of airline choice have shown that convenience, service quality and frequent flyer programs are better predictors of behaviour than price (Bailey & Liu, 1995; Gayle, 2004). These findings are consistent with those of studies of branding strategy that have linked consumer based brand equity to perceived quality (Keller, 1993; Yoo, et al., 2000) and have proposed that it is the key to increasing cash flow through non-price based competitive advantage (Yoo, et al., 2000).

Airline industry branding experts are unequivocal and unanimous: survival through branding comes with building strong and long-lasting brands that are characterized by “laser-sharp focus”, simplicity in pricing structures and convincing the customer that the airline is “doing one thing and doing it well” (Laura Ries president of Ries & Ries quoted in Nigam, 2008). The importance of a consistent branding strategy fully aligned with the service offerings is also strongly emphasised (Collins, 2008) and appears to have been fully espoused by the European low cost carriers who use strong and consistent branding to claim some space in the overcrowded air-space (Spaeth, 2001).

This paper focuses on easyJet, the UK based, cheap, no frills and heavily promoted as the underdog champion of the poor airline brand which enjoys increasing cash flow and market share growth despite the economic crisis (easyJet, 2009b).

## Conceptual framework and research hypotheses

### I. Brand equity and practical support

This paper follows a quantitative empirical perspective and seeks to examine the relationship between the value of the brand expressed in monetary terms by customer purchases, here embodied in the proposed construct of practical support for the brand and the widely discussed in academia construct of brand equity (Berry, 2000; Keller, 1993; Lassar, Mittal, & Sharma, 1995; Shocker & Weitz, 1988; Yoo, et al., 2000).

The usual behavioural measurement of consumer based brand equity through attitude scales (Lassar, et al., 1995) focuses on feeling and assumes that action will follow. This study adopts the Yoo et al (2000) approach to brand equity measurement to explore consumers' feelings towards easyJet.

Branding is traditionally seen as a means of achieving non-price based competitive advantage and, indeed, in choosing airlines, quality, convenience and service have been found to be better predictors of consumer choice than price (Bailey & Liu, 1995; Gayle, 2004). When airline service quality is discussed in its traditional sense, however, it does not really lend itself to describing easyJet, which is designed to be kept 'simple' (easyGroup, 2008) to the point of offering nothing but transportation. EasyJet proudly calls itself the first carrier where you have to pay for coffee (Sager, 1998) and print your ticket yourself. Seating is in a high density, narrow aisle single class cabin and allocated on a first-come-first-served basis with reusable boarding passes (Sager, 1998). However, the fleet is new, with an average aircraft age of 2.2 years, and fuel-efficient (Airbus Press Department, 2006), there are two over-wing exits more than the aviation authority requires (Anon, 2008) and the company has taken a heavily publicised firm stance on environmental issues (Dunn, 2007). The brand message is safe and 'green' travel for the masses. These parameters were used instead of the general statements on quality of the Yoo et al.(2000) brand quality scale items to operationalise the service performance of the airline (brand performance variables in Table 2).

However, what really matters for companies is not so much what people feel but what people buy. Brands are valuable assets that need careful management (Simon & Sullivan, 1993) and branding is an expensive exercise aimed not at having books written about the brand or at livening up the skies with brightly painted aircraft but at generating revenue. The "profitable financial equation" that turns "potential" - brand equity - into "reality" -purchase and repurchase (Kapferer, 2004, p. 13) is conceptualised as practical support and measured here as the percentage of easyJet trips over the total number of air trips taken in the past three years.

Thus attempting to link the concepts of brand equity and practical support, the first hypothesis this paper addresses is:

*H<sub>1</sub> : Brand equity is positively related to consumer support for the brand.*

## **II. The institutional theory approach to brand equity and practical support**

It has been strongly argued that consumer support is conditional upon the firm's ability to demonstrate its being aligned with society's behavioural norms, ideology and moral standards (Brown & Dacin, 1997; Carroll, 1999; Maignan & Ferrell, 1999). Institutional theory posits that, within a given socially constructed value and belief system, a firm will seek legitimation through actions that are perceived as proper and desirable (Suchman, 1995). Using its resources and engaging in profit generating activities in compliance with rules and regulations (Friedman, 1970, 1982) the firm achieves pragmatic legitimacy (Handelman & Arnold, 1999; Suchman, 1995). The achievement of social or moral legitimacy (as defined in Handelman & Arnold, 1999; Suchman, 1995) involves compliance with the higher standards of regional or supra national bodies (Wartick & Wood, 1998), adherence to ethical principles and returning something back to the community the firm operates in (Wood, 1991) with the ultimate aim of establishing a level of identification with customers high enough for them to offer their support to the brand (Pullman, Granzinb, & Olsenc, 1997). In the branding literature, the 'ethical' function, defined "as satisfaction linked to the responsible behaviour of the brand in its relationship with society", is described as the one aspect of the brand that needs to be defended at all times (Kapferer, 2004, p. 22).

Indeed, experimental results of stakeholder expectations of firms' institutional performance have demonstrated that there is a certain level below which the effectiveness of the firm's performative actions, is hindered significantly (Handelman & Arnold, 1999). However, the ability of superior institutional performance to enhance the effect of performative actions and generate support for the firm and higher levels of consumer based brand equity, has never been explored before.

Thus, following the principles of institutional theory, and by including performative (giving customers what they expect) and social (giving society what it expects) legitimation as conceptualised and measured in the Handelman and Arnold (1999) study, this paper explores their link with brand equity and practical support through the following research hypothesis:

*H<sub>2</sub> : Practical support for the brand and consumer based brand equity are positively related to performative and social legitimation.*

## **Empirical Research Method and analysis**

The respondents were approached at the easyJet check-in counters at Luton (UK) and El. Venizelos (Greece) airports while waiting to board a plane to Athens and London respectively. Only British and Greek passport holders were asked to complete the bilingual, self-administered questionnaire. No incentives were offered for participation. Further to the brand equity and legitimation scales, a list of brand values was also presented to the respondents to measure the degree to which corporate communications had managed to convey the intended image of the airline to consumers. All variables were measured using 5-point Likert scales defined as 1=strongly disagree to 5=strongly agree. Demographic characteristics (age, gender, education, occupation, country of origin and country of residence) were also collected using multiple choice scale items except for the number of air-trips and number of easyJet trips taken in last three years that were open.

A total of 244 (83 British people in El. Venizelos and 161 Greek people at Luton airport) agreed to participate and returned useable questionnaires with no missing values. Men and women and younger and older looking people were alternatively approached thus resulting in an almost balanced male (53%) to female (47%) and under 30 (42%) to over 30 (58%) sample. All socioeconomic classes were represented in the sample as follows: blue collar workers (12%), white collar workers, business owners and professionals (52%), students (24%) and unemployed (12%). Overall, about 25% of the respondents had a post-secondary qualification and there were no postgraduate degree holders in either the Greek or the British sample. The majority of Greeks had finished high school (65.8%) but most (62.9%) British people hadn't completed secondary education.

