UNIVERSITY OF THE AEGEAN

DEPARTMENT OF INFORMATION AND COMMUNICATION SYSTEMS ENGINEERING

FACTORS INCREASING THE PRODUCTIVITY OF ICT INVESTMENTS OF GREEK FIRMS-INTERNATIONAL COMPARISONS

Doctoral Dissertation
by
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Abstract

Introduction

In the last decade public and private organizations face massive transformations in their external environment leading them to internal transformations of their structure and processes. Economy globalization, growing markets' complexity and competition, increasing dissemination of ICTs, rapid development of Internet/WWW and growing need for storing, maintaining and effectively utilizing great amounts of information constitute the challenges of the present and offer great opportunities for the future, without neglecting the fact that they hide serious risks, as well. Under those circumastances firms are making great efforts to acquire competitive advantage against their rivals by investing great proportions of their budgets in Information Systems (IS) and Information and Communcation Technologies (ICT) in general, hoping that those investments will help them improve their performance and achieve their objectives.

Therefore the relationship between ICT investments and business performance has been one of the major research topics in the IS domain, and it becomes more important due to the fact that the results of various studies have been rather contradictory. Initial studies (at the beginning of 90') failed to provide empirical evidence of a positive and significant relationship between ICT investment and performance. However, more recent ones (from mid 90' and later) have provided some evidence of a positive association between those two variables, though there are still empirical studies with conclusions in the opposite direction. Furthermore, it should be noted that most of these empirical studies, in both these periods, have been conducted in a few highly developed countries, while there is limited investigation of the above issues in different types of national contexts.

However, in general today it is a common belief that ICTs have a beneficial impact on business performance. Subsequent research has shown that the benefits and value they produce is not only through the simple automation of existing business processes, but also through their transformation and improvement facilitated and enabled by those technologies. ICT business value varies significantly among firms, depending to a large extent on the combination of 'hard' ICT investments (e.g. in computers' hardware, software and networks) with appropriate 'soft investments', e.g. in new organizational practices and skills. For this reason current research in this area focuses on the factors that should be combined with ICT investments for enhancing its positive impacts, which are known as 'ICT complementary factors'.

The main kind of complementary factors that have been discussed in previous literature and practice concern business process change, which is regarded as necessary when new technologies are introduced to an organization, so that they can be utilized to the highest possible extent. There are two main approaches to business process change, Business Process Reengineering (BPR) and Total Quality Management (TQM). BPR is "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical measures of performance such as cost, quality, service, job satisfaction, and speed" (Hammer and Champy, 1993). It is considered as one of the most important issues managers face. On the other hand TQM is defined as "a management approach for an organization, centered on quality, based on the participation of all its mem-

bers and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society".

Moving further 'upstream', both ICT investment and these complentary factors are affected and shaped by by top management's decisions regarding strategy as well as the various factors constituting the external business environment. Strategy is "the determination of the basic long-term goals of an enterprise and the adoption of courses of action and allocation of resources necessary for carrying out these goals". Business environment is anything that affects an organization, but does not belong to it, in other words its surroundings. According to Porter's five forces model there are five main competitive forces that put pressure on a firm: customers, suppliers, competition, new entrants in the market and the threat from substitute products. Therefore it is important, both from researchers and practitioners' perspective, to get a 'holistic' understanding of the whole network of relations between external environment, business strategy, ICT and its complements and finally business performance.

Literature review and research gaps

Previous empirical literature has a lot of gaps and defeciencies regarding the effect of ICT investments on business performance as well as the role of factors, such as BPR, TQM, business strategy and external environment. First of all, there are only few empirical studies regarding the mediating and moderating effects of BPR and TQM in the relationship between ICT and performance. Furthermore, these few studies use subjective metrics for measuring performance, based on personal judgments, which may not (completely) reflect reality. The absence of objectiveness has a serious impact on the conclusions that are drawn, which may not be exploitable and comparable.

Another serious drawback has to do with the lack of a sound theoretical foundations in these studies (e.g. from economic or management sciences), which results in degradation or omission of variables that are important for the production process and the resulting business performance, such as labor and traditional (non-ICT capital), which concerns a great proportion of firms' fixed assets. Besides, the detailed literature review has not identified any studies investigating BPR and TQM at the same time, using the same dataset for comparability reasons, so that a comparison of the above two basic approaches to business process change as to the above issues can be made. Additionally, those two variables, which represent the extent of business change, are measured (most of the times) with only one metric (variable), though their complexity and multi-dimensionality has been recognised by relevant literature. This simplistic approach leads to mismeasurement and inadequate projection of those two notions, which are multidimensional and need to be measured by more variables. Moreover, the role of business strategy and external environment, as well as their interplay with the abovementioned variables, have not been investigated and remain unclear. Finally there is a serious lack of empirical investigations of these issues in various national contexts (characterised by various levels of economic development), and also of international comparative studies, which investigate the relations between the above factors and business performance in more than one countries, using the same survey instruments and data. Such studies would allow international comparisons, which would provide a better insight of the effect of the national context on the above (critical for the performance of organizations) networks of relations.

Finally, it should be taken into account that the introduction of ICT in an organization constitutes a complex process, the success of which is dependent on the success of the various individual IS developed, and therefore on various system-level factors. The success of those individual IS creates the necessary condition for positive results at a firm-level (cost reductions, profit increase, etc). According to the reviewed literature, an extension of the above research for the investigation and evaluation of individual IS productivity and its main determinants, is missing. In this domain existing literature focuses in researching and understanding IS user acceptance, IS success, IS satisfaction, and IS critical success factors. However those studies aim at drawing theoretical conclusions on these topics, and not to enabling the evaluation of the productivity of particular IS and its main determinants.

Contribution of the present research

The present PhD Dissertation contributes to the exising literature by fulfilling the gaps that have been identified and mentioned in the previous section. In particular:

- It empirically investigates the mediating role of business process change, examining and comparing the two abovementioned basic paradigms of it, BPR and TQM, in the relationship between ICT investment and business performance.
- It empirically investigates the moderating role of both BPR and TQM, in the business value created by ICT investments. It offers useful conclusions regarding the BPR and TQM activities having the highest ICT moderating effect.
- Extending this research 'upstream', it offers an empirical study concerning the effect of business strategy on both ICT and business process change (distinguishing again between BPR and TQM), and through them (and also 'directly') on business performance
- It also investigates empirically the same questions for the five M. Porter's forces, which constitute fundamental characteristics of the external environment of an organization.
- It conducts (for first time in Greece) a comparative empirical study of the impact of the various forms of capital used by organizations in modern economy ('traditional' capital, computer capital, human capital, organizational capital (new organizational practices)) on labor productivity, in Swiss and Greek firms.
- All the above empirical studies are based on a sound foundation from economic science, the Cobb-Douglas Production Function.
- Finally, it extends the above research for the level of an individual IS, developing and testing empirically an extension for investigating and evaluating of the productivity of particular IS and its main determinants by estimating 'Value Flow Models'.

For all the above empirical investigations, except for the last one, data were collected through a survey of 304 Greek firms from 27 different industry sectors (covering manufacturing, construction and services), in cooperation with ICAP S.A, one of the largest business information and consulting companies in Greece. Our research hypotheses have been tested mainly through the estimation of Structural Equation Models (SEM), which is an advanced statistical approach that examines and calculates the ralations among multi-

dimensional constructs, which are based on several variables-items. This approach can both test the validity and reliability of those multi-dimensional constructs (in respect to their items/variables) as well as the correctness of theories concerning the ralations among these constructs. For the international comparison the abovementioned data were used (for the Greek firms), in combination with a similar dataset from 1710 Swiss firms, which have been collected through a similar survey instrument by the Federal Technical University (ETH) Zurich. The analysis of those data was conducted by estimating econometric models based on the Cobb-Douglas framework. For the last empirical investigation at the individual system-level we used data collected through a survey instrument regarding the evaluation an e-service (e-learning course), which was delivered to 64 students who attended.

Findings and conclusions

The main findings and conclusions of this PhD Dissertation are (descibed in detail in the following chapters):

- ICT investment has a positive effect on the extent of BPR but not on TQM; on the contrary, non-ICT investment has a positive effect on the extent of TQM but not on BPR.
- BPR and TQM initiatives have both a positive impact on business performance.
- BPR is a partial mediator in the relationship between ICT investment and business perofrmance, whereas TQM is not; on the contrary, TQM is a partial mediator in the relationship between non-ICT investment and business performance, wheras BPR is not.
- BPR and TQM have a significant moderating impact of similar magnitude in the relationship between ICT investment and performance. Process simplification, process improvement and horizontal process creation, are the BPR activities with the largest moderating effects; the TQM activities with the largest moderating effects are systematic measurement of employee satisfaction, simplification of work and close cooperation with suppliers.
- A cost leadership, differentiation or focus strategy does not affect ICT or non-ICT investment
- A cost leadership strategy has a small effect on TQM, but no effect on BPR; a differentiation stategy has small effects on both BPR and TQM. However, a focus strategy has medium effects on both BPR and TQM.
- BPR mediates completely the impact of differentiation strategy on business performance, and partially the impact of focus strategy on business performance; the other business process change paradigm, TQM, mediates completely the impacts of cost leadership strategy and differentiation strategy on business performance, and partially the impact of focus strategy on business performance.
- Concerning the external environment, from the ‘five forces’ of M.Porter’s industry analysis model, non-price competition has a small positive impact on ICT investment, while suppliers’ power have a small negative effect; none of these forces affects non-ICT investment.
- Customer power and threat from substitutes have small to medium effects on both BPR and TQM; also, suppliers’ power has a small to medium effect, and threat of new entrants has a small effect only on TQM.

The abovementioned findings concern the national context of Greece, a small developing country, with particular characteristics, such as small market size and small average firm size. The international comparison with the Swiss firms led to the following findings: starting from the similarities, capital (traditional, computer, human), as well as new organizational practices associated by decentralisation of decision making from management to employees, affect labor productivity in a positive way. On the other hand new organizational practices associated with new forms of work design, such as teamwork, job rotation and decrease of hierarchical levels, does not affect labor productivity. However, significant differences have been identified. Knowledge capital is much higher in Switzerland, and has an impact on labour productivity, while in Greece it doesn't. In Swiss firms the impact of human capital, ICT capital and organizational capital associated with decentralisation is higher than the impact of ''traditional" physical capital, while in Greek firms these three ''new" production factors have on the contrary a lower impact on labour productivity than physical capital. Therefore Greek firms are weak, in comparison to the Swiss ones, with respect to 'knowledge capital', and to the exploitation of the 'new' types of capital (human, ICT and organizational) for improving business performance.

Finally, regarding investigation and evaluation of ICT productivity at system level, the contribution of the present Dissertation is the development of a novel approach based on'value flow models', according to which the quality of the resources and capabilities of an IS results in user satisfaction, in high usage rates and, finally, in future usage intention (which can be translated into acceptance and success of the system). The empirical application of this approach and estimation of a value flow model in an e-learning system provided a good validation of the proposed approach, resulting in the identification of the strenghts and weaknesses of the system, as well as particular improvement priorities.

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Εισαγωγή

Την τελευταία δεκαετία οι δημόσιοι και ιδιωτικοί οργανισμοί αντιμετωπίζουν ένα κύμα τεράστιων αλλαγών στο εξωτερικό περιβάλλον τους, το οποίο τους οδηγεί σε μεγάλες αλλαγές των δομών και διαδικασιών τους. Η παγκοσμιοποίηση της οικονομίας, η εξέλιξη του διαδικτύου, η αυξανόμενη πολυπλοκότητα και ανταγωνισμών των αγορών, η διάχυση των τεχνολογιών πληροφορικής και επικοινωνιών (ΤΠΕ), η ταχύτατη ανάπτυξη του Internet/WWW και οι αυξανόμενες ανάγκες για αποθήκευση, διατήρηση και αξιοποίηση τεράστιων αποθεμάτων πληροφορίας, αποτελούν τις σύγχρονες προκλήσεις για τις επιχειρήσεις, και προσφέρουν μεγάλες ευκαιρίες, αλλά ταυτόχρονα εγκυμονούν και μεγάλους κινδύνους. Κάτω από αυτές τις συνθήκες οι επιχειρήσεις προσπαθούν να αποκτήσουν ανταγωνιστικό πλεονέκτημα έναντι των αντιπάλων τους επενδύοντας σημαντικά ποσοστά των προϋπολογισμών τους σε πληροφοριακά συστήματα (ΠΣ) και ΤΠΕ γενικότερα, προδοκώντας ότι οι επενδύσεις αυτές θα τους βοηθήσουν να βελτιώσουν τις επιδόσεις (business performance) τους και να πετύχουν τους στόχους τους.

Για αυτόν τον λόγο η σχέση μεταξύ επενδύσεων σε ΤΠΕ και επιχειρηματικής επίδοσης αποτελεί ένα από τα σημαντικότερα πεδία έρευνας στο χώρο των πληροφοριακών συστημάτων. Τα αποτελέσματα ωστόσο των διαφόρων μελετών σχετικά με το θέμα αυτό παρουσιάζουν αντιφάσεις. Αρχικές μελέτες (στις αρχές της δεκαετίας του 90') δεν κατέληξαν σε εμπειρικές ενδείξεις θετικής και στατιστικά σημαντικής σχέσης μεταξύ επενδύσεων πληροφορικής και επιχειρηματικής επίδοσης. Νεότερες όμως μελέτες (απο το δεύτερο ήμισυ της δεκαετίας του 90' και μετά) επιβεβαίωσαν τη θετική σχέση μεταξύ των δύο μεταβλητών, αν και υπάρχουν ακόμη εμπειρικές μελέτες με συμπεράσματα προς την αντίθετη κατεύθυνση. Επίσης, πρέπει να επισημανθεί ότι οι περισσότερες από αυτές τις εμπειρικές μελέτες, και στις δύο αυτές περιόδους, έχουν διεξαχθεί σε μικρό αριθμό χωρών με υψηλή οικονομική ανάπτυξη, ενώ τα παραπάνω θέματα έχουν ελάχιστα διερευνηθεί σε διαφορετικούς τύπους εθνικού περιβάλλοντος.

Ομως γενικά, η επικρατούσα άποψη σήμερα είναι ότι οι ΤΠΕ οδηγούν σε υψηλά επίπεδα οφελών για τις επιχειρήσεις και θετικές επιπτώσεις στην επιχειρηματική επίδοση. Μεταγενέστερη έρευνα έδειξε ότι τα οφέλη και η όλη αξία που προσφέρουν οι ΤΠΕ δεν προκύπτει μόνον μέσω της απλής αυτοματοποίησης των προϋπαρχουσών επιχειρηματικών διαδικασιών, αλλά και μέσω της αλλαγής και βελτίωσής τους, η οποία πραγματοποιείται με τις τεχνολογίες αυτές. Η επιχειρηματική αξία (business value) των επενδύσεων ΤΠΕ παρουσιάζει σημαντικές διακυμάνσεις μεταξύ των επιχειρήσεων, εξαρτώμενη σε μεγάλο βαθμό από τον συνδυασμό 'σκληρών' επενδύσεων ΤΠΕ (hard ICT investments) με 'εύκαμπτες' επενδύσεις (soft investment), π.χ. στην δημιουργία νέων πρακτικών και δεξιοτήτων προσωπικού. Για αυτόν τον λόγο η σύγχρονη έρευνα στον

χώρο αυτό εστιάζεται στους παράγοντες που συνδυαζόμενοι με τις επενδύσεις ΤΠΕ οδηγούν στην αύξηση των θετικών της επιπτώσεων, οι οποίοι ονομάζονται ‘συμπληρωματικοί’ παράγοντες των ΤΠΕ (ICT complementary factors).

Η κυριότερη κατηγορία συμπληρωματικών παραγόντων, οι οποίοι έχουν εξετασθεί από την επιστημονική έρευνα και την επιχειρησιακή πράξη, αφορούν στην αλλαγή των επιχειρηματικών διαδικασιών (business process change) που απαιτείται κατά την εισαγωγή νέων τεχνολογιών σε έναν οργανισμό, έτσι ώστε αυτές να αξιοποιηθούν στον υψηλότερο δυνατό βαθμό. Υπάρχουν δυο βασικές προσεγγίσεις στην αλλαγή των επιχειρηματικών διαδικασιών, ο Ανασχεδιασμός Επιχειρηματικών Διαδικασιών (ΑΕΔ) (Business Process Reengineering) και η Διοίκηση Ολικής Ποιότητας (ΔΟΠ) (Total Quality Management). Ο ΑΕΔ ορίζεται ως ‘η εκ θεμελίων αναθεώρηση και ανασχεδιασμός των επιχειρηματικών διαδικασιών για την επίτευξη μεγάλων βελτιώσεων σε βασικές μετρικές επίδοσης, όπως κόστος, ποιότητα, εξυπηρέτηση, ικανοποίηση πελατών και ταχύτητα’. Βασίζεται στην δραστική αλλαγή και στοχεύει στο να φέρει την ‘επανάσταση’ αναφορικά με τις αλλαγές που προτείνει. Χαρακτηρίζεται ως ένα από τα σημαντικότερα θέματα που αντιμετωπίζουν τα σύγχρονα διοικητικά στελέχη. Η ΔΟΠ ορίζεται ως ‘μια διοικητική προσέγγιση για τους οργανισμούς, η οποία αφορά στην ποιότητα, βασίζεται στη συμμετοχή όλων των μελών τους και στοχεύει στη μακροχρόνια επιτυχία μέσω της ικανοποίησης των πελατών, της προσφοράς οφελών σε όλα τα μέλη του οργανισμού και της κοινωνίας’. Βασίζεται στην εξέλιξη, στην ομαλή αλλαγή και στη συνεχή βελτίωση.

Κινούμενοι ‘προς τα πίσω’, κατανοούμε ότι τόσο οι επενδύσεις ΤΠΕ, όσο και οι παραπάνω συμπληρωματικοί παράγοντες, επηρεάζονται και διαμορφώνονται από αποφάσεις της διοίκησης σχετικά με την στρατηγική που θα ακολουθήσει η επιχείρηση, όπως και από τις διάφορες δυνάμεις που διαμορφώνουν το εξωτερικό περιβάλλον τους, στοιχεία τα οποία επηρεάζουν γενικότερα τη λειτουργία τους, και, συνεπώς, τα αποτελέσματά τους. Ως στρατηγική ορίζεται ‘ένα σύνολο αποφάσεων για το μέλλον του οργανισμού, οι οποίες καθορίζουν τους μελλοντικούς μακροπρόθεσμους στόχους, καθώς επίσης και τις κατευθύνσεις δράσης και κατανομής πόρων για την επίτευξή τους’. Διακρίνεται σε δύο βασικά επίπεδα: το επιχειρησιακό (business level strategy), που περιλαμβάνει τρεις βασικές στρατηγικές επιλογές, ηγεσία κόστους, διαφοροποίηση και εστίαση, και το οργανωσιακό επίπεδο (corporate level strategy), που περιλαμβάνει κυρίως τις επιλογές της επέκτασης σε νέες αγορές, σε νέες διαδικασίες και την καινοτομία. Ως εξωτερικό περιβάλλον (external environment) ορίζεται ‘οτιδήποτε επηρεάζει τον οργανισμό, αλλά δεν ανήκει σε αυτόν». Σύμφωνα με το μοντέλο των δυνάμεων του Porter υπάρχουν πέντε βασικές δυνάμεις γενικευμένου ανταγωνισμού που ασκούν πιέσεις σε έναν οργανισμό: οι πελάτες, οι προμηθευτές, ο ανταγωνισμός από άλλες ομοειδείς επιχειρήσεις, η απειλή εισόδου νέων ανταγωνιστ’ων και η απειλή από υποκατάστατα αγαθά. Συνεπώς είναι σημανικό, τόσο για την έρευνα στον χώρο αυτό όσο και για την πράξη, να αποκτήσουμε μία ‘ολιστική κατανόηση’ του όλου δικτύου σχέσεων μεταξύ του εξωτερικού περιβάλλοντος, της στρατηγικής, των ΤΠΕ και των συμπληρωματικών τους παραγόντων και τελικά των επιχειρηματικών επιδόσεων.

Εντοπισμός ερευνητικών κενών και αδυναμιών υπάρχουσας βιβλιογραφίας

Η υπάρχουσα εμπειρική βιβλιογραφία εμφανίζει αρκετά κενά και αδυναμίες σχετικά τόσο με την επίδραση των επενδύσεων πληροφορικής στην επίδοση των επιχειρήσεων

όσο και με το ρόλο των παραπάνω παραγόντων (ΑΕΔ, ΔΟΠ, στρατηγική, εξωτερικό περιβάλλον). Καταρχάς, λίγες μόνον εμπειρικές μελέτες έχουν γίνει αναφορικά με το διαμεσολαβητικό (mediating) και ενισχυτικό (moderating) ρόλο των ΑΕΔ και ΔΟΠ στη σχέση μεταξύ επενδύσεων ΤΠΕ και επιχειρηματικής επίδοσης. Επιπλέον, οι υπάρχουσες μελέτες χρησιμοποιούν υποκειμενικές εκτιμήσεις ως μέτρα της επιχειρηματικής επίδοσης και της συμβολής των ΤΠΕ σε αυτή, οι οποίες βασίζονται στη προσωπική γνώμη των ερωτηθέντων στελεχών, και ενδεχομένως να μην ανταποκρίνονται (πλήρως) στην πραγματικότητα. Απουσιάζει δηλαδή το στοιχείο της αντικειμενικότητας στη μέτρηση της επιχειρηματικής επίδοσης, καθώς επίσης και της συμβολής των ΤΠΕ σε αυτήν, έτσι τα συμπεράσματα που εξάγονται να μην είναι πολλές φορές αξιοποιήσιμα ή συγκρίσιμα.

Ένα άλλο σοβαρό μειονέκτημα είναι η έλλειψη ενός ισχυρού θεωρητικού υποβάθρου στις εμπειρικές αυτές μελέτες (π.χ. από τον χώρο της οικονομικής ή της διοικητικής επιστήμης), η οποία οδηγεί στην υποβάθμιση ή και την πλήρη παράλειψη σημαντικών μεταβλητών που είναι σημαντικές για την παραγωγική διαδικασία, όπως η εργασία (Labor) και το ‘παραδοσιακό’ κεφάλαιο (non-ICT Capital), που αφορά τον λοιπό (εκτός ΤΠΕ) εξοπλισμό παγίων του οργανισμού. Επίσης, κατά την εκτενή επισκόπηση στη σχετική βιβλιογραφία δεν εντοπίστηκαν μελέτες που να εξετάζουν τον ΑΕΔ και την ΔΟΠ παράλληλα, χρησιμοποιώντας τα ίδια δεδομένα, ώστε να είναι δυνατή μία σύγκριση μεταξύ των δύο αυτών βασικών προσεγγίσεων στην αλλαγή των επιχειρηματικών διαδικασιών όσον αφορά τα παραπάνω θέματα. Επιπλέον οι μεταβλητές αυτές, οι οποίες απεικονίζουν το βαθμό επιχειρηματικής αλλαγής, μετρώνται, τις περισσότερες φορές με μια μόνον γενική μεταβλητή, αν και η πολυπλοκότητα και ο πολυδιάστατος χαρακτήρας τους έχουν αναγνωρισθεί από την σχετική βιβλιογραφία. Αυτό έχει σαν αποτέλεσμα την ελλιπή και μη αξιόπιστη μέτρηση των εννοιών αυτών, οι οποίες είναι εκ φύσεως πολυδιάστατες και πρέπει να μετρώνται μέσω ενός καταλλήλου συνόλου μεταβλητών κάθε μία.

Επί πλέον, ο ρόλος της στρατηγικής και του εξωτερικού περιβάλλοντος, και η αλληλεπίδρασή τους με τις προαναφερθείσες μεταβλητές, δεν έχουν επαρκώς διερευνηθεί και παραμένουν ασαφείς. Τέλος, στην βιβλιογραφία υπάρχει σημαντική έλλειψη εμπειρικών διερευνήσεων των παραπάνω θεμάτων σε διάφορα εθνικά περιβάλλοντα (με διάφορα επίπεδα οικονομικής ανάπτυξης), και απουσιάζουν συγκριτικές διεθνείς μελέτες, οι οποίες διερευνούν τις σχέσεις μεταξύ των παραπάνω παραγόντων, καθώς επίσης και με τις επιδόσεις των επιχειρήσεων σε περισσότερες από μια χώρες, χρησιμοποιώντας κοινά εργαλεία έρευνας (ερωτηματολόγια). Τέτοιες μελέτες θα παρείχαν την δυνατότητα διεθνών συγκρίσεων, οι οποίες θα έδιναν την δυνατότητα εξαγωγής συμπερασμάτων για την επίδραση του εθνικού περιβάλλοντος στις παραπάνω κρίσιμες σχέσεις.

Τέλος, θα πρέπει να ληφθεί υπ’ όψιν ότι η εισαγωγή των ΤΠΕ σε έναν οργανισμό αποτελεί μια πολύπλοκη διαδικασία, η επιτυχία της οποίας εξαρτάται απο την επιτυχία διαφόρων επί μέρους ΠΣ που αναπτύσσονται, και συνεπώς από διάφορους παράγοντες που αφορούν τα επί μέρους ΠΣ. Η επιτυχία αυτών των ΠΣ δημιουργεί τις κατάλληλες προϋποθέσεις για θετικά αποτελέσματα σε επίπεδο επιχείρησης (μείωση λειτουργικού κόστους, αύξηση κερδοφορίας, κτλ). Σύμφωνα με την επισκόπηση της σχετικής βιβλιογραφίας, απουσιάζει μία επέκταση της έρευνας που περιγράφθηκε στις προηγούμενες παραγράφους για την διερεύνηση και αξιολόγηση της παραγωγικότητας των επί μέρους ΠΣ και των βασικών καθοριστικών της παραγόντων. Στο χώρο αυτό η υπάρχουσα βιβλιογραφία εστιάζεται κυρίως στην μελέτη και κατανόηση της αποδοχής

ΠΣ από τους χρήστες (IS User Acceptance), της επιτυχίας ΠΣ (IS Success), της ικανοποίησης από τη χρήση ΠΣ (IS Satisfaction) και στους κρίσιμους παράγοντες επιτυχίας ΠΣ (IS Critical Succes Factors). Ωστόσο οι μελέτες αυτές στοχεύουν στην εξαγωγή γενικών θεωρητικών συμπερασμάτων για τα παραπάνω θέματα, και όχι στην υποστήριξη της αξιολόγησης της παραγωγικότητας συγκεκριμένων ΠΣ και των καθοριστικών της παραγόντων.

Συνεισφορά της παρούσας Διατριβής

Η παρούσα Διδακτορική Διατριβή συνεισφέρει στην υπάρχουσα βιβλιογραφία καλύπτοντας τα κενά που αναφέρθηκαν στην προηγούμενη ενότητα. Συγκεκριμένα:

- Εξετάζει εμπειρικά το διαμεσολαβητικό ρόλο της αλλαγής επιχειρηματικών διαδικασιών, εξετάζοντας και συγκρίνοντας και τις δύο προαναφερθείσες προσεγγίσεις, τον ΑΕΔ και την ΔΟΠ, στη σχέση μεταξύ επενδύσεων ΤΠΕ και επιχειρηματικής επίδοσης.
- Εξετάζει εμπειρικά τον ενισχυτικό ρόλο του ΑΕΔ και της ΔΟΠ, στην παραπάνω σχέση μεταξύ επενδύσεων ΤΠΕ και επιχειρηματικής επίδοσης και γενικότερα στην επιχειρηματική αξία που προκύπτει απο τις επενδύσεις ΤΠΕ. Εξάγει επίσης χρήσιμα συμπεράσματα σχετικά με τις δραστηριότητες ΑΕΔ και ΔΟΠ που έχουν τονισχυρότερο ενισχυτικό αποτέλεσμα.
- Επεκτείνοντας την μελέτη αυτή ‘προς τα πίσω’, με στόχο την δημιουργία μίας ‘ολοκληρωμένης εικόνας', πραγματοποιήθηκε στην συνέχεια μια εμπειρική μελέτη όσον αφορά την επίδραση της στρατηγικής στις ΤΠΕ και στην αλλάγη διαδικασιών (διακρίνοντας μεταξύ των δύο παραπάνω μοντέλων της, ΑΕΔ και ΔΟΠ)), και μέσω αυτών στις επιχειρηματικές επιδόσεις.
- Διερευνήθηκαν επίσης εμπειρικά τα παραπάνω θέματα για τις ‘πέντε δυνάμεις’ του εξωτερικού περιβάλλοντος, σύμφωνα με το σχετικό πλαίσιο ανάλυσης του M. Porter.
- Πραγματοποιήθηκε (για πρώτη φορά στην Ελλάδα) συγκριτική διεθνής εμπειρική μελέτη των επιδράσεων των διαφόρων μορφών κεφαλαίου που χρησιμοποιούν οι επιχειρήσεις στην σύγχρονη οικονομία (‘παραδοσιακό’ κεφάλαιο (=κλασσικά πάγια), κεφάλαιο πληροφορικής, ανθρώπινο κεφαλαίου, οργανωτικό κεφάλαιο (=νέες οργανωσιακές πρακτικές)) στην αποδοτικότητα της εργασίας, στις Ελληνικές και Ελβετικές επιχειρήσεις.
- Ολες οι παραπάνω εμπειρικές διερευνήσεις βασίσθηκαν σε ένα ισχυρό υπόβαθρο από την οικονομική επιστήμη, την συνάρτηση παραγωγής Cobb-Douglas.
- Τέλος, η παραπάνω έρευνα επεκτάθηκε και στο επίπεδο επι μέρους ΠΣ, αναπτύσσοντας και ελέγχοντας εμπειρικά μια επέκτασή της για την διερεύνηση και αξιολόγηση της παραγωγικότητας ΠΣ και των καθοριστικών της παραγόντων, μέσω της εκτίμησης ‘Μοντέλων Ροής Αξίας’ (Value Flow Models).

Για όλες τις παραπάνω εμπειρικές μελέτες, εκτός της τελευταίας, χρησιμοποιήθηκαν δεδομένα τα οποία συνελλέγησαν από μία έρευνα μέσω ερωτηματολογίου από 304 Ελληνικές Επιχειρήσεις σε 27 διαφορετικούς κλάδους, σε συνεργασία με την εταιρία συμβούλων επιχειρήσεων ICAP Α.Ε. Ο έλεγχος των ερευνητικών μας υποθέσεων έγινε κυρίως μέσω εκτίμησης μοντέλων δομικών εξισώσεων (Structural Equation Models-SEM), μιας εξελιγμένης στατιστικής προσέγγισης που εξετάζει και υπολογίζει σχέσεις

μεταξύ πολυδιάστατων παραγόντων (constructs), οι οποίες βασίζονται σε περισσότερες της μίας μεταβλητές - στοιχεία (items). Η προσέγγιση αυτή έχει τη δυνατότητα να ελέγχει τόσο την εγκυρότητα και αξιοπιστία των πολυδιάστατων αυτών παραγόντων (σε σχέση με τα στοιχεία που τις αποτελούν), όσο και να εξετάζει την ορθότητα θεωριών αναφορικά με υποθέσεις για τις σχέσεις μεταξύ των παραγόντων. Για την παραπάνω διεθνή συγκριτική μελέτη χρησιμοποιήθηκαν τα δεδομένα αυτά (για τις Ελληνικές επιχειρήσεις), σε συνδυασμό με ένα παρόμοιο σύνολο δεδομένων από 1710 Ελβετικές επιχειρήσεις, τα οποία συλλέχθηκαν από μια παρόμοια έρευνα που πραγματοποιήθηκε από το Ομοσπονδιακό Πολυτεχνείο της Ζυρίχης (ETH Zurich). Η επεξεργασία των στοιχείων αυτών έγινε μέσω της εκτίμησης οικονομετρικών μοντέλων που βασίζονται στο πλαίσιο Cobb-Douglas.

Το τελευταίο τμήμα της Διατριβής που αφορά την παραγωγικότητα και αποτελεσματικότητα των ΤΠΕ επίπεδο συστήματος, περιλαμβάνει την δημιουργία μιας ολοκληρωμένης μεθοδολογίας αξιολόγησης πληροφοριακών συστημάτων, η οποία βασίζεται στην εκτίμηση 'Μοντέλων Ροής Αξίας' (Value Flow Models). Ενα τέτοιο μοντέλο δίνει μία ολοκληρωμένη εικόνα του μηχανισμού και των παραγόντων δημιουργίας αξίας από ένα ΠΣ, και επιπτρέπει την ανάπτυξη μιας ολοκληρωμένης πρότασης προτεραιοτήτων βελτίωσής του, με βάση τις αντιλήψεις των χρηστών. Η μεθοδολογία αυτή εφαρμόστηκε εμπειρικά σε ένα πληροφοριακό σύστημα ηλεκτρονικής μάθησης. Για την αξιολόγηση του συγκεκριμένου συστήματος αναπτύχθηκε δομημένο ερωτηματολόγιο με βάση μία εκτενή βιβλιογραφική επισκόπηση. Το ερωτηματολόγιο επιδόθηκε σε 64 εκπαιδευόμενους που παρακολούθησαν ένα συγκεκριμένο πρόγραμμα ηλεκτρονικής μάθησης. Τα δεδομένα τα οποία συλλέχθηκαν μέσω αυτού χρησιμοποιήθηκαν για την εκτίμηση ενός μοντέλου δομικών εξισώσεων (SEM), από το οποίο προέκυψαν συγεκριμένες προτεραιότητες βελτίωσης του συστήματος αυτού.

Ευρήματα και συμπεράσματα

Τα κυριότερα ευρήματα και συμπεράσματα της Διδακτορικής αυτής Διατριβής (τα οποία παρουσιάζονται αναλυτικά στα παρακάτω κεφάλαια αυτής) είναι τα εξής:

- Οι επενδύσεις ΤΠΕ έχουν θετικές επιπτώσεις στον ΑΕΔ, αλλά όχι στην ΔΟΠ. Αντίθετα οι λοιπές επενδύσεις σε 'παραδοσιακά' πάγια (εκτός ΤΠΕ) έχουν θετικές επιπτώσεις στην ΔΟΠ αλλά όχι στον ΑΕΔ.
- Τόσο ο ΑΕΔ όσο και η ΔΟΠ έχουν θετικές επιπτώσεις στην επιχειρηματική επίδοση.
- Ο ΑΕΔ είναι μερικός διαμεσολαβητής (partial mediator) στη σχέση μεταξύ επενδύσεων ΤΠΕ και επιχειρηματικής επίδοσης, πράγμα το οποίο δεν ισχύει για την ΔΟΠ. Αντίθετα η ΔΟΠ είναι μερικός διαμεσολαβητής στη σχέση μεταξύ επενδύσεων σε λοιπά (εκτός ΤΠΕ) 'παραδοσιακό' πάγια και επιχειρηματικής επίδοσης, πράγμα το οποίο δεν ισχύει για τον ΑΕΔ.
- Οι ΑΕΔ και ΔΟΠ έχουν αμφότερες σημαντική και θετική ενισχυτική (moderating) επιρροή παρόμοιας ισχύος στη σχέση μεταξύ επενδύσεων ΤΠΕ και επιχειρηματικής επίδοσης. Η απλοποίηση διαδικασιών, η βελτίωση διαδικασιών και η δημιουργία οριζόντιων διαδικασιών, αποτελούν τις δραστηριότητες ΑΕΔ με την υψηλότερη ενισχυτική επιρροή. Η συστηματική μέτρηση του επιπέδου ικανοποίησης των εργαζομένων, η απλοποίηση των διαφόρων εργασιών και η

συνεργασία με τους προμηθευτές αποτελούν τις δραστηριότητες ΔΟΠ με την την υψηλότερη ενισχυτική επιρροή.

- Ο βαθμός υιοθέτησης στρατηγικής ηγεσίας κόστους, διαφοροποίησης και εστίασης δεν επιρεάζει το επίπεδο επενδύσεων τόσο σε ΤΠΕ όσο και σε λοιπά (εκτός ΤΠΕ) ΄παραδοσιακά' πάγια.
- Η στρατηγική ηγεσίας κόστους έχει μία μικρού μεγέθους θετική επίδραση στην ΔΟΠ, αλλά όχι στον ΑΕΔ. Η στρατηγική διαφοροποίησης έχει μικρή μεγέθους θετική επίδραση τόσο στον ΑΕΔ όσο και στην ΔΟΠ. Αντίθετα η στρατηγική εστίασης έχει μεσαίου μεγέθους επιδράσεις τόσο στον ΑΕΔ όσο και στην ΔΟΠ.
- Ο ΑΕΔ είναι πλήρης διαμεσολαβητής (complete mediator) της σχέσης μεταξύ στρατηγικής διαφοροποίησης και επιχειρηματικής επίδοσης, και επίσης μερικός διαμεσολαβητής (partial mediator) της σχέσης μεταξύ στρατηγικής εστίασης και επιχειρηματικής επίδοσης.
- Το άλλο μοντέλο μετασχηματισμού των επιχειρηματικών διαδικασιών, η ΔΟΠ, είναι πλήρης διαμεσολαβητής (complete mediator) στις σχέσεις των στρατηγικών ηγεσίας κόστους και διαφοροποίησης με την επιχειρηματική επίδοσης, και επίσης μερικός διαμεσολαβητής (partial mediator) της σχέσης μεταξύ στρατηγικής εστίασης και επιχειρηματικής επίδοσης.
- Οσον αφορά το εξωτερικό περιβάλλον, από τις 'πέντε δυνάμεις' του σχετικού πλαισίου ανάλυσης του M. Porter που εξετάσθηκαν, ο ανταγωνισμός ως προς άλλους παράγοντες εκτός της τιμής έχει μία μικρού μεγέθους θετική επίπτωση στις επενδύσεις ΤΠΕ, ενώ αντίθετα η διαπραγματευτική δύναμη των προμηθευτών έχει μία μικρού μεγέθους αρνητική επίπτωση. Καμμία από τις πέντε αυτές εξωτερικές δυνάμεις δεν έχει επίπτωση στις επενδύσεις σε λοιπά (εκτός ΤΠΕ) ΄παραδοσιακά' πάγια.
- Η διαπραγματευτική δύναμη των πελατών και η απειλή από υποκατάστατα έχουν μικρού προς μεσαίου μεγέθους επίδραση τόσο στον ΑΕΔ όσο και στην ΔΟΠ. Επίσης η διαπραγματευτική δύναμη των προμηθευτών έχει μικρού προς μεσαίου μεγέθους επίδραση, και η απειλή νέων εισόδων έχει μικρού μεγέθους επίδραση, μόνον στην ΔΟΠ.