### **I. Brand Equity and its relationship to practical support for the brand**

Robust tests for equality of group means (Welch and Brown-Forsythe) with groups defined by country of residence (UK and Greece) to control for the effect of exposure to easyJet messages (intensive advertising and the very popular British television reality show 'Airline' which, for almost a decade, showcased weekly the daily happenings of easyJet passengers and staff in the UK but practically no exposure in Greece) and country of origin (British or Greek passport holders) to control for cultural differences in the scoring of questionnaire items revealed that the means for six and eight respectively of the 16 brand equity variables differed significantly at the 0.05 level but discriminant analysis failed to produce two clearly distinct groups for country of residence (Eigenvalue of 0.162, canonical correlation 0.373) and country of origin (Eigenvalue of 0.181, canonical correlation 0.392). Thus, Factor analysis using Principal Component analysis with Equamax rotation with Kaiser Normalization method was performed on all the responses together after removing the variables that had a Measure of Sampling Adequacy below the recommended 0.5 as well as the 'I am aware of easyJet' variable that had zero variance (all responses were 'strongly agree'). The analysis resulted in three instead of the expected four factors (Yoo, et al., 2000) (Table 2) which were saved as new variables using the Anderson-Rubin method.

On average the respondents had taken 9.98 air trips in the last three years (minimum one and maximum 40) and the mode was eight trips. Approximately 20% of the respondents had taken five trips or less, 60% between six and 14 and another 20% over 15 trips. Half of the respondents had taken 10 trips or less. Eight people had never taken an easyJet trip before and the rest reported a mean of 7.69 easyJet trips (minimum 0, maximum 30) in the last three years with a mode of four. The mean percentage of easyJet trips was 77.25%, with 25% of them having taken over half of their trips and 50% of the respondents having taken all their trips with easyJet thus indicating a very high level of practical support for easyJet.

Partial correlations (controlling for country of origin and country of residence) of practical support with the brand equity dimensions revealed only one weak but highly significant correlation with brand loyalty (correlation coefficient of 0.211 significant at the 0.01 level).

In order to make interpretation of people's opinions easier by referring back to the terms of the original variables, a new surrogate variable was computed as the means of all variables included in the brand equity construct as there were no variables that had a sufficiently higher loading on the factors than the rest so that they could be used as substitutes. The new variable was highly correlated with the sum of the factor scores (correlation coefficient 0.909 significant at the 0.000 level) so it was accepted as a good substitute for brand equity for further analysis.

Brand equity, as reported by the respondents, was mediocre (Mean 3.078, mode 3.08 and a standard deviation of 0.555). When the frequencies were run for the 126 people that had taken all their trips with easyJet the statistics did not really improve (Mean 3.11, mode 3 and a standard deviation of 0.580). The cut-off point for the 25<sup>th</sup> percentile was 2.83 and for the 75<sup>th</sup> 3.21.

The two variables had a weak positive but significant (correlation coefficient of 0.142, sig. 0.026) correlation which improved slightly when controlling for country of origin and country of residence (correlation coefficient of 0.143, sig. 0.026). The data support H<sub>1</sub> but show a weak relationship which is based on the loyalty dimension rather than the overall brand equity (graphically depicted in Figure 3).

## **II. The relationship between consumer based brand equity and practical support with performative and social legitimation**

The reasons why the 126 people in the sample had taken all their trips with easyJet was sought first in the variable by variable examination of the frequencies of the respondent responses. It appears that the reasons these 126 people fly only easyJet lie with their perception of the airline as offering routes and services that satisfy their needs (92% and 87% of them strongly agree and agree with that statement) as well as good value for their money (76%). As for the airlines social role, loyal customers find that it sets an example for other airlines' behaviour (73%) and that it genuinely listens to the demands people put on it (75%).

The airline's social role, described in the easy brand values as the underdog fighting for competition and travel for the masses (easyJet, 2009a), appears to have been appreciated by those that are loyal to it as the people that use it exclusively for their air travel think that because of easyJet other airlines were forced to reduce their prices (80% agree and strongly agree) and were made to listen to what people want (72%). They also believe that the competition easyJet has introduced to the airline industry is good for consumers (83%) and that easyJet has provided people on low incomes with an opportunity to travel (80%). When all the responses were examined together the picture did not change.

Factor analysis was performed on all the legitimation variables (Handelman & Arnold, 1999) after removing the variables that had an MSA lower than 0.5. The procedure was carried out using Principal Component Analysis and Equamax rotation with Kaiser Normalization. It converged in 3 iterations and produced two factors accounting for 81% of the variance in the data. The structure of the two factors is shown in Table 3. The factor scores were saved as new variables using the Anderson-Rubin method and were correlated to the brand equity factor scores and practical support measure (the results of the Spearman's rho test are shown in Table 4).

Practical support was not correlated to any of the legitimation dimensions factor scores but brand quality and brand awareness were found to be influenced by perceptions of both performative and social legitimation. Following the procedures described in the previous section, surrogate performative and social legitimation variable were calculated and crosstabulated to brand equity which was found to be moderately but significantly correlated to both (correlation coefficient 0.256 and 0.357, sig. 0.004 and 0.000 respectively). Thus H<sub>2</sub> is also accepted.

## **Conclusions, Limitations and Implications**

The study presented here empirically explores the link between consumer based brand equity, practical support for the brand and institutional performance of the firm. As the analysis failed to differentiate between overall brand equity and brand loyalty as conceptualised in the Yoo (2000) study, the idea that the dimensions of brand loyalty, brand quality and brand awareness and associations contribute to a unique construct of overall brand equity is not supported by the data in the present study. Instead, three independent factors were identified - brand loyalty, brand performance (in this case being safe and significantly cheaper than other airlines but also uncomfortable and offering poor service) and brand awareness. Easy Jet was found to enjoy a middling level of brand equity.

The paper proposed a new construct, practical support for the brand, measured as the percentage of trips taken on the airline in question in relation to all air trips taken over a given period of time (in this study three years). The link between brand equity and practical support for the brand was sought through self-reports of 244 easyJet customers who responded to a questionnaire survey at the airport check-in counters. Easy Jet was found to enjoy a very high level of practical support from the majority of the respondents.

Although the data support H<sub>1</sub>, the relationship between consumer based brand equity and practical support is weak and it appears that feelings towards the airline are spread even for the 126 people that use easyJet services exclusively. These observations reinforce the impression that there is indeed a clear-cut divide between reported attitudes and actual behaviour and cast a serious doubt on the practicality of using attitude-based brand equity measurements.

The reasons why people support a brand that they do not have a very high attachment to were sought through the constructs of performative and social legitimation proposed by institutional theory. It was demonstrated by the data analysis that social legitimation had a stronger impact on brand equity than performative

legitimation but its influence on the dimensions of performance and awareness was weaker. Neither measure had an effect on the brand loyalty dimension so H<sub>2</sub> is only partially supported as there was no correlation between legitimation and practical support for the brand.

As the study was based on self-reports of behaviour and reactions to set attitude scales and only basic demographic data was collected there is no way to assess impact of other possible motives behind the reported behaviour. There is limited information on the demographic characteristics of the respondents from which it is impossible to infer price sensitivity or the specific needs that easyJet fulfils other than the strong agreement of the vast majority with broad statements such as that the airline offers services and routes that satisfy their needs and good value for money.

In summarising the responses it can be proposed that easyJet brand seems to perform functions of the brand for the consumer (Kapferer, 2004) such as 'identification', 'practicality', and 'ethical'. We can also infer from the high levels of practical support for the brand observed in the sample that the 'optimisation' function is fulfilled, at least for the majority, together with the 'guarantee' and the 'continuity' function. However, as the study has demonstrated, opinions and feelings are not necessarily strongly linked with behaviour so, functions that are purely feelings, such as 'badge' and 'hedonistic' should be studied as such and cannot be inferred from actions or attitudes.