Τα ευρήματα αυτά αναφέρονται στο εθνικό περιβάλλον της Ελλάδας, μιας μικρής πληθυσμιακά και αναπτυσσόμενης χώρας, με μικρό μέγεθος αγοράς και μικρό μέσο όρο μεγέθους επιχειρήσεων. Η διεθνής σύγκριση με αντίστοιχες Ελβετικές επιχειρήσεις οδήγησε στα παρακάτω ευρήματα: ξεκινώντας από τις ομοιότητες, και για τις δύο χώρες το κεφάλαιο (παραδοσιακό, πληροφορικής και ανθρώπινο), καθώς επίσης και οι νέες οργάνωσιακές πρακτικές που χαρακτηρίζονται από αποκέντρωση λήψης αποφάσεων, επηρεάζουν θετικά την παραγωγικότητα της εργασίας. Αντίθετα, και στις δύο χώρες, νέες οργάνωσιακές πρακτικές που χαρακτηρίζονται από νέες μορφές οργάνωσης εργασίας, όπως ομάδες εργασίας, εναλλαγή θέσεων εργασίας και μείωση ιεραρχικών επιπέδων, δεν επηρεάζουν την παραγωγικότητα της εργασίας. Ομως παράλληλα εντοπίσθηκαν και σημαντικές διαφορές μεταξύ των δύο χωρών. Το γνωσιακό κεφάλαιο είναι πολύ υψηλότερο στις Ελβετικές επιχειρήσεις, και έχει θετική επίπτωση στην παραγωγικότητα της εργασίας, ενώ στις Ελληνικές επιχειρήσεις μία τέτοια επίπτωση δεν παρατηρείται. Επίσης στις Ελβετικές επιχειρήσεις η παραγωγική επίπτωση του ανθρώπινου κεφαλαίου, του κεφαλαίου ΤΠΕ και του οργανωσιακού κεφαλαίου που αφορά στην αποκέντρωση είναι υψηλότερες από αυτήν του 'παραδοσιακού' κεφαλαίου, ενώ αντίθετα στις Ελληνικές επιχειρήσεις οι τρεις αυτοί 'νέοι παραγωγικοί συντελεστές' έχουν χαμηλότερες παραγωγικές επιπτώσεις σε σύγκριση με το 'παραδοσιακό' κεφάλαιο. Από

τα παραπάνω συμπεράσματα προκύπτει ότι οι Ελληνικές επιχειρήσεις παρουσιάζουν αδυναμίες, σε σύγκριση με τις Ελβετικές, όσον αφορά το γνωσιακό κεφάλαιο, καθώς επίσης και την παραγωγική αξιοποίηση των 'νέων' τύπων κεφαλαίου (ΤΠΕ, ανθρώπινο και οργανωτικό) με στόχο την βελτίωση των επιχειρηματικών επιδόσεων.

Τέλος, αναφορικά με διερεύνηση και αξιολόγηση της παραγωγικότητας των ΤΠΕ σε επίπεδο συστήματος, η συνεισφορά της παρούσας Διατριβής έγκειται στην ανάπτυξη μίας νέας προσέγγισης που βασίζεται σε 'μοντελα ροής αξίας', σύμφωνα με την οποία η ποιότητα των πόρων και δυνατοτήτων ενός ΠΣ οδηγούν σε ικανοποίηση των χρηστών του, σε εκτενή χρήση του και – τελικά - σε πρόθεση για μελλοντική επανάληψη της χρήσης του (δηλαδή στην αποδοχή και επιτυχία του). Η εμπειρική εφαρμογή της προσέγγισης αυτής και η εκτίμηση του μοντέλου ροής αξίας σε ένα σύστημα ηλεκτρονικής μάθησης, προσέφερε μία καλή πρώτη δοκιμή και επικύρωση (validation) της προτεινομένης προσέγγισης και οδήγησε σε συγκεκριμένες προτάσεις βελτίωσης του συγκεκριμένου συστήματος.

Chapter 1

Introduction

1.1 The problem

In the last decade public and private organizations face massive transformations in their external environment, leading them to internal transformations of their structure and processes. Economy globalization, growing markets' complexity and competition, increasing dissemination of ICTs, rapid development of Internet/WWW and growing need for storing, maintaining and effectively utilizing great amounts of information constitute the challenges of the present and offer great opportunities for the future, without neglecting the fact that they hide serious risks, as well. Under those circumastances firms are making great efforts to acquire competitive advantage against their rivals by investing great proportions of their budgets in Information Systems (IS) and Information and Communcation Technologies (ICT) in general, hoping that those investments will help them improve their performance and achieve their objectives.

Today every single organization, which wants to be competitive, invests in ICT, aiming at cost reductions, time saving, better resource management, production improvement and profit increases. During the last three decades a rapid diffusion of information and communication technologies (ICTs) in firms of most sectors has taken place. Realizing such an investment, however, doesn't constitute the "panakeia" for success and performance increase. "Apart from the amount of the investment itself, what is more important is how organizations manage and utilize their IT assets" (Stratopoulos and Dehning, 2000). For this reason among the most important research topics in the area of information systems (IS), attracting for a long time the interest of researchers and practitioners has been the contribution of firms' ICT investments to their performance. The main focus has been placed on understanding the development of ICT business value, aiming mainly at a deeper understanding and assessment of the multiple dimensions of ICT business value at all levels of the economy: at firm, sector and national level. According to Irani and Love (2002) managers need to have a better understanding about the impact of IS on organizational performance, and a better understanding of the benefits, costs and risks associated with financial and social capital investments in developing such infrastructures. Such understanding can help organizations better utilize their resources and improve their position vis-à-vis their competitors. Failure of such understanding can have disastrous consequences, such as inappropriate resource allocation and competitive disadvantage (Irani, 2008). The reasons as to why organizations evaluate IS investments are explained by Irani and Love (2002) as being to:

- Compare between different projects
- Rank projects in terms of organizational priorities
- Justify investment requests by management
- Control expenditure, benefits, risk, development and implementation of projects
- Provide a framework that facilitates organizational learning and
- Facilitate mechanisms to decide whether to fund, postpone or reject investment requests.

Most of the above research has focused on the firm level, since this is where most of the ICT investment decisions are made. This firm level ICT business value research can be broadly divided into four periods, according to Loukis et al. (2008):

I. In the first period (from the mid 1980s until the mid 1990s) the main objective has been the discovering of empirical evidence regarding a positive association between ICT investment and business performance. However, in this period very little empirical evidence was found in this direction (e.g. Roach 1987, Brynjolfsson 1993, Strassman1997), so critical questions were posed concerning the productivity of the big investments organizations made in ICT: do they really contribute to the productivity of firms according to their high expectations, or these expectations were just a result of ICT companies' marketing hype? This problematic is usually referred to as the 'ICT Productivity Paradox' (Brynjolfsson 1993) and is very well reflected in R. Solow's statement that "you can see the computer age everywhere but in the productivity statistics" (Solow 1987). The productivity paradox indicated that investing in ICT is not a necessary and sufficient condition for improving business performance. The 'IS productivity paradox' inspired a lot of researchers to investigate its roots. Brynjolfsson (1993) proposed four explanations, mainly focusing on research methods (mismeasurement, misaligned time of measure), level of analysis (i.e redistribution), and theoretical causation (mismanagement of IS). As main sources of the inconsistent results were regarded the measurement error and data quality (Wan et al; 2007).

II. In the second period (from the mid 1990s until mainly the mid 2000s) some studies provide empirical evidence of a positive impact of ICT investment on several business performance measures (e.g. Brynjolfsson and Hitt 1996, Stolarick 1999, OECD 2004, Arvanitis 2005a), reflecting the growing expertise and maturity of ICT vendors, consultants and adopting organizations in the deployment of ICT and adapting existing proceses and structures; however, some other studies still result in mixed or inconclusive results (e.g. Stiroh 1998, Hartman 2002). These mixed results lead gradually to the conclusion that some additional independent variables, associated with the internal and external context of the adopting organization, have to be taken into account as well. During this period considerable research has also been conducted for better understanding the main dimensions of ICT business value as well as for identifying the main organizational variables affected by ICT at the operational, tactical and strategic level (e.g. labour costs, throughput, workforce composition, plant efficiency, delivery lead-time, flexibility, market share, etc.) laying the foundations for the development of firm level ICT investment evaluation frameworks (e.g. Irani 2002, Irani & Love 2002, Arvanitis 2005b, Gunasekaran et al 2006).

III. In the third period (from 2000 until today), since considerable evidence of positive contribution of ICT investment to various measures of business performance had already been provided by the relevant empirical literature, the research focuses mainly on the identification and deeper understanding of the 'ICT complements'. This term describes factors related to the internal functions of the organization, which in combination with ICT can increase the business value it generates, such as business process redesign, new human skills development, products and services innovations, 'soft ICT investment', etc. (e.g. Devaraj & Kohli 2000, Arvanitis 2005a, Hempell 2005, Loukis et al 2008b). The main idea of this period is very well reflected and summarized by the statement of Brynjolfsson and Hitt (2000) that "...both case studies and econometric work point to organisational complements, such as new business processes, new skills and new organisational and industry structures as a major driver of the contribution of information technology".

IV. In the fourth period (from the mid 2000s until today) research starts dealing with the effect of 'external' factors, which are related to the external environment of the organization, such as generalized competition, industry concentration, industry dynamism, strategy, etc., on ICT business value (Loukis et al 2006, Melville et al 2007, Loukis et al 2008a). However, limited is the research conducted in this direction so far, as stated by Melville, Kraemer and Gurbaxani (2004), who from an extensive review of the literature on ICT value conclude that "we know very little about how industry characteristics moderate the degree of IT business value" and suggest that more empirical research should be conducted in this direction.

The basic explanations provided by the literature for the inconsistency of the results of the abovementioned first period concerning the relationship between ICT investments and business performance was that the full potential of ICTs is exploited not by simply automating existing business processes, but by adjusting and improving them based on the capabilities ICT offer. This process, of course, takes time and requires extensive effort and specialized expertise (e.g. Brynjolfsson & Hitt 1996). According to Bresnahan et al (2002) "firms do not simply plug in computers or telecommunications equipment and achieve service quality or efficiency gains. Instead, they go through a process of organizational redesign and make substantial changes to their product and service mix". In the same direction Brynjolfsson and Hitt (2000) argue that the most beneficial aspect of ICTs is that they are catalysts and enablers of big improvements of existing business processes and work practices, which, in turn, leads to very high levels of benefits. For this reason they expect that the main mechanism of business value creation from ICT will be not the simple automation of existing business processes, but the IT-enabled change and improvement of them, which can result in quite big business benefits. It is therefore important to investigate empirically the mediation effect of business process change on the relationship between ICT and business performance in various sectoral and national contexts, in order to discover to what extent the above expectations are materialized in 'real-life' situations.

Furthermore, the productivity or performance impact from ICT investments is dependent not only on internal (process) factors, but also on external ones, such as national context, competition, business strategy, etc. Regarding national context, the findings of various studies in different countries (Greenan et al, 2001; Lichtenberg; 2005, Lal, 2001) were rather contradictory. At the same time the final conclusion of cross-country studies (Dewan and Kraemer, 2001; Pohjola, 2001) was that in developed countries there is a strong connection between IT and productivity, whereas in developing countries there is not. As far as the time dimension is concerned, Dedrick et al (2003) support that the fact that ICT investment was not (strongly) correlated with productivity in some previous studies may have been because firms were gradually learning over time to apply ICT capital more productively. In a more recent study Brunjolfsson and Hitt (2000) have found that ICT investment payoffs occur after a lag of 4-7 years. Additionally, there is a lot of research in the area of business value connecting performance with a firms' choice regarding the strategy it follows as well as the type of pressure it faces from its competitors.

Therefore firm performance is the outcome of the interplay between the abovementioned internal and external factors. It is very common that firms in the same national context do not have the same IT productivity impacts, meaning that they use IT much more productively than others. Dedrick et al (2003) mention two basic factors that cause those 'firm effects': a) specific firm characteristics such as market position, rigidities in cost structures, brand recognition, and vision and abilities of key executives, who influence firms' strategy, and b) specific features of organizational structure, strategy and management practices that can be compared systematically across companies. They pose that "…the management of a firm can directly influence these features through restructuring, new management control systems, process redesign, or by upgrading employee training."

As a conclusion we could say that measuring economic performance from ICT investments is a hard task for firms since it necessitates a lot of aspects to be taken into account. According to Brynjolfsson and Hitt (2000) its main difficulty is to identify all costs stemming from ICT investments. A new ICT asset requires the necessary changes in the structure and processes of an organization in order to operate effectively. Dedrick et al. (2003) claim that apart from the direct investments in computer software and hardware, firms underestimate the costs of investing in complementary factors such as process reengineering and training, which can be much larger than the actual direct investment in IT. ICT business value is dependent on both internal (firm context) and external (environmental context) factors. Internal factors are those that should accompany ICT investments in order to be efficient and play a key role to their success; they are known as 'complementary factors'. Through this term are denoted factors related to the internal functions of the organization, which in combination with ICT can increase the business value it generates, such as business process redesign, new human skills development, products and services innovations, 'soft ICT investment', etc. (e.g. Devaraj & Kohli 2000, Arvanitis 2005a, Hempell 2005, Loukis et al 2008b). The main idea of the term is very well reflected and summarized by the statement of Brynjolfsson and Hitt (2000) that '..both case studies and econometric work point to organisational complements, such as new business processes, new skills and new organisational and industry structures as a major driver of the contribution of information technology'.

ICT investments cause massive transformations, in firms' structure, as well as in their processes. Business change is the result of the introduction of new ICTs in any firm. Among the main research foca of this study is the investigation of the role of business change, which is the most important complementary factor. The most widely used approaches to change are 'Business Process Reengineering' (BPR) and 'Total Quality Management' (TQM). BPR was first presented in two articles written by Hammer (1990) and Davenport & Short (1990), though it incorporates some theories and tools already existing in management science and practice. It was introduced as a means to "break away from the outdated rules and fundamental assumptions that underline operations" (Hammer and Champy, 1990). It is defined as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical measures of performance such as cost, quality, service, job satisfaction, and speed" (Hammer and Champy, 1993). Another more holistic definition offered by Al Mashari and Zairi (2000, p. 36) about BPR is "…a continuum of change initiatives with varying degrees of radicalness supported by IT means, at the heart of which is to deliver superior performance standards through establishing process sustainable capability". BPR

incorporates change in processes, people and technology with business vision, structure and relationships within an organization.

Another widely used approach, which is less radical and aims at long-term continuous improvements, is 'Total Quality Management' (TQM). It is defined by the 'International Organization for Standardization' (ISO) (http://www.iso.org/iso/home.htm) as "a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society". According to Collins (1996) TQM is a management philosophy which highlights the need to improve the quality of goods and services in order to better utilize the resources of organizations. During the last years TQM is regarded as a proven systematic approach to the improvement of the organizations' overall business processes, including products and services.

The role of BPR and TQM in the relationship between ICT investment and business performance is an issue, due to the fact that existing literature either does not offer a satisfactory number of empirical studies, or the results are inconsistent. Besides, since the decision about conducting a BPR or TQM project is taken by top management, it is very interesting to examine if those decisions are taken as a result of changes or pressures from the external environment of the firms, as well as if they are the outcomes of a business strategy with particular objectives. In other words, we should examine whether business performance is influenced by external factors, as well. According to Tallon (2007) business strategy is defined as "the determination of the basic long-term goals of an enterprise and the adoption of courses of action and allocation of resources necessary for carrying out these goals". In order therefore to capture the entire value creation process by an organization, we should also examine the role of strategy in the realization of ICT investments and the creation of business performance.

Figure 1.1 shows the surroundings of an organization, as well as the internal part of them. Organizations do not operate as distinct entities, isolated from their competitors and, generally, their external environment. As business environment could be regarded anything that affects an organization, but does not belong to it, in other words its surroundings. The environment has an impact on the strategy, decisions, processes and performance of the firms. It could be distinguished into two categories: the micro environment, consisting of different types of stakeholders - customers, employees, suppliers, board of directors and creditors, and the macro environment, which includes factors which are beyond the control of the business, social, technological, economical and political. Changes in the microenvironment will directly affect and impinge on the firm's activities. Changes in the macro environment will indirectly affect the business but will nonetheless affect it.

As we can see in the figure below organizations are affected by external (industry, competition, market, etc.) as well as by internal factors (among which is strategy, processes, which are supported by particular IS, etc).

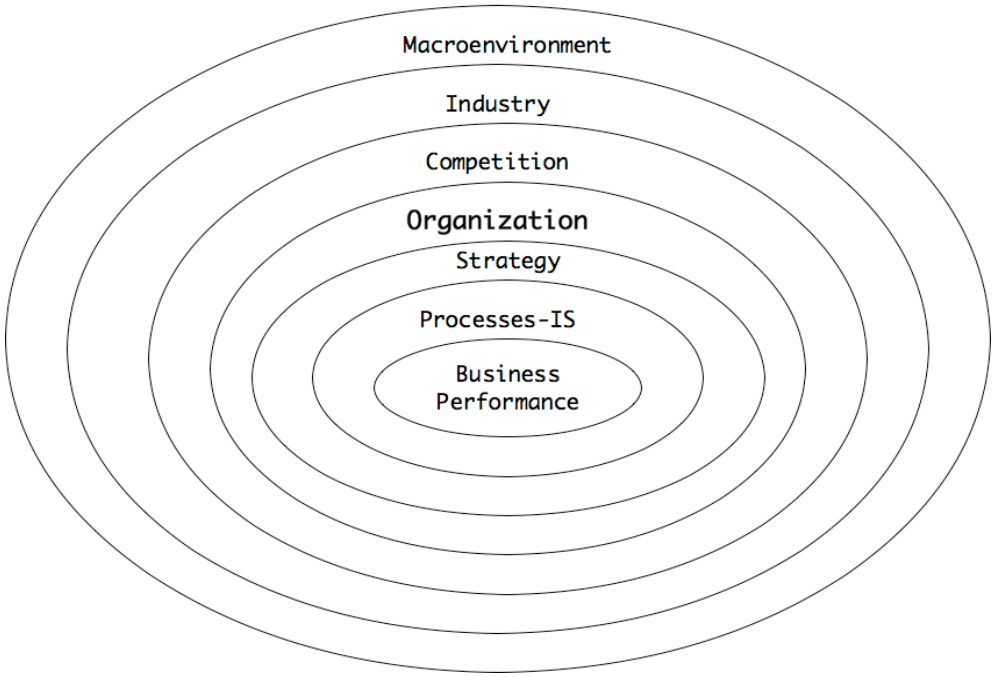


Figure 1.1: Factors affecting organizations

The impact of ICT investments on firm performance represents the evaluation of those ICT assets at a firm level mainly in economic terms. However, it does not provide information about the impact of those assets on the everyday operations of the organizations, the extent of utilization and the value they deliver on the firms' various stakeholders. Irani (2008) supports that "to view evaluation in simple cash or cost-benefit terms only addresses one particular area of expectation when engaging an IS project. Although a cash return on investment is necessary for a business operation to remain healthy a positive result cannot be taken as an indication that the project will succeed to meet its stakeholders' expectations. The acquisition of ICT assets enables firms to employ particular IS for supporting their processes. Apart from the various complementary factors at a firm-level, business performance is also influenced by the efficient and effective utilization of particular IS. The extent of success of particular IS should therefore be evaluated. The whole point of IS evaluation is to predict (ex ante) or assess (ex post) how well an IS project meets the various expectations of stakeholders. Therefore after the investigation of the abovementioned aspects we also deal with the evaluation of IS at a system level, having as main objective to detect the pros and cons of particular IS and to decide what improvements should take place in order to increase the value it delivers to stakeholders. The main question is whether a specific IS utilizes effectively its resources and produces value for its users, which will contribute to performance enhancement at a firm level. This investigation bridges the gap between economic evaluation of an IS investment and success or business value assessment of particular IS.

1.2 Motivation

Taking into account the literature review we conducted in the above areas, which is presented in the following chapters, the main motivations for conducting the present research are:

- Existing studies have widely discussed and emphasized the role and the potential of business process change as mediator of the relationship between ICT and business performance; however they have empirically investigated it only to a very limited extent. Furthermore, most of this limited previous empirical research focuses mainly on BPR and neglects TQM, even though the later represents a widely adopted paradigm of business process change. Additionally, these empirical studies are not based on theoretically sound models, omitting thus important independent variables that affect substantially their selected measures of business performance, such as non-ICT capital, labor, etc., and use various subjective measures of business performance as dependent variables. Finally, there are no empirical studies investigating the mediation effects of both BPR and TQM on the relationship between ICT and business performance using the same firm-level dataset, which would allow for a comparison between them.
- Regarding the moderating role of BPR on ICT business value, previous studies have investigated it only to a very small extent, while the moderating effect of TQM on ICT business value has not been empirically investigated. Even these very few empirical studies of the moderating role of BPR are not based on theoretically sound models including all the fundamental variables; Therefore further empirical research is necessary concerning the moderating effects of the two different business process change paradigms (BPR and TQM) on ICT business value in various sectoral and national contexts.
- The extent of process change in organizations (expressed through BPR and TQM activities) has not been measured in a reliable way. There are studies, which use only one item, or a small number of items that cannot capture the multidimensional nature of the two main process change paradigms. A need has therefore been identified for a multi-scale and reliable measurement of BPR and TQM.
- The positive effects of ICT investments, BPR and TQM on business performance have been extensively mentioned by the existing literature. However little is known about the antecedents of ICT investments, i.e the factors that make managers take investment decisions. Among those factors is business strategy. It is a fact that business performance is closely related to the strategy of the firms and is measured aligned with the particular strategic choices of each. Existing literature has studied (though to a small extent) the intervening roles of BPR and TQM in the ICT-performance relationship. It has also studied, the role of IT in strategy implementation and their effect on business performance (Theodorou and Florou, 2008). However BPR and TQM have been studied separately, as distinct process change paradigms. Besides, performance is influenced by non-ICT investment as well, its 'traditional' capital, especially in the industry sector. It would be therefore interesting to study the effects of strategy on both ICT and non-ICT capital, process change (expressed through BPR and TQM), and, finally the contribution of all to business performance.
- Furthermore, there are a lot of studies describing the relationship between external environment and business performance. Similarly, there are studies relating the various environmental dimensions with business change (BPR, TQM or other form). However, our literature review has not conveyed empirical studies on the relationship between environment and ICT investment. As a conclusion, there is a serious gap in the literature regarding a study, which integrates all those variables

(which have been sporadically mentioned) into one single model. In other words, a study regarding the interplay between external environment, ICT/non-ICT investment, BPR or TQM (as business transformation paradigms) and performance, is missing.

- There is also a serious lack of empirical investigations of these issues in various national contexts (characterised by various levels of economic development), and also of international comparative studies, which investigate the relations among the above factors and with business performance in more than one countries, using the same survey instruments and data. Such studies would allow international comparisons, which would provide a better insight of the effect of the national context on the above (critical for the performance of organizations) networks of relations.
- Taking into account that the impact of ICT investment of a firm on its productivity and performance is achieved through the development of particular IS, it is necessary to extend the above firm-level research towards system-level as well, aiming at investigating and evaluating of the productivity of particular IS and its main determinants.

1.3 Aims of the study and research objectives

The current PhD dissertation attempts to investigate the role of some key complementary factors in the creation of ICT business value. By developing complex models of ICT value generation, including both 'internal' and 'external' factors, it examines the interplay between them and also their combined effect on ICT business value, providing a deeper understanding of the mechanisms of ICT business value generation.

Having as basic foundation the Cobb-Douglas production function, which constitutes a sound foundation from the area of microeconomics that has been extensively used in the past for estimating the contribution of ICT investment to firm output (Brynjolfsson & Hitt 1996, Stolarick 1999, OECD 2003, etc.), this study attempts to shed light on the ICT business value generation process. This has been realized by examining the role of the external environment, business strategy, ICT and non-ICT investments, BPR and TQM (complementary factors), and also their interpley, on business performance. Additionally, as mentioned above, the role of national context has beeen empirically examined in respect to the above, since it is regerded as playing a significant role in the structure, operation and culture of the organizations, as well as in their performance (Hofstede, 1991). Finally, an extension at system-level has been made, so as to determine the basic determinants of IS value.

The main research questions of the present study are:

1. What is the role of the major complementary factor, business process change, in the relationship between ICT investment and business performance?
2. What is the impact of the external environment and business strategy on the firms' decisions on ICT (and non-ICT) investments, the extent of business transformation and business performance?
4. What is the effect of ICT capital and its main complements, such as human capital, new organizational practices (representing business process change), and also their

combined use, on labour productivity; Does national context play a significant role on the above?
5. Are there any potential ways of measuring and enhancing the business value of particular IS (system-level value), in order to be able to achieve firm-level (business performance) improvements?

1.4 Contribution

The present thesis makes the following contributions to ICT business value and IS investments evaluation research:

- First of all, it is based on a sound and established theoretical foundation from the area of microeconomics, the Cobb-Douglas production function, so it includes all the fundamental independent variables, such as ICT and non-ICT capital, and also labour, which affect business performance, which is measured through an objective and widely accepted measure, firm Value Added.
- Second, it develops multi-item scales for measuring BPR and TQM (representing the extent of process change), which have been created based on extensive review of the relevant literature and then tested in terms of validity and reliability using the methods proposed by the relevant statistical literature. These multi-item scales will be used for addressing the above research questions, which include as vital components BPR and TQM.
- Third, it fulfills the existing research gap regarding the role of business process change as a mediator in the relationship between ICT and business performance. This is accomplished by empirically investigating and comparing the mediation effects of the two main paradigms of business process change, BPR and TQM, on the relationship between ICT investment and business performance; moreover it empirically investigates and compares the mediation effects of BPR and TQM on the relationship between non-ICT investment ('regular capital', such as mechanical equipment, physical structures, etc.) and business performance, and proceeds to a comparison between ICT investment and non-ICT investment in this respect.
- Fourth, it provides an empirical investigation and comparison of the moderating role of the two basic process change paradigms, BPR and TQM, on the business value generated for firms by their ICT investments, which aims at contributing to filling the existing research gap on this issue. It also provides useful managerial hints regarding the most widely accepted and used, as well as the most influential BPR and TQM activities. Another important contribution of this work was the identification of the "most valuable" BPR and TQM activities by constructing regression models with each activity separately
- As a fifth contribution, it moves one level 'ustream', by empirically investigating the effect of business strategy on firms' investments (ICT and non-ICT), its abovementioned basic complements, BPR and TQM, and finally firm performance. By adapting Porter's framework of strategy typologies we have extracted useful conclusion regarding performance variations related to strategic choices on behalf of the firms' top management.
- Sixth, in the same direction this Dissertation conducts an empirical investigation of the impact of the external environment on firms' investments (ICT and non-

ICT), extent and nature of process transformation (examining both BPR and TQM), and business performance. Porter's five forces industry analysis model has been used for operationalizing the environment of organizations.

- Seventh, it realizes (for the first time in Greece) a comparative international empirical study of the effect of ICT capital, human capital, new organizational practices (representing business process change) and their combined use, on labour productivity, in Greece and Switzerland, based on firm-level data from both countries. Both the Greek and the Swiss part of this study are based on the same questionnaire and samples of similar composition (concerning firm sizes and sectors), and also use the same variables and models specification, being therefore comparable. Another contribution is that it is the first study of this type for Greece, whose economy is quite different from the economies of the highly developed countries, in which most of the empirical studies on these research questions have been conducted.
- Finally, it extends the above firm-level research for the level of an individual IS, developing and testing empirically an extension for investigating and evaluating of the productivity of particular IS and its main determinants by estimating 'Value Flow Models'.

Based on the contributions and results of this Dissertation, the following publications have been produced:

Journal papers

- Pazalos, K., Loukis, E., Georgiou, S. (2009). Evaluating e-courses based on value flow models estimation, International Journal of Applied Systemic Studies, xx(xxxx).
- Loukis, E., Pazalos, K. (2009). An Empirical Investigation of the Moderating Effects of BPR and TQM on ICT Business Value, Journal of Enterprise information management, 22(5).

Conference Papers

- **Konstantinos Pazalos**, Euripidis Loukis, "An extended Methodology for e-Learning Evaluation Based on the Accomplishment of Educational Objectives", EDEN 2006 Conference, Vienna
- Euripidis Loukis, **Konstantinos Pazalos**, Fotini Michailidou, " Electronic Collaboration Networks in the cultural heritage domain: the e-RMIONE project", EGOV 2006 Conference, Krakov.
- **Konstantinos Pazalos**, Vassilis Nikolopoulos, Euripidis Loukis, Athena Thanou, Martin Ulmann, "e-RMIONE-An e-Learning Resource Management Service for Constructing Interoperable Networks in the European Cultural Heritage Domain", EDEN 2006 Conference, Vienna
- Euripidis Loukis, **Konstantinos Pazalos**, " A Methodology for the Evaluation of an e-Learning Service in the Cultural Heritage Domain", ETPE 2006 Conference, Thessaloniki.
- Euripidis Loukis, Stelios Georgiou, **Konstantinos Pazalos,** "A Value Flow Model for the Evaluation of an e-Learning Service, ECIS 2007 Conference, 7-9 June, St. Gallen, Switzerland.

- Alexandra Zgouva, **Konstantinos Pazalos**, "Integrating e-Learning in Enterprise Information Systems: A Strategy for Effective Development and Evaluation", EDEN 2007 Conference, Naples, Italy.
- **Κωνσταντίνος Παζάλος**, Ευριπίδης Λουκής, Στέλιος Γεωργίου, "Ένα μοντέλο ροής αξίας για την αξιολόγηση ηλεκτρονικών υπηρεσιών", 3ο συνέδριο Ελληνικής Εταιρίας Συστημικών Μελετών, Πειραιάς, Μάϊος 2007.
- Loukis, E., Pazalos, K., and Georgiou, S. (2008) "The Moderating Role of BPR and TQM on ICT Business Value", European Mediterranean Conference of Information Systems, May 2008, Dubai, UAE.
- Loukis, E., **Pazalos, K**. (2008). "The Intervening Role of BPR in the ICT - Business Performance Relationship". In Proceedings of the 12th Pan-Hellenic Conference of Informatics, Samos, Greece.

1.5 Structure of the Dissertation

This introductory chapter is followed by chapter 2 describing the conceptual background of this Dissertation based on a review of the existing literature regarding business value, productivity, performance and evaluation. Furthermore the notions of external environment, business strategy, BPR and TQM are described in detail and a further analysis on the relationship between ICT investment and business performance is made.

In chapter 3 the research methodology and data collection process of this empirical study are described. The basic foundations of this Dissertation (such as the Cobb-Douglas production function) and the main tools that have been used for data analysis (such as Structural Equation Modelling (SEM)) are analyzed.

Chapter 4 examines empirically the mediating role of BPR and TQM, as main process change paradigms, after a critical review of the literature regarding this relationship, while chapter 5 empirically investigates the moderating role of BPR and TQM. The following chapter 6 goes one step upstream, dealing with the network of relationships between business strategy, BPR, TQM, ICT and non-ICT investment, and finally business value. In the next chapter 7 the role of the external environment in respect to the same critical factors, is empirically investigated. In chapter 8 an international comparison of the effects of the various forms of capital used by organizations in modern economy ('traditional' capital, computer capital, human capital, organizational capital (new organizational practices)) on labor productivity, in Swiss and Greek firms, in order to shed light on the role of national context concerning these effects.

Chapter 9 extends this firm-level research for the individual system-level. After a detailed review of the literature regarding system-level IS evaluation, it describes a new approach for evaluating IS value, through the estimation of value flow models, aiming at capturing the value-flow creation process, and identifying the main weaknesses of this IS, which need improvements. Furthermore, an application of this approach for the evaluation of an e-learning system is described. Finally, chapter 10 summarizes the conclusions drawn in this Dissertation.

CHAPTER 2

Conceptual Background

2.1 IS Evaluation

As mentioned earlier, firms nowadays are investing great proportions of their assets on IS, in order to better manage their resources and gain competitive advantage among their rivals. Consequently, they wish to know whether their investments are effective, in other words, whether the utilization of the new software or hardware equipment has caused positive changes that are depicted in the economic results. Therefore they need a mechanism, a process, which will be able to assess the outcome of their utilization. This process is called IS evaluation. Smithson and Hirscheim (1998) define IS evaluation as "the assessment or appraisal of the value, worth, or usefulness of an information system". Another definition has been offered by Smithson and Tsiavos (in Avgerou et al; 2004): "evaluation is an organizational process to establish by qualitative or quantitative means the worth of an IT system to the organization. In other words it is a management judgement of the value of a particular system in a particular organizational context" (p. 208). According to Smithson and Hirschheim (1998) evaluation is endemic to human existence and, hence, an automatic response to a changing situation. In the case of IS the need for evaluation becomes more and more urgent as dramatic organizational changes associated with IS take place. Evaluation provides the basic feedback function to managers, being essential for problem diagnosis, planning and reduction of uncertainty (Hawgood and Land, 1988). This issue becomes more important considering the low perceived success rates achieved in the development of new IS, which have been estimated to be as low as 30-40% (Willcocks and Lester, 1993).

Traditionally IS evaluation has focused on a cost-benefit analysis regarding the introduction of a new system in an organization. Over the years however, those studies were found to capture only a small proportion of IS value. The key evaluation points were the feasibility study (forecasting the likely impact of the new IS) and a post-implementation assessment of the actual impact. Therefore there has been a need to adopt a wider perspective of evaluating IS, since this process has yet been regarded as complex and multidimensional.

The first problem concerns the level of evaluation. Smithson and Hirscheim (1998) propose five different levels: macro, sector, firm, application and stakeholder, with different concepts, frames of reference and criteria applying at each level. The introduction of a new IS is normally expected to improve the productivity of its users. At a firm level, for example, the introduction of a new IS may impact in economic terms (e.g costs, output, turnover), organizational terms (e.g changes in organizational structure or procedures), social terms (e.g social interaction, quality of working life, organizational culture) and management terms (e.g decision making and access to information). It would be therefore problematic to isolate any of the above factors, which influence the process and cause costs or benefits.

Additionally, a new IS may have unplanned consequences or unexpected events may arise. The decision thus of 'what' to measure is extremely difficult since there are not only 'tangible elements', but also 'intangible' (Brown, 1994). This is the main reason why early is evaluation studies did not achieve to identify a positive relationship between IS investments and firm performance (productivity paradox).

IS evaluation entails other numerous difficulties as well. IS are social systems evolving over time making it so difficult to curry out an evaluation process. Smithson and Tsiavos (in Avgerou et al.; 2004) argue that "an evaluation is not the result of the efforts of a single group of stakeholders, but rather of the complex interplay of various actors, both human and non-human" and that "an evaluation is a series of episodes, a process that comes from the past, but looks forward to the future. It may sometimes seem rational, orderly, and stabilizing, but it is never static; Rather, it is a dynamic process that is always changing."

On the other hand, learning difficulties of users may cause a lag in delivering benefits (Brynjolfsson, 1993). There could be also mentioned other problems like lack of understanding of the human and organizational costs involved, the danger of over and understating costs, neglect of intangible benefits and risks, the use of inappropriate measures, and the problems with traditional finance-based evaluation techniques (Willcocks and Lester, 1993). Moreover, Canevet and Smithson (1994) mention that organizations face difficulties in getting users to participate, choosing appropriate measures, measurement inaccuracy and the acceptability level of results. Powell (1992) mention the following reasons explaining the lack of formal IS evaluation studies: ambiguity concerning organizational goals, the belief that IT is 'strategic' and thus not amenable to formal evaluation, situations where there is no alternative or where cost is unimportant, a climate of cynicism and perceived failure due to past IS disasters, and difficulties in obtaining senior management support for IT projects.