Interestingly, when all the responses are examined together the picture does not change from the one given by loyal customers so it can be clearly seen that the messages easyJet sends have been received and believed as intended by the general travelling public. Branding has been described as the process of understanding consumers' current needs (Quelch, 2008) and communicating the brand's ability to fulfil these needs through icons, plots and characters that customers can identify with (Holt, 2004). EasyJet has been doing this consistently for over a decade now, so, it appears that successfully communicating and upholding brand values that reflect societal expectations of firm conduct as well as consistently delivering the promised benefits that reflect what customers really need and are prepared to pay for is a strategy that delivers increasing market share and turnover even in a recession.

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## Tables and Figures

## A. Tables

Table 2: Rotated Component Matrix for Brand Equity variables

Variables	Component		
	Brand Loyalty	Brand Performance	Brand Awareness
It makes sense to fly easyJet instead of any other airline, even if they are the same	<b>0.931</b>		
Even if there is another airline as good as easyJet, I prefer to fly easyJet	<b>0.887</b>	-0.130	0.146
If another airline is not different from easyJet in any way it seems smarter to fly easyJet	<b>0.882</b>	-0.157	0.141
I will not fly other airlines on a route that easyJet flies	<b>0.876</b>		
Even if another airline is the same as easyJet, I would prefer to fly easyJet	<b>0.873</b>	-0.157	0.107
I consider myself to be loyal to easyJet	<b>0.868</b>		
easyJet would be my first choice	<b>0.860</b>	-0.122	0.109
easyJet prices are significantly lower than those of other airlines	0.113	<b>0.867</b>	0.275
easyJet is a safe airline	0.123	<b>0.783</b>	0.483
Flying with easyJet is uncomfortable	-0.313	<b>0.771</b>	-0.374
The service that easyJet offers is poor	-0.330	<b>0.753</b>	-0.348
I can recognise easyJet among other airlines			<b>0.868</b>
I can quickly recall the easyJet Logo			<b>0.826</b>
<b>Variance in the data explained by the factor</b> (total variance explained = 80%)	44%	20%	16%
<b>Scale reliabilities</b> Cronbach's Alpha Based on Standardized Items	0.950	0.813	0.756

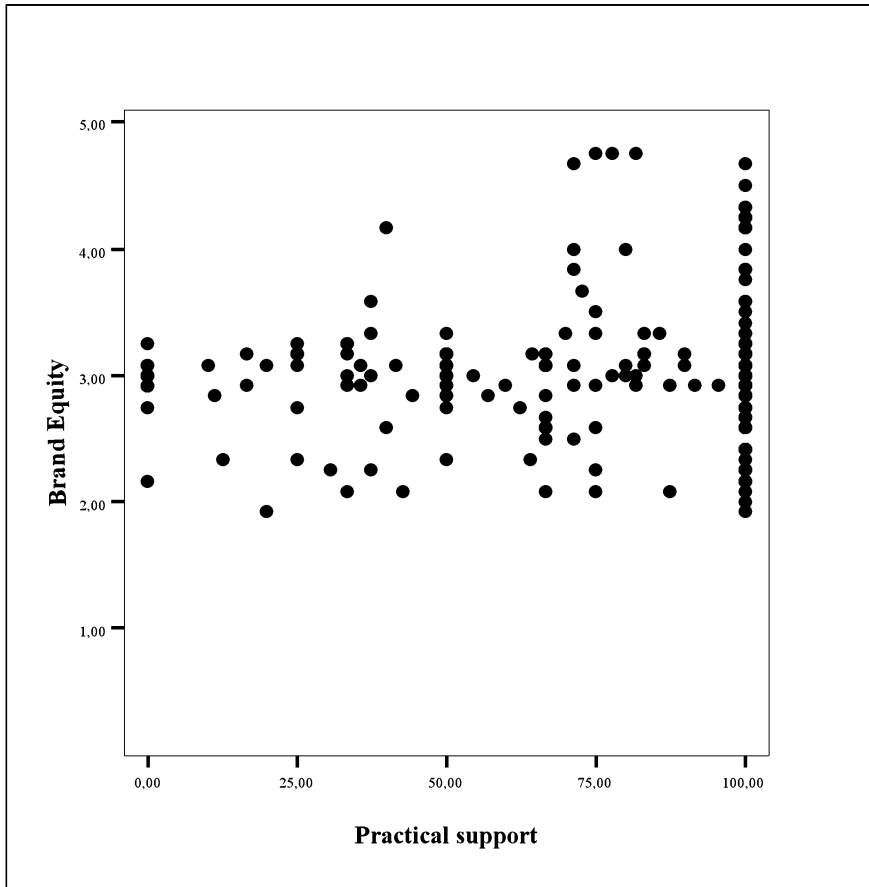
Table 3: Rotated Component Matrix of Legitimation variables

Variables	Component	
	Social Legitimation	Performative Legitimation
EasyJet genuinely listens to the demands that people put on it	<b>0.937</b>	
EasyJet sets an example for how airlines should behave	<b>0.936</b>	
EasyJet sets an example for how other airlines should conduct their activities	<b>0.700</b>	0.541
EasyJet routes satisfy my needs	-0.227	<b>0.866</b>
EasyJet offers good value for money	0.395	<b>0.786</b>
EasyJet offers services that meet my needs	0.584	<b>0.609</b>
<b>Variance in the data explained by the factor</b> (total variance explained = 81%)	47%	34 %
<b>Scale reliabilities</b> Cronbach's Alpha Based on Standardized Items	0.869	0.723

Table 4: Correlations of brand equity and legitimation

LEGITIMATION A-R factor scores	BRAND EQUITY A-R factor scores			Brand Equity	
		loyalty	performance	awareness	means
performative	Cor	-0.119	-0.276 (**)	0.429 (**)	0.026
	Sig	0.063	0.000	0.000	0.688
social	Cor	0.048	0.381 (**)	0.241 (**)	0.339 (***)
	Sig	0.458	0.000	0.000	0.000

**B. Figures**



**Figure 3: Relationship between Brand equity and practical support for easyJet**



# THE EFFICIENCY OF THE HEALTH SYSTEM IN GREECE COMPARED TO RELEVANT E.U.'s STANDARDS

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## Abstract

*The purpose of the present paper is to investigate the efficiency of the health system in Greece after the end of the World War II and the analysis of the results that may occur and their possible reconsideration.*

*We are going to compare both weaknesses and achievements to relevant E.U. standards before and after the enlargement of the 25.*

*The fore coming results are expected to be the investigation of the determinants of the health system evolution in Greece.*

*The approach of the subject is going to be held through the review of relevant literature and moreover through the analysis of raw material, as they conclude from WHO, OECD and member-states data.*

*Keywords: Health system, efficiency, satisfaction, public expenditure,*

## 1. Introduction

The objective of this report is to present the efficiency of the Greek health system compared to relevant E.U.'s standards. These conclusions emerge from comparison and analysis of the basic efficiency indicators of the systems, qualitative as much as quantitative. The main target is to compare the efficiency of these systems through the satisfaction indicators of the people. A very important role is the one of health expenditures. Regarding those people can answer a few simple questions such as:

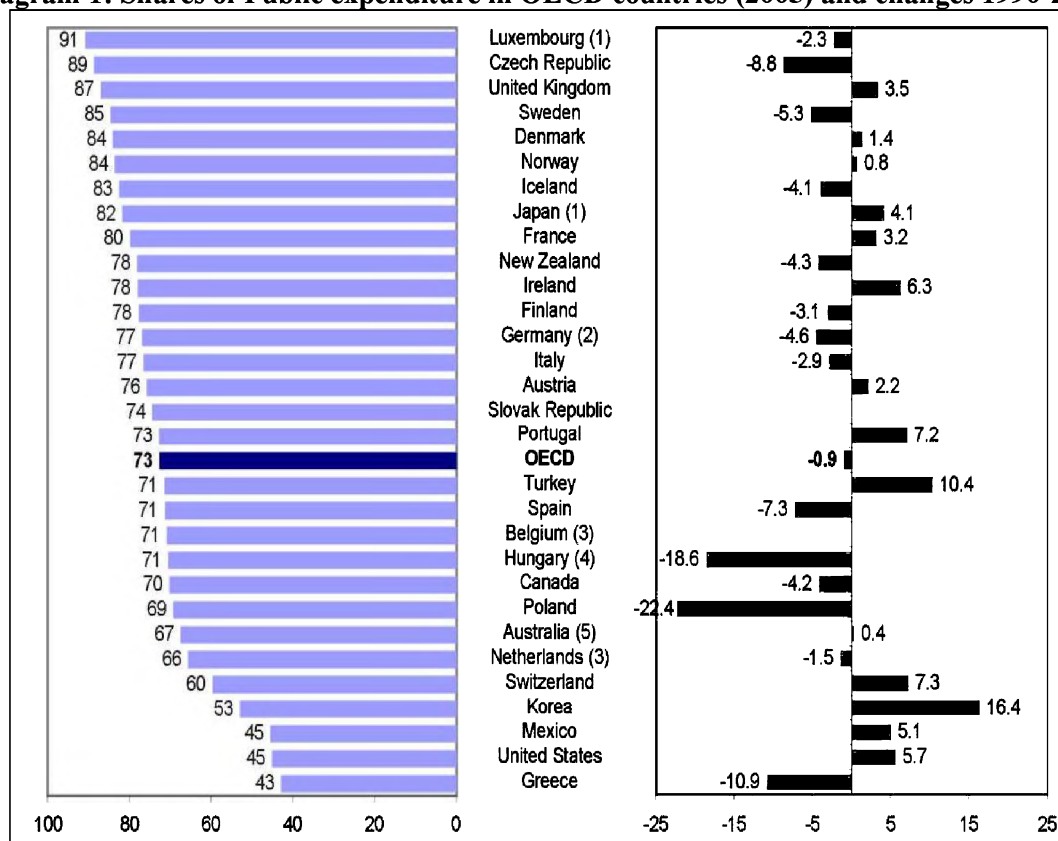
- Is a health system necessarily efficient if the health expenditures are high?
- Are health expenditures related to citizens satisfaction and
- To which degree do all these indicators affect a country's health system and furthermore the satisfaction indicators?

Simultaneously, an attempt to explain the reasons of the low percentage of satisfaction in the Greek health system will be made.

## 2. Health Expenditures

Health expenditures determine the efficiency of health systems. Especially through the two general categories of them, which are the public and the private health expenditures conclusions relevant to health systems can be made. On one hand, high health expenditures usually mean that health is considered to be a public good and on the other hand, low mean that it is considered as a private good.

**Diagram 1: Shares of Public expenditure in OECD countries (2005) and changes 1990-2005**



Source: OECD Health Data 2007

During the period of 1950-1970 there was a steady rise of the public expenditures in general apart from two countries, U.S.A and Japan. After the 1980's and 1990's and the crisis of the social state the percentage of private expenditures increased slowly as the diagram I shows.

In Greece, a fall of 0,9% was marked in 2006 at the percentage that the country disposed to health compared to 2004. Therefore it reached 9,1% of G.D.P. Moreover in Greece a National Health System has been legislated in order to serve all citizens as in the Beveridge system but as it seems this was not enough for the private expenditures to stay at the same level and they kept rising. As a result, private health expenditures in Greece are higher than those in U.S.A.

The privatization of the health system is a fact. In 2005 public expenditures in health were only 43% of total expenditures when at the same time U.S.A. had 45%. The fall of 11% among 1990-2005 of expenditures is explained by the fall of the social state and the unimportant role of the National Health System. In relation with those mentioned above it can be said that only some of the countries of the ex socialism have the same tendency and therefore high private expenditures as Greece has. Private expenditures replaced public expenditures. In Poland and Hungary the reduction was 22,4 and 18,6 correspondingly in fifteen years and in Czech Republic 8,8. On the contrary there are countries such as Korea and Turkey that had a really small percentage of public expenditures compared to total and this rose steadily. (Korea 16,4%, turkey 16,4%, e.t.c.).

It is of high importance to understand the reasons responsible for the increase in private expenditures in the country, compared to most of the other E.U. countries. The fact that public expenditures decreased had as a result the decrease in financing hospitals. This naturally led to the creation of large waiting lists and low quality services. All citizens that belong to middle society classes had no choice but to turn either to private hospitals, so they enforced the private sector or to stay at the public sector but use out of the pocket payments so that they can have a chance to better care. That is also responsible for the enlistment of Greece among the biggest paraeconomies of the West. In addition, the decrease in financing hospitals caused low quality of hostelry services which made a large number of people not to prefer them any more. Clear examples for this are the pediatric hospitals that are now the choice of the low income families and the foreigners that cannot afford a "real" hospital.

The private sector, taking under consideration all these needs that are both aesthetical and psychological provide sufficient hostelry, support to patients but at the same time expensive.

In conclusion, despite the fact that in most E.U. countries the public sector in health seems to grow, in Greece the opposite phenomenon occurs. Thus, the National Health System does not fulfill its potentials and after 1990 it started collapsing.

### **3. Human and material resources**

The efficiency of health systems as much as in Greece as in the rest of the E.U.'s countries depends on human and material resources.

Furthermore, a health system in which, the proportion of the nurses, pharmacists even beds per 100,000 habitants is high, it's expected that it will be more efficient than another that lacks human dynamic or materialistic.

As far as the nurses are concerned, according to EUROSTAT and OECD data, Ireland from 1997 to 2006 occupied 1291 and 1488 people per 100,000 habitants. This enlists Ireland at the top of this category and Sweden goes next. The latter from 1007 practicing nurses per 100,000 habitants in 1997 with small but steadily increasing rates reached the proportion of 1138/100,000 habitants in 2006. It does not come as a surprise that those countries have two of the best health systems and data justifies their efforts.

In 2006 the average for the Europe of 27 was 504 nurses per 100,000 habitants; a fairly small analogy compared to previous data. This average is also exceeded by other big countries with considerable health systems such as Germany and United Kingdom. In 1997, Germany occupied 905 people per 100,000 habitants and with a clear fall reached 782 people per 100,000 habitants in 2006 whereas United Kingdom raised this proportion from 674 to 783 per 100,000 habitants at the same period.

In this table no information is found concerning Greece but due to the fact that this health system is similar to that of Spain and Portugal an overall can be made. The proportions are under E.U.'s 27 average. Specifically, in 1997 Spain occupied 343 nurses per 100,000 habitants and in 2006 412. The relevant data for Portugal reflects the low level of its health system where nurses do not exceed 46/100,000 habitants in 2006. This analogy can only be compared with Turkey (69 nurses/100,000 habitants in 2003).

Pharmacists also play a very important role in every health system. They are the main medicine suppliers and in some cases they act as doctors.

According to OECD's table in which someone can see the number of pharmacists per 1,000 habitants from 1970 to 2010, Finland is at the top with 1,5 pharmacists, way beyond E.U.'s standards (0,7 pharmacists/1,000 habitants). At the top of this survey lies Italy with 1,1 pharmacists per 1,000 habitants.

Worth noticing is the fact that in this section Greece's density is not only higher than OECD's standard but it's higher than the one of Germany; Ireland; Sweden and Spain with 0,9 pharmacists per 1,000 habitants in 2000. The countries mentioned above occupy 0,6 pharmacists/1,000 habitants. As a result they are in the same level with Czech Republic; Hungary and Denmark with 0,5 pharmacists per 1,000 habitants in 2000.

Another indicator that contributes to the efficiency of health systems is the availability of hospital beds. The table represents the number of available hospital beds per 100,000 habitants that every country disposes between 1996 and 2007 according to EUROSTAT.

E.U.'s standard is 590 hospital beds in 2005, a really small number if someone considers that in 1997 hospital bed's availability was 695/100,000 habitants. On one hand, Greece disposed 517 and 474 beds/100,000 habitants in 1996 and 2005 correspondingly. On the other hand Germany managed to stay above E.U.'s average all this period despite the fact that she shows a fall in the proportion (958 and 809 beds/ 100,000 habitants in 1996 and 2006 correspondingly).

Moreover, France disposes a respectable number of hospital beds per 100,000 habitants (708 in 2007) whereas United Kingdom and Sweden come behind (389 and 293 beds/100,000 habitants correspondingly).

Last but not least, it is obvious that Greece holds a better position than Spain or Portugal or even Cyprus. However, this cannot change the fact that smaller countries such as Lithuania have hospital bed disposal similar to the one that Germany has. Finally, what really matters is how a health system uses its resources and what priorities it has so it can find the balance between all sectors and therefore be more efficient.

### **4. The outflows of the educational system to health related occupations.**

According to diagram I of the index, the students of Technological Educational Institutes and school of health and care occupations reached 20,000 in 2006 and are expected to exceed 25,000 in 2010. The rise is

impressive if one considers that in 1974 this number was more or less 500. The number of graduates of the same school in 1996 was 1500 and it is expected to stay at the same levels the fore coming years.

From the diagram II it is easily concluded that the number of students in the school of health science of universities remained almost the same over 1974-2006 (almost 12,000). In 2010 its size is not estimated to change.

The student outflows in 1974 were 2.300 people, a number that will be slightly reduced in 2010 and reach 1950 people.

Young people turn to health related occupations due to the demand that they have in the market. The huge number of people occupied in them is justified in a big part from the people that studied abroad and came back to work in Greece. Facing the demands of the market and the deficiencies of the health system Universities have created similar departments to those of the technological educational institutes. According to a recent survey for the period from 1992 to 2010 it is extracted that there are changes in occupation in the category of profession. In 2004 doctors in Greece were 56,000 and dentists two years later were 13,000. The predictions for the next years show increasing grammic tendency. Nurses and midwives that emerge from universities are not few. Characteristic prices are those of >100 in 1997 and 1300 in 2004. Midwives graduates from technological educational institutions are approximately 3500 and nurses from the same derivation from 18000 in 1992 are expected to reach 52000 in 2010.

## **5.Satisfaction**

As we have already mention above, purpose of the work is to scrutinize the efficiency of the Health System in Greece comparing with the international standards and especially the grade of contentment that the H.S offers in relation with its granting services.

According to recent elements from 1999's Euro barometer, only the 18.6% of the Greeks state to be almost or very satisfied from the granting services that the existing H.S offers them as opposed to the 79.8% of the population of the country that state to be almost till very disappointed .

In a more recent research of Euro barometer, that took place in 2002 the 50.5% of the population of the country believes that the Health System must be changed and reformed fundamentally and on the other 27.6% believes that the only solution is the rebuilding of the Health System.

All the above elements bring Greece in the first place of the EU's countries that the citizens are disappointed from theirs' countries' health system.

And to be more specific Greece takes first place in the research that concerns the disappointment of the population from the H.S. and the second place after Polonius with total 80.4% in the research which subject was the essential changes on the H.S. It is quite clear that the initial expectations of the National Health System of Greece are really far from reality that Greek people feel.

Mostly Greek patients , as far as others , not only they have to face their health problem but also the health systems' problems too which was made in order to support them in those difficult situations.

As a result from the above, the health systems' problems affect not only the health problem that they already have, but also their psychology. Consequently, the situation of their health is getting worse.

The results from the above mentioned researches show the insufficient function of the hospitals, of the insurance companies clinics and also all the supporting system around them.

The lack of computerization and the ghostly presence of bureaucracy make services to the people a real Calvary.

The huge waiting lists to the outpatients departments, the "panic" during the emergency hospitals, the limited potentials of real support in case of emergency incidents (e.g. accidents) for patients that live away from urban areas, are only some of the cases that verify the fact that there is space for remarkable improvement in nowadays reality. It is also worthy of mention that it is common for patients trying to fix an appointment with the doctor, the first available to be after weeks or months, fact that can make their situation to become worse or at the worst the patient to end up.

Another problem that Greek patients have to face frequently is the bad behavior of the employees in the field of Public Health. That happens basically because public employees are relied on what they have to do and they no sentiment of doing a little more in order to make the patient feel a little better.

In this particular problem Greek government has great responsibility due to not giving the necessary motivations to the healthy employees.

As a result of the lack of motivations the employees do not give 100% of their capabilities knowing also that they are protected from the Greek law of permanency.

It is also very important concerning the negative aspect that Greek patients have when they visit a public hospital, the fact that these buildings look neglected. Mentioning that most of the countries of the EU they have give great importance in that specific field of health system as far as the private field of the health system in our country.

These are some of the reasons that people of this county have such a bad opinion and asking for direct changes. So, it is easily understood that in Greece there is plenty space for radical changes and improvements of the health system not only for its image towards people but also substantially. Of course , problems like or similar to these we have already mentioned we meet also to other European countries .But there are countries like Scandinavians that their health system consists to be a model.

In Germany, Ireland and Spain the percentage of the contentment people from their health system is the same with those who are disappointed in accordance with the elements of 1999's Eurobarometer. Sweden and England have more of the 50%of their population satisfied while from the most contentment is France, Finland, Austria and Denmark with 74-84% for the same year.

## 6. Conclusions

Considering all the above it is more than certain that the health system in Greece has to overcome some serious issues. Part of these problems is similar to those that other EU countries are also dealing with on an every day basis. The difference is on the degree that each one of these issues affects the health system in each country. It is most certain that crucial changes must take place in order to create a better, more functional and more effective health system. In order for these changes to be more efficient and successful, all parties involved should participate on a serious, decisive and dynamic way in the reorganization of the system's itself. Of course it is also very important for the government to redefine its objectives on its own Health System. The government ought to support the Health System essentially and stop acting with the same philosophy of all those years which is not giving real solution to the problems that appear but instead the state gives off-hand solutions. Instead the government has to make radical changes in order to improve the quality and responsiveness of the health system services, and moreover advance not just its overall image but the State's also.

The situation becomes more and more complicated bearing in mind the lack of funds that the system is facing year after year. As a result, this is the most important problem that the health care's services suffer from. The government must follow the example of the way other EU countries overcome the specific situation, which is no other than the direct increase of the funds disbursed for the health sector. Also it is of absolute need to maximize resources invested on the domain of health as well as the benefit of from their usage. Furthermore, cases of wasting public funds must be avoided if not eliminated.

The state must ensure that the necessary medical staff will be available at all hospitals in order to ensure appropriate effectiveness and eliminate phenomena of under-usage. There are many cases where in several hospitals you can see sectors operating normally and some others not, due to lack of personnel even if they are equipped in the best possible way.