Over the last years there have been considerable changes in the business, organizational and technological contexts within which IS evaluation is carried out. These have mostly increased the need for evaluation as well as the complexity of the process. The variety of IS which have been developed for serving different purposes demands for the existence of different IS evaluation methodologies and tools. Farbey et al. (1995) supported that there are lots of IS categories, each one having different aims, producing different kinds of benefits and value, leading to the need of developing different evaluation methods for each. They group IS into eight categories, according to the approach needed for evaluating them, suggesting a distinct evaluation method for each. These categories, arranged as benefits 'ladder' (Figure 2.1), range from mandatory changes, on the first rung, to business transformation on the top rung.

Each rung represents a different kind of IS, according to the extent and magnitude of change it causes to the organization. Going up the ladder the potential benefits as well as the uncertainty concerning the results, risks and communication difficulties increase gradually. More particularly the eight categories of IS are: mandatory IS, automation IS, direct value-added IS, management IS (MIS)-decision support systems (DSS), infrastructure IS, interorganizational IS, strategic IS and business transformation IS.

Another important aspect before one proceeds with IS evaluation, is the understanding of the purpose of the evaluation, or 'why it is being carried out?'. This 'why', according to Smithson and Tsiavos (2004), has considerable implications for the design, and the expected, or permitted, outcomes of the evaluation. Consequently, the various reasons for performing an evaluation lead to numerous roles (abstract level of analysis-political, consensus achievement, organizational exploration and organizational learning) and modes (at a lower level of analysis-feasibility study, impact analysis, performance

measurement, problem diagnosis, risk assessment, and portfolio optimization) of evaluation.

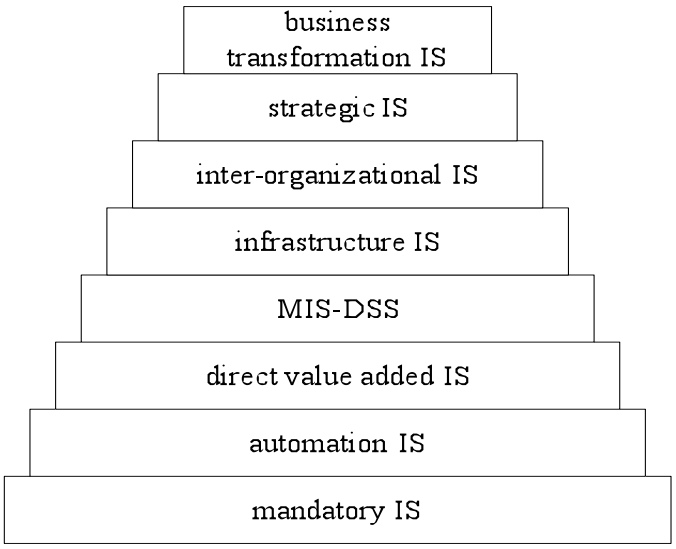


Figure 2.1: The ladder of Farbey et al. (1995)

The choice of a particular role and mode will lead to decision making regarding the aspects of the system that will be evaluated, as well as the evaluation methodology and metrics that will be used (e.g. cost-benefit analysis, user satisfaction survey, technical benchmarks). Finally one should also take into consideration and analyze the context within which the organization (beholder of the IS) operates. Pettigrew (1985) distinguishes outer from inner context. Outer context is the social, economic, political and competitive environment. Inner context refers to the structure, corporate culture, and political context within the organization, through which ideas for change have to proceed.

2.2 Business performance

Performance is an imprecise concept, open to a variability of definitions. According to the Oxford English Dictionary, it can be defined as "the accomplishment or carrying out of something commanded or undertaken: the doing of an action or operation" and "the quality of execution of such an action, operation, or process; the competence or effectiveness of a person or thing in performing an action; especially the capabilities, productivity, or success of a machine, product, or person when measures against a standard". According to Folan et al (2007) the idea of performance itself is probably one of the least understood, or certainly the one where the greatest leap of intuition is used, as the initial starting point of the researcher. Lebas (1995) states that it is a frustrating term to define, with few people agreeing on what it really means.

Firms face many difficulties to measure their performance at the firm level since it is difficult to identify all costs during the production process, especially those costs stemming from IT investments (Brynjolfsson and Hitt, 2000). However, the elusive competitive environment, which demands non-stop performance improvement, as well as the continuously falling costs of the appropriate technology for measuring performance

have brought performance evaluation among the top managerial priorities (Lynch and Cross, 1991, Johnson, 1995).

In the last decade interest in measures of performance (or effectiveness) has grown enormously. The era of the "productivity paradox" gave birth to a continuous debate regarding the various ways business performance should be measured. The inability of the traditional economic performance measures to provide evidence for a statistically significant and positive relationship between ICT investments and performance (the case of the 'Productivity Paradox), made researchers wondering about whether they were using the right metrics. However, the need for realizing complementarity investments (as discussed in section 1) complicates the situation and requires additional metrics for measuring business performance. Hogue (2004) notes that the emergence and extensive use of "benchmarking", "BPR" and "TQM" necessitated the performance measurement in all dimensions, financial as well as non-financial.

The notion of performance has not been treated in the same way by all researchers. According to Folan et al. (2007) "the idea of performance itself is probably one of the least understood, or certainly the one where the greatest leap of intuition is used, as the initial starting-point for the researcher". The problem is that not all people understand performance in the same way. Lebas (1995) notes that performance is a frustrating term to define, with few people agreeing on what performance really means. According to the Oxford English Dictionary it takes three basic definitions: a) the accomplishment or carrying out of something commanded or undertaken: the doing of an action or operation, b) the quality of execution of such an action, operation, or process, c) the extent to which an investment is profitable, especially in relation to other commodities (from business). Dedrick et al (2003) support that economic performance can be interpreted in many ways, according to the desired level of analysis: country level (the measure used is economic growth=GDP or the rate of change in real output) and firm level (known measures are labor productivity and profitability).

The choice regarding performance measures is crucial since it may influence the final results of our research. According to Badri et al (2000) the appropriateness of the performance measure to use may depend on the circumstances unique to the study. In all circumstances the choice of performance measures in performance evaluation is essential to enhanced organizational performance (Hogue, 2004).

There are various existing studies measuring business performance using financial measures. Koka and Prescott (2008) measured business performance as a dependent variable by sales/employee in constant US dollars. The reasons for choosing this productivity measure were the following: 1) it is consistent with the way productivity is measured at the macroeconomic level (output/man hour), 2) provides a measure of the efficiency of the firm's operation, 3) differences in accounting practices prevented them from utilizing accounting measures of performance given that their data were collected from over 40 countries. Mahmood and Mann (2000) measured the impact of IT investment on firm performance by selecting six direct measures: ROI, ROS, growth in revenue, sales by total assets, sales by employee, and market to book value. After an exhaustive review of the literature they identified the following five IT investment measures: IT budget as a percentage of revenue, value of an organization's IT budget spent on staff, percentage of IT budget spent on the training of IT staff, and number of

PC's and terminals as a percentage of total employees. They found that IT investment measures were weakly associated with individual organizational, strategic and economic performance variables.

Davis et al (2002) used also financial metrics, assessing performance in terms of profitability, using two measures of profitability, Return on Assets (ROA) and Return on Sales (ROS). In particular they asked managers (through a five-point Likertscale) to compare their business unit's ROS and ROA over he last year with similar firms in their industry. They argued that the advantage of their approach was that respondents' ratings reflected intra-industry performance outcomes common across the sample firms. Similarly, Byrd et al (2006) followed another approach trying to estimate business performance. They created a performance construct including: pretax profits for the past year per employee and revenue for the past year per employee.

In the last years an increasing number of studies including non-financial measures of performance has been emerged. Hogue (2004) used a combination of financial and non-financial measures, a well-tested and robust instrument initially developed by Govindarajan (1984). The questionnaire asked respondents to asses their organization's performance over the past three years, across 12 dimensions: operating profits, ROI, sales growth rate, market share, cash flow from operation, new product development, market development, R&D, cost reduction programs, personnel development, workplace relations, and employee health and safety. Similarly, Hyvonnen (2007) used a combination of contemporary and financial performance measures as indicated by Innes and Mitchel (1995). Contemporary measures included non-financial measures, qualitative measures, balanced scorecard and customer satisfaction surveys. Financial measures included budget variance analysis, controllable profit, divisional profit and ROI. The results however of her study indicate that managers find it difficult to use contemporary performance measures in complex business environments.

Finally, Tallon (2007) tried to measure IT business value by first viewing IT impacts at the process level of the organization, following the argument that the first-order impacts of IT spending occur at the process level (Barua et al., 1995; Melville et al., 2004). Thus he used the five primary processes of the value chain (supplier relations, production and operations, produce and service enhancement, marketing and sales support, and customer relations) with 5 items (questions) per process. Financial performance was measured with margin and asset turnover, return on equity (ROE), and sales markup.

The authors of the abovementioned studies supported that the focus on traditional performance metrics distracted the attention from also important non-financial factors, such as market share, customer satisfaction, efficiency and productivity, product quality and employee satisfaction, which could also be considered as a dimension of performance. A second argument was that non-financial metrics might help managers to recognize changes in the business environment, determine and assess progress towards business objectives, and affirm achievement of performance goals (Kaplan and Norton, 1996).

Despite the fact that non-financial (or contemporary) measures are being more and widely adopted, however their contribution to performance improvement is questionable. According to Hyvonen (2007) "while there has been extensive interest in the role of

contemporary measures to assist in developing differentiation strategies including customer-focused strategies, survey evidence suggests that financial measures remain important to managers". Objective performance measures are preferred to perceived measures of performance. The latter can be used and are recommended as a substitute when objective measures are unavailable (Badri et al; 2000).

Dedrick et al (2003) developed a conceptual framework (figure 2.2) of economic performance that offers a general view by enabling the definition of the key variables and relationships mentioned in the various research studies concerning this issue. The framework identifies the various inputs (labor, capital, etc) to the production process, as well as the complementary factors that affect substantially the outputs (value-added, GDP) and, consequently, the outcomes (economic growth, profitability, labor productivity, consumer welfare) from the specific inputs. The framework makes a clear distinction between the levels of analysis (firm, industry and country level).

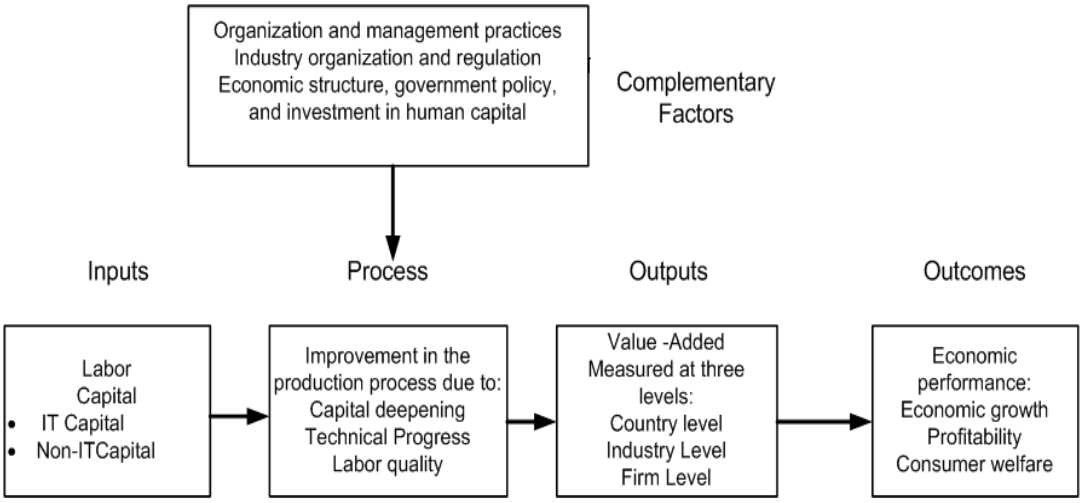


Figure 2.2: The conceptual framework of economic performance (Source: Dedrick et al; 2003)

2.3 Business Value of ICT Investments

Today the great importance of ICT on firms' survival and growth is widely recognized. However there is still an ongoing debate about whether ICT can cause differential business value to an organization over its competitors. The problem of measuring the benefits of employing ICT emerges again. Business performance is an indicator of the outcomes, but has a serious disadvantage: It neglects the process of value creation. As mentioned in the introduction, relevant research is at its 4th period regarding the investigation of the relationship between ICT investments and performance (Loukis et al 2006, Melville et al 2007), trying to identify the role of external factors (generalized competition, industry concentration, industry dynamism), their linkage to business strategy and to complementary factors within the organization. In other words emphasis is placed not only in the performance of the firms, but also in the various ways of reaching it. The need for a holistic approach of business value creation from ICT investment is necessary more than ever.

Various theories have tried to explain the value creation process. Among the most famous economic theories is the production theory (Morrison and Berndt, 1991). It posits that firms employ a method for transforming various inputs into outputs, which is generally represented by a production function. Organizational inputs include labour, materials and capital. Organizational outputs include the products and services delivered by the organization. IT, which captures, transmits, stores and disseminates information, can support work systems by influencing the combination of inputs that can be used to generate a certain level of output (Radhakrishnan et al., 2008).

In the current dynamic and competitive environments firms have to realize the changes and keep up. However managers complain that strategic planning is too static and too slow (Collis and Montgomery, 2008), compared to the changes required. The traditional economic approaches, combined with the notions of quality management and process reengineering have dominated management thinking since late 80's. However those approaches cannot grasp the intangible dimension of current complex organizations. As a result, a new organizational approach appeared, named resource-based view (RBV-Barnley, 1991). RBV offers very rational explanations on how a company's resources drive its performance in a competitive environment. Resources could be defined as the wide variety of tangible and intangible factors from reputation to interorganizational relationships in place (Galbreath and Galvin, 2008). The main idea is that the key point for gaining competitive advantage is the best possible exploitation of the available resources. In terms of strategy a resource is valuable if it is hard to copy, it depreciates slowly, is controlled by the company (and not by customers, suppliers or other stakeholders), cannot be easily substituted and it is better than competitors' similar resources (Collis and Montgomery, 2008). The RBV combines the internal analysis of phenomena within companies (a preoccupation of many management gurus since the mid-1980s) with the external analysis of the industry and the competitive environment (the central focus of early strategy approaches) in order to explain in clear managerial terms why some competitors are more profitable than others, how to put the idea of core competence into practice and how to develop diversification strategies that make sense (Collis and Montgomery, 2002). Its main characteristic is that it does not see firms' high returns as the result of a favourable industry structure, but rather as a result of their access to unique, or otherwise costly-to-copy resources (Stoelhorst and Raaij, 2002).

One of the greatest debates of management-related literature concerns the extent of the impact of industry structure and firm factors on business performance. The most crucial point of the debate regards the importance of external factors (industry structure) compared to internal factors (resources) and the extent of their impact on business performance. The reason for this debate was the existence performance variation even between firms operating in the same sector and/or of similar size. Interest in industry structure as a variable for explaining performance variation has been expressed since the middle of the last century (Bain, 1954) as a research topic of industrial organization (I/O). However, a complete and widely accepted framework had not been developed until 1980 when Porter managed to offer a tool for explaining how exogenous factors impact firms in a given industry. Stoelhorst and Van Raaij (2004) note that Porter's framework has concentrated the focus of much attention in the extant literature, particularly with respect to analyzing performance differentials.

On the other hand a firm utilizes its resources and capabilities according to the strategy it has chosen to follow. According to Collis and Montgomery (2008) superior performance will be based on developing a competitively distinct set of resources and deploying them in a well-conceived strategy. Since Miles and Snow (1978) and Porter (1980) introduced their generic strategy typologies, many researchers have sought to determine the 'best strategy' among other proposals. The drawback of all those studies is that they appear to be oversimplified in their consideration of only one primary variable-strategy-in the determination of business performance. Instead, the existing literature suggests that the strategy-performance relationship is moderated by a variety of industry and environmental variables. In other words, superior business performance appears to be linked not only to generic strategy, but also to other organizational and environmental factors, which influence the success or failure of a given strategy (Barney, 1991).

Melville et al. (2004) tried to describe the IT business value creation process. By reviewing the existing literature on the role of IT investment on business performance they reached to the following conclusions: a) IT impacts organizational performance via intermediate business processes, b) other organizational resources, such as workplace practices interact with IT, whether as mediator or moderator, in the attainment of organizational performance impacts, c) the external environment in IT business value generation and d) it is important to disaggregate the IT construct into meaningful subcomponents. Based on those conclusions they posited that the locus of IT business value generation is the organization that invests in and deploys IT resources, which we call the focal firm. But external factors also play a role in shaping the extent to which IT business value can be generated and captured. More particularly, the competitive environments as well as the macro environment are salient to IT business value generation. Figure 2.3 shows the model, which describes the business value generation process, according to Melville et al (2004).

Tallon and Kraemer (2007) tried to bridge the gap between qualitative and quantitative measures of ICT business value by combining perceptual and objective metrics in a way that is mindful of the strengths and limitations of each. They developed a model that related what executives notice about process-level IT impacts with sense making-based perceptions of IT impacts at the firm level, and firm performance as the ultimate arbiter of perceptual accuracy (figure 2.4). Their work managed to highlight a variety of IT impacts at the process level, thereby reducing the risk of mismeasurement of IT impacts, which is a common issue when measuring it using only financial measures.

As a conclusion on the above we could say that investing in ICT is a necessary but not the only condition in order to enhance business performance and gain competitive advantage. Technology itself is not a unique, costly to copy resource. Rather its combination with the appropriate process change, the choice of strategy type and the impact of the external environment, will influence the final outcome. Therefore, a holistic approach should be undertaken so as to comprehend the complete value creation mechanism.

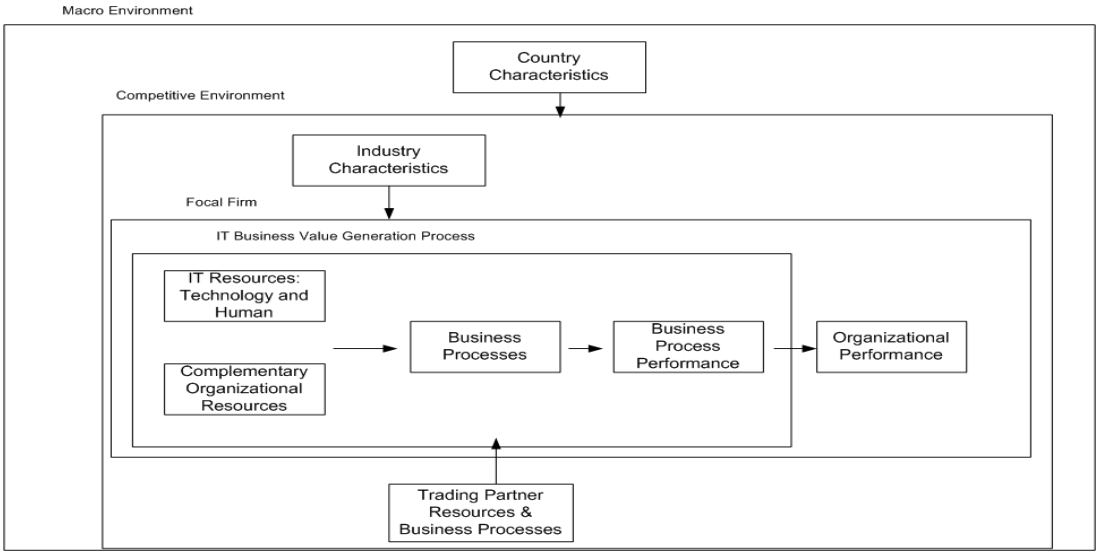


Figure 2.3: The business value generation process (adopted from Melville et al, 2004)

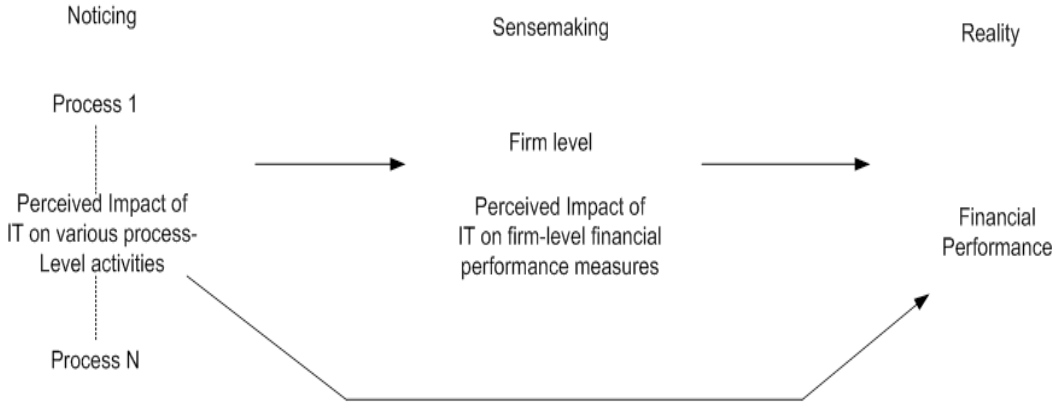


Figure 2.4: Financial and non-financial IT impacts (Source: Tallon and Kraemer, 2007)

In the coming sections follows a detailed presentation of the main factors complementing ICT in rder to produce value. In particular, it includes the main business change approaches (Business Process Reengineering and Total Quality Management), as complementarity investments, as well as a literature review on external factors that contribute to business value creation (according to figure 2.3), business strategy and external environment.

2.4 Organizational Change as complementary factor

As mentioned in the introduction, firms invest in ICT in order to enhance their performance. Additionally to those investments there are other investments that have to be made as well, known as 'complementary investments'. The most important complementary investment is business process change, which is expressed in this study through BPR and TQM.

2.4.1 Business Process Reengineering (BPR)

Apart from the main BPR definitions mentioned in the introduction, the relevant literature has proposed numerous definitions of BPR the most known of which are:

- "a set of logically related tasks performed to achieve a defined business outcome" (Davenport and Short, 1990).
- "any sequence of pre-defined activities executed to achieve a pre-specified type or range of outcomes" (Talwar, 1993).

All of the abovementioned definitions seem to have a shared understanding of several key elements, which, according to Kallio et al (1999), are: radical change, dramatic performance improvements, high potential business benefits, process-based organizations, customer orientation, IT as an enabler, rapid pace of change, and high risks.

According to Kallio et al (1999) more than 70% of large American and European companies have adopted BPR as a means to improve their operations. Similarly, 88% of large corporations in the U.S.A were already using BPR or were about to start a BPR project. Today BPR is at its second decade, however its importance as a change paradigm is still undoubtful. Within a dynamic business context, where organizations develop interorganizational relationships, alliances and other kinds of cross company coordination, facilitating processes across the boundaries of those organizations, is a matter of reengineering (Attaran, 2003). The increasing emphasis which is placed on e-commerce, and the development of new kinds of IS (CRM, WMS, etc) require organizational databases. Such system integration requires substantial reengineering (Kalakota and Robinson, 1999). Furthermore in this decade businesses are starting to add customers, suppliers and other stakeholders, using appropriate technologies, to their interorganizational process redesign projects, which has been characterized by Champy (2002) as "X-engineering".

Despite all those positive things that have been written about BPR, according to many studies, it has failed to meet the expectations that had been initially placed on it. Existing literature contains numerous BPR failures: Holland and Kumar (1995) showed that 60-80% of reengineering programs end unsuccessfully. Moad (1993) reported that most of the reengineering projects consistently fell short of expectations. Moreover, a critical examination of BPR by Biazzo (1998) reached to the conclusion that the 'process' concept can be understood in terms of sociotechnical systems, and thus, 'reengineering' should be forgotten. A prospect of change is only possible under the shield of a long-term change strategy.

There are many factors preventing the effective implementation of BPR, such as loss of nerve, focus and stamina, lack of a holistic focus and settling for minor improvement gains; human and organizational issues, organizational culture, attitudes and skills based; and resource restrictions and fear of information technology (Irani et al.; 2000). Holland and Kumar (1995) note that 60-80% of reengineering programs have been unsuccessful. Grover et al. (1995), from an extensive review of the literature regarding BPR came up with the following categories of problems regarding BPR implementation: management support problems, technological competence problems, process delineation problems,

project planning problems, change management problems and project management problems.
However the high potential benefits have tempted companies to adopt reengineering, despite the high risk of failures (Kallio et al; 1999). Consequently, there are numerous BPR case studies that prove its influence on the firm's operational capabilities. In Ford Motor Corporation reengineering efforts achieved a 75% reduction in the workforce. In CIGNA reengineering brought about a focus using IT to meet business strategies. Management style changed from control-based and functional, to leadership based and team-oriented. The hierarchy was flattened, increasing flexibility (Bower, et al. 1994). Finally, internet technology used by FEDEX for document automation resulted in a 20-70% reduce of purchase cycle times. Grover et al. (2001) mention that a BPR project should emphasize in the following goals: cost reduction, cycle-time reduction, increase in customer satisfaction levels, increase in worker productivity, defects reduction.

Many studies have tried to identify the conditions under which a BPR project could be successful. Grover et al (1995) claim that the broad organizational focus and deliberate nature of BPR requires preparation and deliberate action, support from management, technical competence, and mitigation of resistance to the change are critical success factors of a reengineering project. Flynn (1994) concluded in motivation, leadership, organization-wide ownership, common vision, focus, as well as defined roles and responsibilities, tangible products, technology support, expert guidance and risk taking.

An extensive synthesis of the reviewed literature by Terziovski, et al (2003) regarding BPR predictors, came up with six themes: strategy, management commitment, information technology, customer focus, continuous improvement, and performance outcomes. Similarly, Kallio et al (1999) identified the following BPR drivers: internal inefficiency within a company's current operations, changed customer/supplier requirements for current products or services, and external changes, uncontrollable and unpredictable to the industry. The main conclusion regarding the literature review conducted is that BPR entails a lot of benefits but constitutes a highly risky approach. It should not be considered as a standalone solution, but should be viewed as a part of a more holistic approach, as the answer to the pressures of the external environment (customers, suppliers, competitors, etc) and as the outcome of a long-term strategic planning from the organizations.

2.4.2 Total Quality management (TQM)

TQM is a management philosophy, which highlights the need to improve the quality of goods and services in order to better utilize the resources of organizations (Collin, 1996). It is also defined as the strategic commitment to improving quality by combining statistical quality control method with a cultural commitment to seeking incremental improvements that increase productivity and lower costs (Stoner and Freeman, 1992). During the last years, the TQM concept is a proven systematic approach to the improvements of the organization's overall business process, including product and services (Lau and Iris, 2001). TQM addresses overall organizational performance and recognizes the importance of processes along with customer–supplier interfaces, both internally and externally. Therefore it is considered as an important process change paradigm, as well.

As with BPR, TQM implementation is not always easy. It can also be a success or failure depending on how well it is planned, implemented, measured and encouraged. Problems related to TQM implementation are lack of management commitment and understanding on the concept of 'quality', lack of awareness on the benefits of TQM, improper understanding of the measurement techniques used by TQM, lack of a clear implementation plan, lack of awareness regarding the positive results of continuous improvements, and ignoring the importance of customers. If organizations overcome those difficulties and implement successfully a TQM project, they will enjoy numerous benefits, such as reduced operating costs, improved employee involvement and company morale, as well as establishment of a 'continuous improvement' attitude. However, existing studies suggest that TQM programs have not been effective (Hendricks and Singhal, 1997). Other studies mention some minor, discontinuous process improvements on a small scale to several strategic business units within a company, such as Ford's accounts payable with respect to Mazda (Hammer, 1990), Zerox inefficient office systems with respect to Canon (Davenport and Short, 1990), or IBM's Credit's inefficient approval process (Hammer and Champy, 1993). All those cases, despite the fact that they keep breast of technological improvements, competitive pressures and customer requirements, they fail to take into account step changes in technology, or to drive changes across divisional boundaries, being thus incapable of making significant bottom line improvements (O'Neill and Sohal, 1999).

Existing literature o TQM contains numerous studies about critical success factors of TQM. According to Laszlo (1997), effective TQM programs are based on the involvement of the employees in the organization, customers and suppliers and the management leadership to align daily priorities and activities through out the organization. Oakland (1993) mentions 10 basic steps for successful TQM implementation:

1. Gain commitment of the top management
2. Develop a 'mission' or 'vision' about change, generate awareness, educate project stuff.
3. Define the measurable objectives, which must be agreed by the team.
4. Document the project but do not fall into the trap of bureaucracy.
5. Develop the mission into its critical success factors.
6. Breakdown critical success factors into key activities.
7. Prepare project quality plans for all levels of work.
8. Monitor and adjust the process alignment in response to difficulties in the change process.
9. Promote stuff participation and contribution by quality control circles and initiate motivation program.
10. Review quality plans and measure performance.

Seetharaman et al (2006) have identified six critical issues in total quality management namely: (a) the importance of management commitment and management understanding of quality. (b) understanding of TQM guidelines, methods and implementation plan. (c) the benefits of TQM implementation. (d) understanding of TQM philosophy and its measurement techniques. (e) understanding that customers are key to the organizational success. (f) understanding the importance of continuous improvement and incorporating it into the system. Furthermore, the success of TQM depends on many type of variables, it

can be controllable or uncontrollable, whereby majority of it have a direct relationship to the company's culture, customers, capability, and infrastructure. Therefore, each company should tailor its own approach to develop its distinctive strengths and focus on the specific weaknesses.

As a conclusion regarding TQM literature review, we could say that, since the objective of TQM is the quality improvement of goods and services, a TQM project should be planned according to the standards of the industry the organization belongs, to the pursuits of its customers and suppliers and finally according to a long-term strategy for continuous improvement. Therefore, TQM is not a standalone process, however it should be linked and adjusted according to the particular characteristics of each organization, its external environment, strategic directions, technological infrastructure and capabilities, in order to cause effective change and produce value.

2.4.3 Similarities and differences between BPR and TQM

Between these two types of process change there are considerable differences (Yeo 1996, Al Mashari and Zairi 2000, Fazel 2003): i) BPR is radical, revolutionary and follows an one-time approach, while on the contrary TQM is incremental, evolutionary and continuous, ii) BPR has a wider scope and focuses on processes that cross multiple functions, while TQM focuses on more narrow intra-departmental processes, and iii) BPR has a wider range of targets than TQM, which are associated not only to quality improvements, as well as to cost and cycle-time reductions.

According to Altinkemer et al. (1998), practitioners see only two major differences between BPR and TQM: length of the project and amount of change attempted. On the contrary, academicians recognize ten: role of top management in identifying changes, role of management in project management, pace of results during implementation, employee participation, impact of the change program on employee morale, need for empowerment and the importance of being able to see when a certain process or division needs to be changes as significant differences between TQM and BPR. Al Mashari et al. (2001) see TQM as a part of BPR implementation:'Change management, TQM and benchmarking are important tools for organizations aiming to establish the BPR practice. Change management facilitates the insertion of the newly designed business processes in the working environment. TQM ensures that reengineering efforts take place when and where they are needed, securing longer life for the improvements attained. Benchmarking helps shape the strategic direction of the efforts.

2.5 Business Strategy

Organizations follow different directions in order to achieve their objectives. Decisions are made according to the particular strategy they have selected. Langefeld and Smith (1997) define strategy as "a pattern of decisions about the organizations' future, which take on meaning when it is implemented through the organizations' structure and processes". According to Tallon (2007) business strategy is defined as "the determination of the basic long-term goals of an enterprise and the adoption of courses of action and allocation of resources necessary for carrying out these goals". Business strategy sets the

path on which an organization will walk in order to reach to the intended outcomes. The nature of business strategy is also a factor in firm's ability to realize value from IT investment (Tallon, 2007). For other researchers strategy can also represent "objectives" (Reich and Benbasat, 1996), plan or "planning" (Teo and King; 1997) consisting of: a) IT/IS strategy b) business strategy. According to Chan et al (1997) "companies that appear to perform best are companies in which there is alignment between realized business strategy and realized IS strategy. Relevant literature has empirically investigated the ways strategy affects business performance. It is evident that the choice of a strategy will affect particular processes within the organization, which will in turn activate specific mechanisms in the value chain, being reflected in different performance measures each time (financial or non-financial).

Strategy selection is closely related to what is happening 'outside' the organization. Top management 'receives' the messages from the environment and adjusts the organization's strategy according to its particular needs by choosing the appropriate strategy type. Desarbo et al (2005) note that strategy selection is conditional on how closely a business is aligned with its environment.

Strategy research has identified various different typologies and categories, based on different criteria. Porter (1980, 1985) described three generic strategies: cost leadership, differentiation, and focus. In order to gain a low-cost position relative to competitors a firm should emphasize in aggressive construction of efficient-scale facilities, vigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customers accounts, and cost minimization in areas like RnD, service, sales force, advertising and so on. A differentiation strategy focuses on creating and providing products or services that customers perceive as unique and valuable as compared to those of its competitors. A focus strategy concentrates on a narrow segment and within that segment attempts to achieve either a cost advantage or differentiation. The premise is that the needs of the group can be better serviced by focusing entirely on it. A firm using a focus strategy often enjoys a high degree of customer loyalty, and this entrenched loyalty discourages other firms from competing directly (Porter, 1980).

Miles and Snow (1978) recognized three successful organizational types: defenders, prospectors and analyzers. Prospectors constantly seek out new technological and product-market opportunities to exploit for first-mover advantages. This requires significant capacities to learn and distribute information rapidly in order to be attentive to customers. Analyzers follow a second-but better strategy. They tend to closely monitor competitors' activities in making strategic decisions. Defenders seek to maintain a secure niche in a stable product-market, focusing on a few products and on cost control (Hughes and Morgan, 2007). The abovementioned strategy categories are the most widely known and broadly used in the literature, without excluding other approaches.

Furthermore, the classification of build, hold, harvest and divest belongs to Gupta and Govindarajan(1984). It focuses on the differences on strategic missions, which implies the firms' trade off between market share growth and the maximizing short-term earnings. Companies that follow a build strategy aim at improving market share and competitive position even if this means short term profit and cash flow decreases. This can only be achieved under a situation of a clear competitive advantage. A harvest strategy is followed when a firm desires short-term profit and cash flow maximization

rather than pursuing market share increase. A hold strategy is use by firms to protect heir market share and competitive position, pursuing a reasonable return on investment. Finally when a business plans to cease operations, it follows a divest strategy.

Miller and Friesen (1982) categorized firms as conservative or enterpeneual. Desarbo et al (2005), by comparing the results of their research they came up with 4 strategic groups: 1) Asian-based prospecting firms with technology strengths, 2) Defensive firms with marketing skills, 3) US-based firms with market linking and management strengths, and 4) Balanced-prospecting firms. Finally, Wirtz et al (2007) have identified the following strategy dimensions: product differentiation (the degree to which a firm differentiates itself in a competitive market), image differentiation (the degree to which a company differentiates itself), proactiveness (the extent of continuous search for productive opportunities and innovative kinds of business activity), replication (the extent of efficient redeployment of knowledge and competencies), reconfiguration (the ability to react on the need to reconfigure the firm's asset), and cooperation (the extent to which maintains cooperative arrangements). His results showed that proactiveness, product differentiation, and reconfiguration have the highest performance impact, and should therefore be at the centre of top management's attention.

For many years there has been a debate concerning the ability of the various strategy dimensions (types) to be combined with one another if judged by top management as necessary in order to produce a better outcome. While the traditional literature suggests that specific strategies may not be compatible, recent evidence shows that strategies should be thought of us 'conjunctive' (Wirtz et al, 2007). In other words the existence of a particular strategy type within an organization does not exclude another type on the condition that the combination of those two will be regarded as beneficial for the organization. Tallon (2007) in an attempt to identify the paths of business value creation, as a result of ICT investments, mentions that "while firms with multi-focused business strategies may be vulnerable to lower firm performance, IT business value at process and firm-level can, paradoxically, be higher than in firms with a single-focused strategy". According to Tallon (2007) "firms with a narrow strategic focus realize less value from IT than those that espouse a broad or multi-focused strategy. The level and the locus of IT business value are sensitive to the type of strategic foci underlying a business strategy".

2.6 External Environment

As business environment could be regarded anything that affects but does not belong to an organization, in other words its surroundings. The environment has an impact on the strategy, decisions, processes and performance of the firms. It could be distinguished into two categories: the micro environment, consisting of different types of stakeholders - customers, employees, suppliers, board of directors and creditors, and the macro environment, which includes factors which are beyond the control of the business, social, tehnological, economical and political (Pantazi and Georgopoulos, 2006). Changes in the micro environment will directly affect and impinge on the firm's activities. Changes in the macro environment will indirectly affect the business but will nonetheless affect it. External environment describes the factors that affect the organization but do not belong to it.

Dess and Beard (1984) distinguished the following three factors characterizing external environment: munificence, complexity, and dynamism. Munificence relates to the scarceness of environmental resources that support firm's growth within a given industry. Environmental complexity reflects the heterogeneity and concentration of environmental elements. Environmental dynamism refers to the rate of change and degree of instability of the environment. Rapid change, short product lifecycles and processes of creative destruction are typical characteristics of dynamic environments. Organizational theory has established several dimensions of environmental characteristics: uncertainty, directness, change, dynamism, homogeneity, complexity and munificence (Aldrich, 1979).