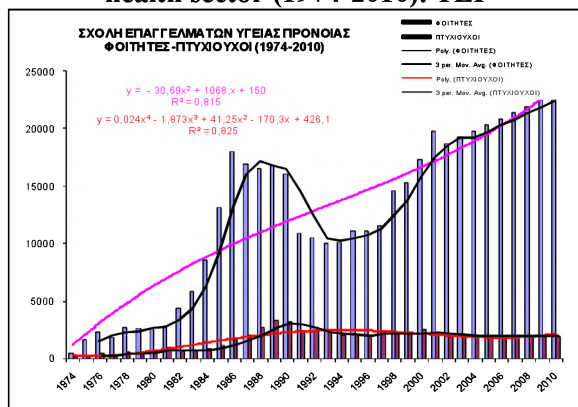
Taking into consideration the above, it's beyond any doubt that the reconsideration of the health system must be basically focused on a significant increase of financial support, elimination of public resources' waste, the development of the first grade of the health care, the substantial capitalization of the human resources and technology and finally the modernization of the system on its entire whole, so that to be able to respond to the nowadays needs of the Greek citizens.

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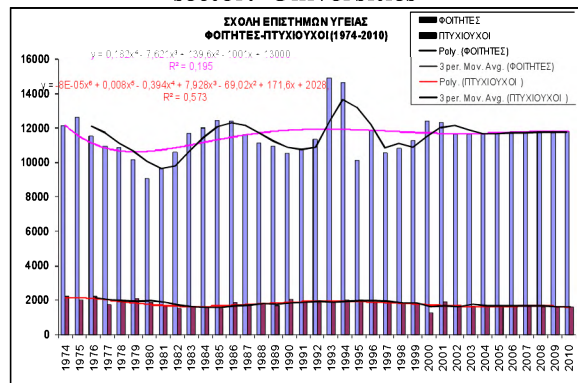
Appendix

Diagram 2: Graduate Students and Graduates in health sector (1974-2010). TEI



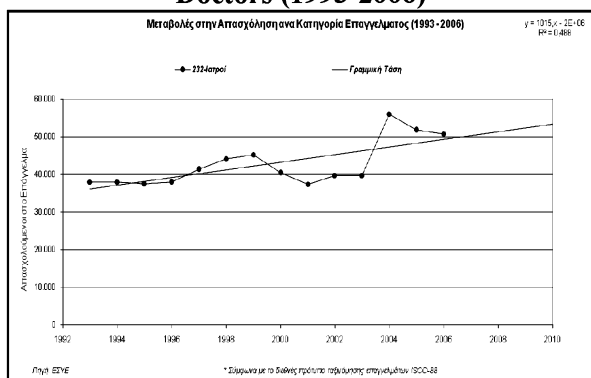
Source: Papailias T. (2006) Supply and Demand Skills in the greek educational system, Athens, Dionicos

Diagram 3 : Studens and Graduate in health sector. Universities



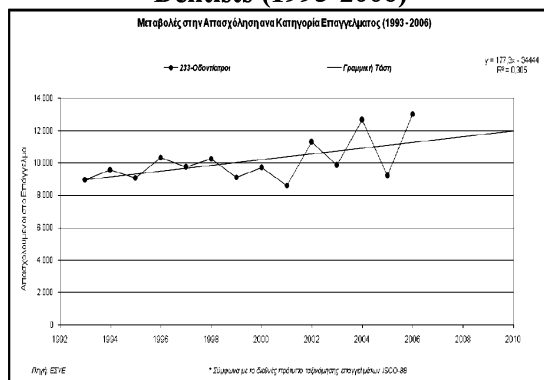
Source: Papailias T. (2006) Supply and Demand Skills in the greek educational system, Athens, Dionicos

Diagram 4: Changes in the Employment of Doctors (1993-2006)



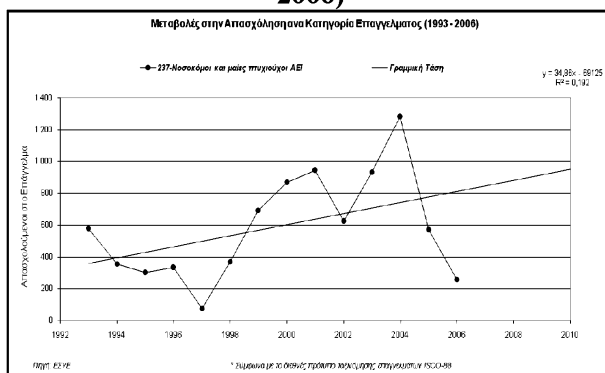
Source: Papailias T. (2006) Supply and Demand Skills in the greek educational system, Athens, Dionicos

Diagram 5 : Changes in the Employment of Dentists (1993-2006)



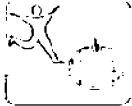
Source: Papailias T. (2006) Supply and Demand Skills in the greek educational system, Athens, Dionicos

Diagram 6 : Changes in the Employment of Nurses who graduated from University (1993-2006)



Source: Papailias T. (2006) Supply and Demand Skills in the greek educational system, Athens, Dionicos

**Table 5 : Total number of practising nursing and midwives staff per 100.000 inhabitants**

 EUROPEAN COMMISSION HEALTH & CONSUMER PROTECTION DIRECTORATE-GENERAL Directorate C - Public Health and Risk Assessment C2 - Health information										
Total number of practising nursing and midwives staff per 100,000 inhabitants										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
<b>EUR27*</b>	<b>667.9</b>	<b>631.1</b>	<b>633.2</b>	<b>594.3</b>	<b>602.1</b>	<b>589.0</b>	<b>619.5</b>	<b>619.5</b>	<b>699.9</b>	<b>504.3</b>
Belgium	:	:	:	:	:	:	:	:	:	:
Bulgaria	639.7	641.9	616.6	449.1 b	421.8	407.1	424.4	427.6	449.4	:
Czech Republic	:	:	:	:	:	:	:	:	:	:
Denmark	:	:	:	954.7	961.3	968.9	955.4	975.6	988.2	:
Germany	905.4	918.9	928.5	747.6	756.9	763.3	769.4	774.5	782.4	:
Estonia	654.6	650.0	644.3	623.1	617.4	642.8	652.4	643.9	657.8	:
Ireland	1291.2	1315.1	1363.9	1384.6	1463.1	1515.9	1464.4	1479.0	1488.2	:
Spain	343.6	324.7	344.4	354.8	366.9	406.1	397.4	411.7	415.0 b	412.3
France	:	:	:	:	:	:	:	:	:	:
Italy	444.3	455.2	445.8	467.1	483.8	495.9	:	:	:	:
Cyprus	:	:	:	:	:	:	:	:	:	:
Latvia	489.2	468.7	442.7	438.3	426.9	425.1	435.9	:	:	:
Lithuania	:	:	:	:	:	:	:	:	:	:
Luxembourg	:	:	:	:	:	:	:	:	:	:
Hungary	386.1	402.0	420.4	414.6	417.2	437.8	436.3	444.5	459.6	:
Malta	:	:	:	:	:	549.2	550.2	561.3	579.9	596.3
Netherlands	:	:	:	:	:	235.5	:	299.6	:	:
Austria	552.4	561.8	576.9	589.6	592.3	591.5	599.8	604.1	610.8	:
Poland	626.4	603.9	563.2	553.2	544.8	543.3	530.0	550.8	564.3	:
Portugal	:	:	:	52.0	50.0	45.7	44.1	45.8	:	:
Romania	:	:	:	:	:	:	:	:	:	:
Slovenia	:	153.7	154.7	155.2	161.4	165.7	170.0 b	174.1	180.5	:
Slovakia	:	:	:	:	:	:	:	:	:	:
Finland	:	:	:	:	:	:	:	:	:	:
Sweden	1007.5	1027.8	1040.2	1059.2	1073.3	1096.0	1106.2	1126.1	1138.8	:
United Kingdom	674.4	680.7	689.8	671.6 b	694.1	723.5	755.9	773.9	783.2	:
Croatia	454.6	465.8	475.3	485.1	499.9	502.2	:	:	:	:
former Yugoslav Republic of Macedonia, the	:	:	:	:	:	:	:	:	:	:
Turkey	125.7	114.6	106.4	95.1	82.6	73.8	69.1	:	:	:
Iceland	843.7	885.5	879.5	862.2	887.7	881.2	920.3	928.2	:	:
Norway	:	:	:	:	:	1257.8	1320.9	1368.3	1418.2	:
Switzerland	:	:	:	1290.0	1320.0	1370.0	1430.0	1410.0	:	:
Canada	1040.0	1020.0	1010.0	1010.0	1000.0	940.0 b	980.0	990.0	1000.0	:
United States	790.0	790.0	790.0	800.0	790.0	790.0	:	:	:	:
Japan	:	730.0	:	760.0	:	780.0	:	900.0 b	:	:

Source: Eurostat (Online Database) and OECD Health Data 2007 (Switzerland, Canada, United States and Japan)

Indicator No. 33 (SL40) last updated by SANCO.C.2 in March 2008

b Break in series  
: Not applicable

\* The average is calculated by SANCO from available data within the EU.

Source : Eurostat (Online Database) and OECD Health Data 2007

Table 6 : Practicing Pharmacists in OECD Countries (1970-2000)

	Practising pharmacists:						
	Per 1 000 population				Annual per cent growth		
	1970 <sup>a)</sup>	1980 <sup>b)</sup>	1990 <sup>c)</sup>	2000 <sup>d)</sup>	1970 <sup>e)</sup> -1980 <sup>e)</sup>	1980 <sup>e)</sup> -1990 <sup>e)</sup>	1990 <sup>e)</sup> -2000 <sup>e)</sup>
Australia	0.7	0.7	0.5	0.8	0.0	-3.3	4.8
Austria	0.3	0.4	0.5	0.6	2.9	2.3	1.8
Belgium	0.7	1	1.2		3.6	1.8	
Canada		0.5	0.6	0.6		1.8	0.0
Czech Republic	0.4	0.4	0.4	0.5	0.0	0.0	2.3
Denmark			0.5	0.5			0.0
Finland		1.4	1.4	1.5		0.0	0.7
France	0.5	0.7	0.9	1	3.4	2.5	1.1
Germany		0.4	0.6	0.6		4.1	0.0
Greece	0.2	0.5	0.7	0.9	9.6	3.4	2.5
Hungary	0.3	0.3	0.3	0.5	0.0	0.0	5.2
Iceland	0.5	0.7	0.9	1.2	3.4	2.5	2.9
Ireland		0.6	0.6	0.8		0.0	2.9
Italy		0.8	1	1.1		2.3	1.0
Japan	0.4	0.5	0.7	1.1	2.3	3.4	4.6
Korea							
Luxembourg	0.5	0.6	0.8	0.7	1.8	2.9	-1.3
Mexico							
Netherlands	0.1	0.1	0.2	0.2	0.0	7.2	0.0
New Zealand		0.7	0.7			0.0	
Norway			0.5				
Poland	0.4	0.4	0.4	0.6	0.0	0.0	4.1
Portugal	0.3	0.5	0.5	0.8	5.2	0.0	4.8
Slovak Republic				0.4			
Spain				0.8			
Sweden	0.4	0.5	0.6	0.6	2.3	1.8	0.0
Switzerland	0.3	0.4	0.5		2.9	2.3	
Turkey	0.1	0.3	0.3	0.3	11.6	0.0	0.0
United Kingdom			0.6				
United States	0.5	0.6	0.7		1.8	1.6	
OECD point average <sup>f)</sup>	0.4	0.6	0.6	0.7	3.0	1.6	1.9
14 comparable countries <sup>g)</sup>							
Average	0.4	0.5	0.6	0.7	3.0	1.6	2.4
Standard deviation	0.2	0.2	0.2	0.3	3.6	2.5	2.2

a) Data refer to 1971 for Australia.  
b) Data refer to 1981 for Australia; 1982 for Canada.  
c) Data refer to 1989 for Norway; 1992 for Denmark.  
d) Data refer to 1999 for Iceland and Sweden.  
e) Unweighted average. Includes all available countries at the relevant point in time.  
f) Unweighted average. Includes only Australia, Austria, Czech Republic, France, Greece, Hungary, Iceland, Japan, Luxembourg, Netherlands, Poland, Portugal, Sweden and Turkey.  
g) Unweighted average. Includes only Australia, Austria, Czech Republic, France, Greece, Hungary, Iceland, Japan, Luxembourg, Netherlands, Poland, Portugal, Sweden and Turkey.

Source: OECD HEALTH DATA 2003 3rd ed.

Source: OECD Health Data 2003

Table 7 : Public's satisfaction with health care system, EU countries, 2002

	B	DK	D	TOTAL	GR	E	F	IRL	I	L	NL	A	P	FIN	S	UK (Tot.)	EU 15
TOTAL weight:	1049	1001		2043	1002	1000	1007	991	1002	600	1014	1018	1000	1005	1000	1350	16129
1. Runs well	23.8	16.5	15.6	2.9	13.2	22.0	3.7	6.5	21.7	6.5	31.8	1.8	24.0	11.4	8.3	13.2	
2. Minor changes needed	41.3	35.1	31.5	15.9	32.4	41.9	16.7	24.4	46.0	39.1	35.4	12.5	48.6	36.3	22.9	30.7	
3. Fundamental changes needed	22.7	39.4	34.8	50.5	38.6	25.5	39.3	45.6	20.4	46.8	23.0	39.0	21.0	37.8	49.7	38.2	
4. Completely rebuild system	5.2	6.1	11.1	27.6	12.1	7.0	32.9	19.9	8.2	6.8	4.3	41.4	3.2	10.6	15.8	13.5	
5. Uncertain/Do not know	7	2.8	6.9	3.1	3.7	3.6	7.5	3.5	3.8	0.8	5.5	5.4	3.1	3.8	3.3	4.4	