The main characteristic of the environment is the existence of other firms, which compete each other to gain competitive advantage. Competitive environment can be characterized by various dimensions, including market turbulence, demand uncertainty, buyer power, market growth, competitive hostility, competitive intensity, technology turbulence, and supplier power (Porter, 1985). Miller (1987) uses the term environmental competitiveness to reflect the number of competitors, and of areas in which there is competition. Jaworski and Kohli (1993) use the term competitive intensity, which reflects the behaviour, resources and ability of competitors to differentiate their products or services.

The most influential work however, is the one of Porter (1980), who introduced the five forces model. According to this model the forces evoking industry competition, and thus affect firm performance, are: threat of entry, the power of buyers, the power of suppliers, threat of substitute products, and rivalry among existing competitors (Porter calls them incumbents).

Threat of entry: new firms entering an industry bring new capacity and a desire to gain market share that puts pressure on prices, costs, and the rate of investment necessary to compete. The threat of entry in an industry depends on the height of entry barriers as well as on the reaction entrants can expect from already competing firms. There are seven major sources of entry barriers: supply-side economies of scale, demand-side benefits of scale, capital requirements, incumbency advantages independent of size, unequal access to distribution channels, and restrictive government policy.

The power of suppliers: powerful suppliers charge higher prices, limit the quality of goods or services, or transfer costs to industry participants, capturing thus the greatest proportion of value for themselves. They can squeeze profitability out of an industry that is unable to pass on cost increases in its own prices. A supplier is powerful under the following conditions: is more concentrated than the industry it belongs to, serves various industries and does not rely heavily on a particular one, makes it difficult for its customers to change supplier, and offers highly differentiated products difficult to be substituted.

The power of buyers: they are able to force down prices, demand better product and service quality, raise ethical or environmental concerns, and generally influence negatively industry profitability. Customers have great influence and negotiating power if: there are few or each one purchase in volumes relatively large to the size of a single vendor, the industry's products are standardized or undifferentiated, and have low switching costs when changing suppliers.

The threat of substitutes: a substitute product or service has the same or similar function as an industry's product or service. When the threat of substitutes is high, industry profitability suffers, since it limits an industry's profit potential by placing a ceiling on prices. If a firm does not escape from substitutes through product quality, marketing, branding, etc, its profitability will be threatened. The threat of substitutes is high when they offer an interesting value-for-money suggestion, the buyers' switching costs are low, or their brandname is strong.

Rivalry among existing competitors: high rivalry limits of an industry. It can be expressed through price discounting, product introduction, advertising campaigns, and service improvements. The degree to which rivalry drives down a firm's profit potential depends on the intensity of competition and on the basis on which firms compete. Rivalry among competitors increases when competitors are numerous or are roughly equal in size and power, industry growth is slow, there are high exit barriers, rivals are highly committed to the business and have aspirations for leadership, and there is a lack of communication and familiarity among rivals.

The extended rivalry that results from all five forces defines an industry's structure and shapes the nature of competitive interaction within an industry. And this industry structure is what drives competition and profitability, no matter if the industry produces a product or service, is emerging or mature, high tech or low tech, regulated or unregulated (Porter, 2008). Each of these forces determine prices, costs and investment requirements that drive long-term profitability and hence, industry attractiveness. Essentially, the five forces of industry structure effects overall industry performance, and therefore the performance of firms within the industry. Thus the competitive forces of an industry are key to explaining performance variation. Understanding them and their underlying causes, the roots of an industry's current profitability will be revealed (Porter, 2008).

CHAPTER 3

Methodology and Data

3.1 Introduction

The main objective of this PhD dissertation (covering chapters 4-8) is to investigate the effects of external environment, business strategy, ICT and non-ICT investment on business performance, as well as to examine the roles of BPR and TQM on the abovementioned relationships. In other words it aims at investigating the business value creation process in organizations. At the same time it attempts to capture the role of external factors (to the inner part of an organization) such as its top management strategy and the external business environment. This is realized through the development and testing of hypothetical models (research hypotheses). Business performance has been measured by firm output, which has been used by previous studies as the dependent variable of the production function. In particular, the production function (F) relates firm output (Q) to firm inputs ($X_{1, 2,..., ..., n}$) (Nicholson, 2004). Most empirical studies on the effect of ICT on productivity and business performance use the Cobb-Douglas production function (Lichtenberg, 1995; Brynjolfsson and Hitt, 1996; Gurbaxani et al, 1998). It posits that firm output in a given time period is an exponential function of the capital and the labour employed in this period.

The Cobb-Douglas production function constitutes a sound, mature and complete foundation from the area of microeconomics, including all the fundamental variables that affect firm output. It has been extensively used in the past for estimating the contribution of various firm inputs, including ICT capital, to firm output (e.g. Brynjolfsson & Hitt 1996, Stolarick 1999, Preslac 2003, etc.). Therefore it fulfils all the abovementioned requirements: i) it provides objective measures of business performance (value added), ICT investment (value of computer capital) and non-ICT investment (value of non-computer capital) ii) it is complete and includes all the fundamental variables that affect this measure of business performance (value added) and iii) it is a widely accepted approach and has been thoroughly used by researchers in similar empirical studies. In this study we have used an extended form of the Cobb Douglas production function, in which the capital is divided into computer capital and non-computer capital:

$$VA = e^{\beta_0} L^{\beta_1} K^{\beta_2} CK^{\beta_3} \qquad (3.1)$$

where VA is the yearly firm value added (which is equal to yearly sales revenue minus yearly expenses for buying materials and services from external suppliers), and L, K and CK are the yearly labour expenses, value of the non-computer capital and value of the computer capital respectively. Based on the above function and according to the relevant literature review, we have developed several research hypotheses, which are going to be presented and examined throughout the coming chapters.

The first set of hypotheses regards the ICT-business performance relationship. We have also included in our investigation non-ICT investment (the 'traditional' assets) as well, for comparison purposes between ICT investment and non-ICT investment regarding the above aspects. The reason for doing this is that, despite the growing investment of firms in ICTs, non-ICT investment constitutes in most sectors the biggest part of firms' total investment. Various empirical studies conducted in order to investigate the contribution of firms' ICT investment to their business performance have also dealt with the contribution of non-ICT investment as well, and have provided evidence of a positive and statistically significant contribution of non-ICT investment to business performance (e.g. Brynjolfsson and Hitt 1996, Stolarick 1999, Preslac 2003, etc.). The segregation between

computer (ICT) capital and non-computer (non-ICT) capital (traditional assets) has been also realized so as to offer a better understanding of the similarities and differences of those two. As already mentioned, the contribution of ICT investments to business performance has been broadly acknowledged. However, according to equation 3.1, firms' capital consists of computer capital and non-computer capital and is directly related to all firm performance indices (Sircar et al, 2000). According to the findings of Atzeni and Carboni (2006) ICT differs from conventional capital but they both contribute, in their manner, to firm performance. Bertschek and Kaiser (2004) note that positive and highly significant effects of ICT investment, non-ICT investment, and labor productivity are found in all productivity estimations. Therefore the role of non-ICT capital in the creation of business value has also been acknowledged. By log-transforming (3.1) we obtain the following linear form of it:

$$\ln VA = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(CK) + u_t \qquad (3.2)$$

By normalizing both sides of (3.2) by the number of employees (n) and then adding the various complementarity investment variables (e.g BPR, TQM, etc) as mediators in the relationships of ICT investment and non-ICT investment with business performance we formulate the hypothesized models of this thesis. In all models business performance is measured by the log-transformed value added per employee (labour productivity). It is a fundamental measure of business performance, as it incorporates the value of the products and services a firm produces (taking into account both their quantity and their quality as it is reflected by their unit prices), the value of the materials and services it buys from external suppliers as well as the number of employees; another important advantage it offers is that it is supported by a sound theoretical foundation in terms of the basic variables affecting it (the Cobb-Douglas production function). For these reasons labour productivity has been used as dependent variable in many empirical studies of the effect of ICT and organizational change on business performance (Bertschek & Kaiser2001, Black & Lynch 2004, Arvanitis 2005). ICT investment is measured by the log-transformed value of the ICT equipment (hardware, software and networks) per employee, while non-ICT investment is measured by the log-transformed value of non-ICT assets (= total value of assets minus value of ICT equipment) per employee. For testing the research hypotheses we estimated the hypothesized models and the underlying research hypotheses following the structural equations modelling (SEM) (Kline 2005) technique.

We note that the present dissertation has two additional objectives: The investigation of the effect of the national context on the abovementioned variables, which is going to be described in chapter 8, as well the identification of the value creation process of particular IS in chapter 9. The former will be examined through an international empirical investigation between two countries, Greece and Switzerland. The later will be investigated through the development of a value flow model and an empirical investigation of a particular Information System providing e-learning services. The survey instruments for the examination of the abive additional objectives will be presented and analyzed, together with the whole methodological approach and relevant literature, in chapters 8 and 9 respectively.

3.2 Structural Equation Modeling

3.2.1 Introduction to SEM

The origins of SEM can be traced at the early years of the 20th century, when Spearman (1904) developed what is now called as exploratory factor analysis (EFA). The work of Wright (1934) offered the initial steps of path analysis. SEM is a combination of factor analysis and path analysis. It constitutes a "second generation" statistical technique that offers several important advantages over the 'first generation' techniques (such as Multiple Regression Analysis, Analysis of Variance (ANOVA), Principal Components Analysis, etc.). According to the relevant literature (Sharma 1996, Gefen et al 2002, Haenlein and Kaplan 2004, Kline 2005, etc.) first generation techniques share some significant limitations: they can handle models of simple structure (e.g. with one layer of independent variables and one layer of dependent variables, so that one variable cannot be at the same time dependent (predicted by other variables) and independent (predict other variables)) and they assume that all the variables are observable and measurable without error. These limitations restrict seriously their applicability in complex research problems. SEM overcomes those limitations, since it enables:

a) modeling complex relationships among multiple predictor (independent) and criterion (dependent) variables, in which one variable can be at the same time dependent and independent (e.g. a 'mediating' variable),
b) constructing unobservable latent variables, which are estimated from observed variables,
c) modeling errors in measuring the observed variables,
d) testing simultaneously structural and measurement assumptions using empirical data.

It is a much more powerful technique than multiple regression, since it offers the capability of modeling correlated independents, measurement error, correlated error terms, multiple latent independents and multiple latent dependents, each latent construct being measured through multiple observable variables-indicators. In particular, SEM enables the identification of relationships among unobserved variables (called "constructs" or "latent variables") (these relationships constitute the "structural model") as well as the relationships between constructs and the observed variables related to them (called items, indicators or manifest variables) (these relationships constitute the "measurement model"). In figure 2 we can see an example of a typical SEM model with three (reflective) constructs (usually represented by circles or ellipses) and a total of nine items (usually represented by rectangles), three items per construct, as well as the measurement errors of each item. Causal relationships in the model are indicated by single headed arrows, with the variable at the tail of the arrow causing the variable at the point. These single headed arrows represent direct effects (will be discussed later) either between constructs (the paths of structural model) or between a construct and its items (measurement model).

3.2.2 Reflective and formative indicators

A construct can have one or more indicators, which can be formative or reflective. Reflective measures are caused by the latent construct whereas formative measures cause the

latent construct. In a reflective measure the arrow begins from the construct and ends to the indicator whereas in formative indicators the arrow points from the indicator to the construct. The direction of causality is very important and should be taken always under careful consideration in order to avoid misspecification errors (the assumption that a construct is always reflective when indeed is formative). An underlying assumption for SEM is that the items or indicators used to measure a latent variable are reflective in nature (Chin, 1998). A common and serious mistake often comitted by researchers is to inadvertently apply formative indicators in a SEM analysis.

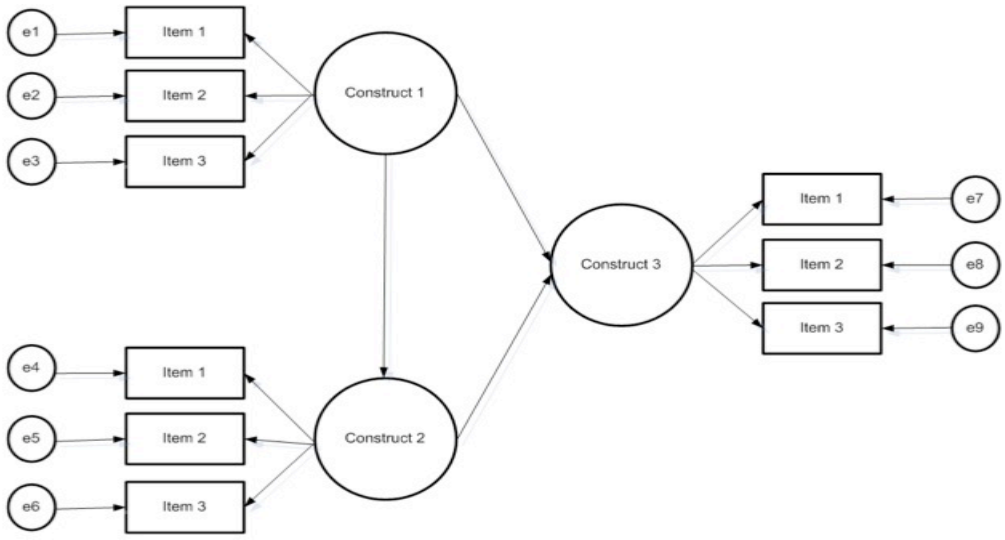


Figure 3.1: A Structural Equation Model

A typical example of formative indicator, which has been extensively used in the relevant literature, is socio-economic status (SES), where indicators such as education, income and occupational prestige are items that cause or form the LV SES. If an individual loses his/her job, the SES would be negatively affected. But the opposite (that a negative change which has occurred in an individual's SES, implies a job los) would be a mistake to infer. Additionally a change in income does not necessarily imply a similar directional change for the other indicators (education or occupational prestige).

3.2.3 Total, mediating and moderating effects

In path analysis, we commonly refer to three types of effects: total effects, direct effects and indirect effects. The total effect is the degree to which a change in an upstream (exogenous) variable, such as X has an effect on a downstream (endogenous) variable such as Y. A direct effect is the degree to which a change in an exogenous variable produces a change in an endogenous variable without "going through" any other variable. On the other hand an indirect effect is the degree to which a change in an exogenous variable produces a change in an endogenous variable by means of an intervening variable. The total effect equals the direct effect plus all indirect effects.

According to Cole and Maxwell (2003) a variable serves as a mediator under the following conditions. First, X has a direct effect on M, second, M has a direct effect on Y, controlling for X. Third, if M completely mediates the X-Y relation, the direct effect of X on

Y (controlling for M) must approach to zero. Alternatively, if M only partially mediates the relation, the direct effect of X on Y may not approach zero. There are two additional requirements for a variable (M) to be regarded as a mediator: It must truly be a dependent variable relative to X, which implies that X must precede Y in time and M must be truly an independent variable relative to Y, implying that M precedes Y in time (figure 3.2). In the present thesis chapters 4, 6, 7 and 8 deal with the investigation of total, mediating and direct effects between constructs.

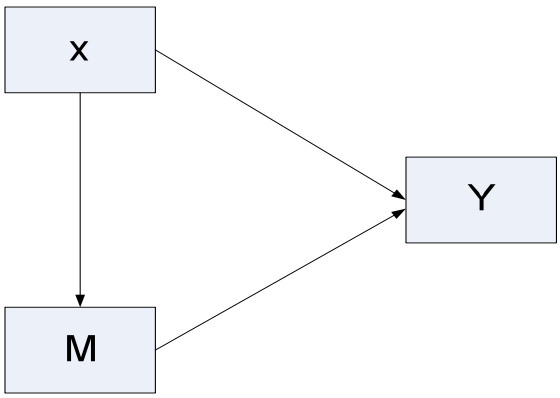


Figure 3.2: Graphical representation of mediating effects

A variable could be thought as moderator under the following situation: X has direct effect on Z, Y has a direct effect on Z, and a third variable (N), which is the combination or interaction of X and Y (X*Y), has also a direct effect on Z. The size of the interaction effect will determine the extent to which N is moderating the relationship between X, Y and Z (figure 3.3). Chapter 5 deals with the identification of moderating and total effects between variables.

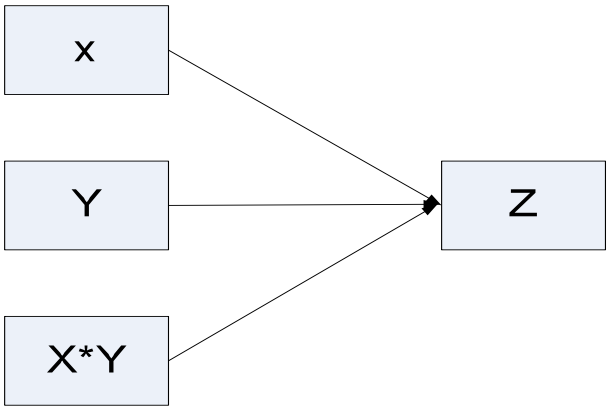


Figure 3.3 Graphical representation of moderating effects.

3.2.4 Model validation

Model validation depends also on the direction of relationships between the measures and the construct. For example construct validation for reflective constructs is realized through CFA (convergent and discriminant validity) and reliability testing (Cronbach's a). Convergent validity answers to the question whether the items loadings are strongly associated with their construct, whereas discriminant validity examines if the measures

discriminate among constructs. In contrast, validity for formative constructs is concerned with the strength and significance of the path from the indicator to the construct (Straub et al, 2004). Reliability in the internal consistency sense and construct validity in terms of convergent and discriminant validity are not meaningful for formative constructs. Discriminant validity however, can be tested for both kinds of constructs, by examining whether the constructs are "less than perfectly correlated". High correlations among formative indicators could indicate that the scale items are measuring essentially the same concept. This could lead to multicollinearity problem and the need to eliminate one or more indicators (Freeze and Rascke, 2006). The identification of model parameters (direct effects between latent constructs, loadings of constructs on items, variances, etc.) is performed through the minimization of the difference between the covariance matrix of the observable variables and the one predicted by the hypothesized model.

In SEM it is of critical importance first to specify the model (both the measurement and the structural parts of it) based on existing theory and previous empirical research. The first step of the analysis is the assessment of the measurement model, which includes the testing of constructs' reliability, convergent validity and discriminant validity; if at least one of these tests gives a negative result, it is necessary to modify the measurement model (i.e. some items might have to be deleted from their constructs).

3.2.5 Model fit

The next step is to assess how well the model fits the data, which is realized through various goodness-of-fit (GOF) indices. There are several complex algorithms used by SEM to maximize model fit. The most widely used method is maximum likelihood (ML), which assumes multivariate normal data and a reasonable sample size (>200). Goodness-of-fit indices have been developed to avoid dependence from sample size or data distribution (Hox and Bechger, 1998) and are related to the ability of the model to account for the sample covariances and therefore assume that all the measures are reflective (Chin, 1998).