Source : Eurobarometer, 2003



**Table 8 : Hospital Beds (per 100.000 inhabitants)**

geo\time	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<b>EU (27 countries)</b>	:	694.8	679.8	661.9	652.6	640.9	628.6	607.5	595.9	590.4	:	:
<b>EU (25 countries)</b>	:	685.6	673.4	656.1	645.4	633.3	622.6	604.7	592.7	586.6	:	:
<b>EU (15 countries)</b>	:	669.4	657.0	638.0	626.6	614.6	603.5	590.5	577.2	570.7	:	:
<b>Belgium</b>	798.3	794.8	787.5	782.3	777.8	767.4	759.2	752.3	749.1	744.8	672.3	:
<b>Bulgaria</b>	1049.6	1031.1	843.5	751.3	743.0	722.1	650.4	630.3	614.7	642.9	621.4	:
<b>Czech Republic</b>	886.9	866.9	852.6	837.8	846.0	849.6	850.6	845.3	837.2	829.1	817.0	:
<b>Denmark</b>	470.1	461.5	451.1	435.7	426.7	419.1	414.0	399.0	382.5	370.7	361.8	:
<b>Germany</b>	957.8	938.0	929.3	920.2	912.2	901.9	887.8	874.4	857.6	846.4	829.1	:
<b>Estonia</b>	795.5	774.8	761.9	754.9	719.0	684.7	608.2	593.4	582.6	548.4	565.3	:
<b>Ireland</b>	673.7	663.8	647.4	632.0	619.9	595.6	583.4	572.4	563.0	546.3	524.7	:
<b>Greece</b>	517.3	512.4	508.0	496.6	495.2	478.2	472.1	470.3	469.8	473.8	:	:
<b>Spain</b>	389.1	382.9	378.4	376.0	369.7	361.6	356.7	347.8	344.5	338.9	334.1	:
<b>France</b>	853.8	:	847.7	832.6	816.8	793.6	782.5	767.2	748.2	733.4	718.3	707.5
<b>Italy</b>	655.0	588.3	555.1	492.8	470.9	461.5	444.6	417.9	400.6	400.9	395.2	:
<b>Cyprus</b>	498.7	467.3	455.9	449.9	455.8	439.8	438.2	431.1	421.0	380.0	373.7	:
<b>Latvia</b>	1038.3	975.1	936.6	900.0	870.3	809.5	773.4	779.3	771.4	766.4	758.6	755.4
<b>Lithuania</b>	1092.0	1023.0	1007.1	988.4	979.2	923.7	896.2	870.3	845.8	814.7	801.0	:
<b>Luxembourg</b>	1079.9	1066.8	1055.1	712.5	657.1	651.7	644.3	:	643.8	583.4	569.4	:
<b>Hungary</b>	903.0	817.9	821.5	826.1	826.2	786.8	786.3	784.5	783.5	786.2	792.1	:
<b>Malta</b>	576.8	562.0	559.8	556.0	539.8	753.6	745.8	740.5	755.2	742.5	752.3	237.8
<b>Netherlands</b>	522.2	520.1	512.3	505.7	492.1	468.1	461.6	442.3	439.5	437.9	438.2	:
<b>Austria</b>	746.3	736.6	723.9	878.4	698.7	853.6	845.8	835.7	776.5	770.9	:	:
<b>Poland</b>	766.3	757.4	743.8	735.3	726.2	725.1	717.6	668.1	667.0	652.2	647.5	:
<b>Portugal</b>	399.3	394.4	387.6	385.8	381.6	374.9	365.1	366.2	365.1	:	:	:
<b>Romania</b>	757.0	738.7	731.6	731.3	743.9	769.2	747.1	657.4	658.3	661.8	658.6	:
<b>Slovenia</b>	566.6	565.3	559.1	554.0	540.6	516.9	508.9	496.0	480.1	483.9	477.5	:
<b>Slovakia</b>	832.7	815.2	804.6	795.7	784.1	766.9	756.9	723.9	690.1	677.3	671.4	:
<b>Finland</b>	803.0	790.8	778.2	761.4	754.8	747.2	735.9	725.5	705.6	704.2	695.6	:
<b>Sweden</b>	559.8	522.1	380.4	373.8	358.5	326.9	312.8	304.5	300.6	292.6	287.7	:
<b>United Kingdom</b>	:	433.4	424.7	415.7	413.1	408.5	405.3	404.6	398.3	388.7	:	:
<b>Croatia</b>	618.5	600.8	606.2	593.0	606.9	599.8	566.8	561.1	552.7	545.0	:	:
<b>Fyrom</b>	523.0	517.1	516.0	511.4	506.9	494.6	479.2	481.5	477.8	470.2	463.1	:
<b>Turkey</b>	248.5	252.4	254.5	257.3	258.0	262.1	264.7	235.0	241.2	:	:	:
<b>Iceland</b>	:	:	:	:	:	:	:	:	:	:	:	:
<b>Norway</b>	400.6	395.9	393.5	390.3	380.8	382.5	432.3	428.2	420.6	405.9	402.7	:
<b>Switzerland</b>	665.9	663.7	664.0	662.7	630.5	605.8	596.9	584.4	568.9	555.6	:	:

Source : Eurostat

## Index of Authors

- Aggelopoulos 117  
Akrivos 14  
Asonitou 19  
Bartzis 294  
Beskos 30  
Binioris 155, 164  
Bouris 37  
Bozios 44  
Carp A. 52  
Carp C. 52  
Christodoulou 61, 385  
Christopoulos 149  
Abu-Dayyeh W. 66  
Delistravrou 75  
Dimas 83  
Dimitriadis 89  
Dimopoulou-Dimaki 370  
Dimotikalis 95  
Dobre 104  
Dorvlo 66  
Duller 113  
Elefteriadis 385  
Elmatzoglou 492  
Enusi 104  
Evripiotis 334  
Filiis 328  
Frangos Chr. 117, 126, 132, 173, 251, 492, 508, 515  
Frangos Con. 117, 126, 132, 421, 508, 515  
Fredriksson 138  
Fritaki 44  
Galanou 141  
Georgakopoulos 414  
Gerantonis 149, 484  
Giovanis 155, 164, 173  
Goula 83  
Gounas 75  
Gravas 225  
Hatzikian 179  
Kakouris 346, 406  
Kalamara 379  
Kaldis 187  
Kallivokas 196  
Kaltsidou 89  
Kapantaidakis 203  
Karagiorgos 385  
Karamanis 209  
Karapistolis 219  
Kartalis 225  
Karteri 379  
Kazanas 232  
Kefis 242  
Kivotos 251  
Koemtzopoylou 219  
Komisopoulos 44  
Konstantinidou 219  
Korres 260  
Koucouletsos 19  
Koutras 14  
Kremmyda 303  
Al-Kubaisi M. 276  
Kyritsis 414  
Lagos 287  
Laliotis 294  
Laloumis 298  
Makridis 484  
Malindretos 303  
Manolopoulos 310  
Mavridis 320  
Motou 303  
Notaras 501  
Novas 155, 328  
Orfanos 334  
Panodimos 501  
Papacharalambous 346  
Papagianoulis 357, 363  
Papailias 370  
Papakonstantinidis 353  
Papanicolas 379  
Papathanasiou 173  
Pasparakis 428  
Pazarskis 61, 385  
Pierrakos 83  
Plakarou 570  
Polychronopoulos 164  
Priftis 544  
Rompolis 389  
Sachinidis P. 401  
Sahinidis A. 401  
Al-Saidy Obaid 66  
Sambracos 544  
Sariannides 225  
Siameti 406  
Sklavakis 294, 303  
Sotiropoulos 126, 414, 421  
Stamatiadis 428  
Stamatopoulos 437  
Swanepoel C. 445  
Swanepoel J. 464  
Tan E.C. 549  
Tilikidou 75  
Toudas 484  
Tourna 19  
Tsagris 492  
Tsiakis 501  
Tsiridani 155  
Tzavalis 232, 389  
Valvi 126, 132, 508, 515  
Vasilakis 521  
Vergos 149  
Vlachos 353  
Vlachou 353  
Voskoglou 528, 536  
Vozikis 196, 544  
Wang 138  
Warren 138  
Yee C.F. 549  
Zafeiriou 557  
Zarkada 562  
Zervakakis 570  
Zisopoulos 225  
Zondiros 328