Fit in SEM models is assessed through two types of statistics: the likelihood ratio chi-square, which is computed to test the null hypothesis that the specified model fits perfectly in the population, and other alternative measures of model fit, known as fit indices. Chi-square tests the difference between the covariance matrix of the observable variables and the one predicted by the hypothesized model. If this chi-square index is of high magnitude, so that it becomes statistically significant, then the hypothesized model is rejected and the researchers should look for modifications of this model or even for another model (Hox and Berger 1998). A model can be modified by deleting non-significant parameters or adding new ones to improve the fit. SEM software assists in this process by producing modification indices (M.I), the value of which is the minimum amount that the x^2 statistic is expected to decrease if the corresponding parameter is freed. (Hox and Bechger, 1998)

SEM literature always reports results of the chi-square tests; however the later has some serious limitations. According to Bielby and Houser (1977) the first problem is that the power of chi square (its ability to reject the null hypothesis Ho when it is false) is unknown. Fornell and Larcker (1981) mention two additional drawbacks: first, the test may indicate a good fit between the hypothesized model and the observed data even though both the measures and theory are inadequate, leading thus to the possibility of accepting a

model in which there is no relationship between the theoretical constructs. Second, the impact of sample size on the statistic of chi-square may lead to type II errors. Moreover chi-square imposes an overly stringent and unrealistic criterion, it provides results highly dependent on sample size, and, although it facilitates dichotomous accept or reject decision as a badness-of-fit measure, it provides less useful information regarding the degree of model fit (Tomarken and Waller, 2003). The limitations of chi-square gave rise to other alternative fir indices (NFI, RFI, TLI, RMSEA, etc) for model fit estimation. In the SEM context fit indices serve essentially the same function as measures of association strength or of effect size used in other contexts. They indicate the degree of fit and they are less affected by sample size than is the chi-square test of exact fit. Therefore, with large sample sizes, fit indices may well indicate that a model fits well even though the chi-square test rejects the null hypothesis of exact fit. Models with low R^2 and/or low factor loadings can still yield excellent goodness-of-fit (because fit measures only relate to how well the parameter estimates are able to match the sample covariances and not relate to how well the latent variables or item measures are predicted (Chin, 1998).

It should be emphasized that the most important strength of SEM is the capability to specify and estimate more complicated models, with intervening (mediating) variables/constructs between the independent and dependent variables/constructs (Hox and Berger, 1998). There are two kinds of SEM techniques (each of them supported by a different family of software tools): the covariance-based ones (supported by software tools such as LISREL, EQS, AMOS, etc.) (Byrne, 2001) and the variance-based (or component-based) ones (supported by the PLS-GRAPH software tool) (Chin 1998, Haenlein and Kaplan 2004). Subsection *3.2.6.1* presents a covariance-based tehnique, Maximum Likelihood, which is used in the present thesis in chapters 4-8. On the other hand, in *3.2.6.2* a variance-based technique is presented (PLS), which has been empirically applied in chapter 9.

3.2.6 Parameter Estimation

There are two general methods of parameter estimation. They are least-squares estimation (LSE) and maximum likelihood estimation (MLE). This section presents two types, a covariance based (ML) and a variance-based one (Partial Least squares; PLS).

3.2.6.1 Maximum Likelihood

The idea behind maximum likelihood estimation (MLE) is to determine the parameters that maximize the probability (likelihood) of the sample data. From a statistical point of view, the method of maximum likelihood is considered to be more robust (with some exceptions) and yields estimators with good statistical properties. In other words, MLE methods are versatile and apply to most models and to different types of data. In addition, they provide efficient methods for quantifying uncertainty through confidence bounds. Although the methodology for maximum likelihood estimation is simple, the implementation is mathematically intense. Using today's computer power, however, mathematical complexity is not a big obstacle.

Once data have been collected and the likelihood function of a model given the data is

determined, one is in a position to make statistical inferences about the population, that is, the probability distribution that underlies the data. Given that different parameter values index different probability distributions ML focuses on finding the parameter value that corresponds to the desired probability distribution. The principle of maximum likelihood estimation (MLE), originally developed by R.A. Fisher in the1920s, states that the desired probability distribution is the one that makes the observed data 'most likely', which means that one must seek the value of the parameter vector that maximizes the likelihood function. MLE, as a typical covariance-based SEM approach, has as first step the estimation of the model parameters and then as a second step the calculation of the values of the LVs for all cases.

ML is a standard approach to parameter estimation and inference in statistics. It has many optimal properties in estimation: sufficiency (complete information about the parameter of interest contained in its MLE estimator); consistency (true parameter value that generated the data recovered asymptotically, i.e. for data of sufficiently large samples); efficiency (lowest-possible variance of parameter estimates achieved asymptotically); and parameterization invariance (same MLE solution obtained independent of the parameterization used). Furthermore, many of the inference methods in statistics are developed based on MLE. For example, MLE is a prerequisite for the chi-square test, the G-square test, Bayesian methods, inference with missing data, modeling of random effects, and many model selection criteria such as the Akaike information criterion (Akaike, 1973) and various model fit indices, like RMSEA, NFI, TLI, etc.

3.2.6.2 The Partial Least Squares (PLS) approach

Covariance-based SEM constitutes a 'hard modeling' approach, which is characterized by several distributional assumptions and necessitates large samples. An advantageous alternative is the PLS variance-based SEM approach, which has been first introduced by H. Wold (1975); it is a 'soft modeling' approach with very few distributional assumptions and can be performed even with smaller samples. In the present thesis PLS has been used for the investigation of system-level value determinants in chapter 9.

As mentioned in section 3.1, in the covariance-based SEM the model parameters are calculated through minimization of the difference between the covariance matrix of the observable variables (MVs) and the one predicted by the hypothesized model. On the contrary in the PLS approach the model parameters are calculated through maximization of the variance of the dependent variables explained by the independent ones (Haenlein and Kaplan, 2004). It can simultaneously model the structural paths (i.e. relationships among LVs) as well as the measurement paths (i.e. relationships between a LV and its MVs); it also includes a third component, the weight relations, which are used to estimate case values for the LVs as linear combinations of their corresponding MVs. In PLS the first and basic step is the estimation of the weights linking each LV with its MVs, using a complex two-step algorithm (Tenenhaus et al 2005). Then as a second step using those weights the values of the LVs for all cases are calculated. Finally these LV values are used for the estimation of the structural paths between them though a number of regressions.

PLS has a lot of advantages that make it more preferable than the other SEM existing approaches. As mentioned above it has very few assumptions concerning the distributions of the data. It is quite robust with regard to several inadequacies (skewness, multicollinearity, misspecifications of the structural model, as concluded by several studies based on simulations (e.g. Cassel et al 1999). It can model both reflective and formative MVs and is particularly used in situations where constructs are measured by a very large number of items**.** Each MVs varies in how much it contributes to the composite score of the LV and the weights provide an exact linear combination of the MVs for forming an LV score, which is not only maximally correlated with its own set of MVs, as in Principal Components Analysis, but also correlated with other LVs, according to the structural or theoretical model (Chin, et.al, 2003). MVs with weaker relationships with other MVs and with their LV are given lower weightings, so that higher reliability for the LV estimate can be achieved. The standard errors of the estimated paths can be estimated via several resampling procedures, such as the "Jack-knife" or the "Bootstrap" ones (Tenenhaus et al 2005). The PLS approach can also assess the reliability of the estimated LVs with composite reliability indices, which do not assume equal loadings among the items (e.g. as it happens with Cronbach Alpha), so they are more accurate estimates of composite reliability (Chin, et.al, 2003).

However in PLS there are also some negative points. Contrasted to other causal modeling techniques, PLS tends to be more conservative in its estimates of structural paths and more positively biased towards its loading estimates; it tends to underestimate the structural paths that connect LVs and overestimate the measurements paths (loadings) connecting LVs to their MVs (Chin et.al 2003, Haenlein and Kaplan; 2004). Finally it does not provide an overall model fit index (while the covariance-based SEM approaches provide numerous model fit indices), even though some solutions to this problem have been proposed (Tenenhaus et al 2005).

3.2.6.3 ML or PLS?

The choice of estimation method is a very important decision. In this study the dilemma lies within the choice between a full information (ML) estimation approach (Joreskog, 1978) and a PLS estimation approach (Wold, 1982). In this section we are going to examine the pros and cons of the ML and PLS approaches, since those two have been used for model estimation. Maximum likelihood has several strengths for theory testing and development. As other full information methods, it provides parameter estimates that best explain the observed covariances (Anderson and Gerbing, 1988). Moreover it produces the most efficient parameter estimates and an overall test of model fit (Joreskog and Wold, 1982).

PLS is better for application and prediction. It assumes that all observed measure variance is useful variance to be explained (i.e it assumes no random error variance or measure-specific variance). Parameter estimation is done so as to maximize the variance explained in either the set of observed measures (reflective models) or the set of latent variables (formative models) (Fornell and Bookstein, 1982). Model fit is judged in terms of the percentage of variance explained in the specified regressions (Anderson and Gerbing, 1988). A PLS approach estimates the latent variables as exact linear combinations of the

observed measures offering therefore the advantage of exact definition of component scores.

As shortcomings of PLS could be mentioned its inability to assume or asses unidimensional measurements (items that belong to more than one construct), as well as that PLS parameter estimates are not as efficient as full-information estimates due to the fact that PLS constitutes a limited-information estimation method (Fornell and Bookstein, 1982). Therefore resampling (bootstrap or jackknife) procedures must be used in order to obtain estimates of the standard errors of the parameter estimates. Finally PLS does not offer the ability of an overall model fit test.

As far as the choice between an ML or PLS approach is concerned, Anderson and Gerbing (1988) note that "it is a complementary choice depending on the purpose of the research: ML for theory testing and development and PLS for application and prediction". According to the conclusions of Joreskog and Wold (1982) "ML is theory oriented and emphasizes the transition from exploratory to confirmatory. PLS is primarily intended for causal-predictive analysis in situations of high complexity but low theoretical information" (p. 270).

3.3 Data, tools and techniques

For testing the research hypotheses of this thesis we used firm-level data which have been collected through a questionnaire-based survey among Greek firms conducted in cooperation with ICAP, one of the largest business information and consulting companies of Greece. This survey instrument can bee seen in Appendix A. All the hypotheses that have been developed in chapters 4-7 have been tested through the questions included in Appendix A. An initial version of the questionnaire was reviewed by three highly experienced experts from ICAP S.A., and based on their remarks its final version was formulated.

The sample of the survey was randomly selected from the database of ICAP and included 304 Greek firms from the 27 most important sectors of Greek economy covering both manufacturing and services; it is characterised by equal representation of small, medium and large firms: it included 103 small firms (with more than 10 and less than 50 employees), 103 medium ones (with more than or equal to 50 and less than 250 employees) and 98 large ones (with more than or equal to 250 employees). Two similar samples were also created with the same proportions of small, medium and large firms, and also the same proportions of firms from these 27 sectors. Initially the questionnaire was sent by mail to the Managing Directors of the 304 firms of the first sample, who were asked to fill in the questionnaire and return it by fax or mail within one month. After one month the recipients who had not responded were contacted by phone again and reminded of the questionnaire. The companies, which refused to participate, were replaced by 'similar' companies (i.e. from the same size group and industry) from the second sample, and in cases that the similar companies of the second group were used, the companies of the third sample were used. In this way we managed to have a balanced sample concerning company size and industry. Finally were received complete questionnaires from 271 companies (88 small, 105 medium and 78 large ones). In order to assess whether there is non-response bias we compared variables' means of the early respondents with the ones of the

late respondents (Armstrong and Overton 1977, Chapman 1992); since we did not find any statistically significant differences, we can conclude that there is no non-response bias.

For elaborating the data in the present thesis we have used SPSS (version 15), AMOS (version 7), and PLS GRAPH (version 3) software packages. The techniques used are: descriptive statistics, regression analysis, Structural Equation Modeling (SEM), Confirmatory Factor Analysis (CFA), Principal Component Analysis (PCA), Convergent and Discriminant Validity Analysis, Reliability Analysis with Cronbach Alpha coefficient and Model Fit testing. Those techniques are not going to be analyzed at this point. Instead they are going to be explained throughout the coming chapters during the empirical investigation of this thesis' research hypotheses.

CHAPTER 4

The Mediation Effects of BPR and TQM on the Relationship Between ICT Investment and Business performance

4.1. Introduction

During the last two decades a rapid diffusion of information and communication technologies (ICTs) in firms of most sectors has taken place. Firms have made big investments in ICTs with high expectations of various kinds of benefits from them. As mentioned in the introduction of this thesis, one of the most important research topics in the area of information systems (IS) that has attracted for long time the interest of researchers and practitioners has been the contribution of firms' ICT investment to their business performance. The conclusions of this research have been mixed and inconsistent. Some of the early studies that have been conducted on this topic, mainly during the 80s and the 90s, did not find evidence of a positive statistically significant association between ICT investment and business performance (Roach 1987, Strassman 1990, Brynjolfsson 1993, Loveman 1994, Strassman 1997, Stiroh 1998); these early counter-intuitive conclusions are usually referred to as the "ICT Productivity Paradox" (Brynjolfsson 1993). On the contrary, some later studies after the mid 90s have found evidence of a positive statistically significant association between ICT investment and business performance (Brynjolfsson & Hitt 1996, Dewan & Min 1997, Stolarick 1999, Devaraj & Kohli 2000, Preslac 2003, OECD 2004, Arvanitis 2005). One of the explanations provided by the literature for this inconsistency was that the full potential of ICTs is exploited not by simply automating existing business processes, but by adjusting and improving them based on the capabilities that the ICTs offer, which takes time and requires extensive effort and specialized expertise (e.g. Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 2000, Bresnahan et al 2002). According to Bresnahan et al (2002) "firms do not simply plug in computers or telecommunications equipment and achieve service quality or efficiency gains. Instead they go through a process of organizational redesign and make substantial changes to their product and service mix". In the same direction Brynjolfsson and Hitt (2000) argue that the most beneficial aspect of ICTs is that they are catalysts and enablers of big improvements of existing business processes and work practices, which, in turn, lead to very high levels of benefits; for this reason they expect that the main mechanism of business value creation from ICT will be not the simple automation of existing business processes, but the IT-enabled change and improvement of them, which can result in quite big business benefits.

It is therefore important to examine to what extent the above expectations of the literature are materialized in 'real-life', through empirical investigation of the mediation effect of business process change on the relationship between ICT and business performance in various sectoral and national contexts. In general, it is of high theoretical and practical importance to understand not only 'to what extent' but also 'how' ICT affects business performance by identifying and investigating mediating variables in this critical relationship, such as business process change.

Business Process Reengineering (BPR) and Total Quality Management (TQM) constitute the two main paradigms of business process change today. As mentioned in chapter 2 BPR is "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical measures of performance such as cost, quality, service, job satisfaction, and speed" (Hammer and Champy, 1993). BPR remains a highly interesting topic for long time; Initially a 'first generation of BPR' was characterized by too rapid pace of implementation, unrealistic goals, limited attention to human factors, downsizing and main focus on increase of operational efficiency through personnel reductions, had

mixed results (resulting in both successes and failures). However a more mature 'second BPR generation' emerged subsequently, focusing on increase of organizational effectiveness mainly through superior value production (and not through downsizing and personnel reductions), paying more attention to change management and human factors and more realistic goals (Martinsons and Revenaugh 1997). In this direction a continuously growing number of organizations start BPR projects of various types aiming to increase their performance and competitiveness (Al-Mashari 2001). This renewed interest of the business world in BPR usually ICT-based is reflected in the results of the survey conducted regularly by the Society for Information Management (SIM) of USA (www.simnet.org) concerning the key IS management issues, in which BPR has been ranked as the fifth most important issue that IS managers face (Luftman et al 2006).

On the other hand TQM constitutes a different business process change paradigm, less radical and focusing on long-term continuous improvements. It is defined by the 'International Organization for Standardization' (ISO) (http://www.iso.org/iso/home.htm) as "a management approach for an organization, centered on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society". The improvement of products' and services' quality as a basic means for outperforming competitors becomes gradually a basic element of the strategies and plans of an exponentially increasing number of firms around the globe; Soltani et al (2008) state that "from 'The Business Week' and 'The Economist' pages and from sources as Conference Board, EFQM, ISO, IPM, ESRC, AQAF and the Deming Institute, examples assail us of moves to TQM, to produce products and services that meet and exceed the needs and expectations of customers, to obtain a strategic orientation, to improve performance with the consequence of greater competitiveness'. As mentioned in the literature review (chapter 2) BPR and TQM, despite that they both regard change, they have some basic differences.

Although, as mentioned above, the role and the potential of business process change as mediator of the relationship between ICT and business performance has been widely discussed and emphasized in the relevant literature based on a rich theoretical argumentation, it has been empirically investigated only to a very small extent (Grover et al 1998, Martinez-Lorente et al 2004, Albadvi et al 2007). Furthermore, as described in more detail in the following section 4.2, most of this limited previous empirical research concerning the mediating effects of business process change on the relationship between ICT and business performance focuses mainly on BPR and neglect TQM, even though it represents a widely adopted paradigm of business process change. Also, these empirical studies are not based on theoretically sound models, omitting thus important independent variables that affect substantially their selected measures of business performance, such as non-ICT capital, labor, etc., and use various subjective measures of business performance as dependent variables. Finally, there are no empirical studies investigating the mediation effects of both BPR and TQM on the relationship between ICT and business performance using the same firm-level dataset, which would allow for a comparison between them.

In this chapter the abovementioned research gaps are fulfilled. The mediation effects of both BPR and TQM on the relationship between ICT investment and business performance are investigated and compared. This is operationalized through objective measures

of both, by developing structural equation models (SEM), which are based on the Cobb-Douglas production function (a sound theoretical foundation from the area of microeconomics), including all the fundamental independent variables. The extent of BPR and TQM are measured through corresponding multi-item scales that have been developed based on extensive reviews of the relevant BPR and TQM literature. Furthermore, the same questions are investigated for non-ICT investments (in regular capital such as mechanical production equipment, physical structures, etc.) as well; the mediation effects of both BPR and TQM on the relationship between non-ICT investment and business performance are empirically investigated as well, and comparisons are made with ICT investment in this respect. Previous literature has identified a fundamental difference between ICT capital and non-ICT (regular) capital (e.g. Bresnahan and Trajtenberg 1995, Melville et al 2007, etc.):ICT capital is a 'general purpose technology', i.e. it is highly flexible and adaptable, so it can be used in many different ways and for various purposes, and enable innovations; on the contrary non-ICT capital is not a general purpose technology, i.e. it is much less flexible and adaptable to different uses, so it can serve much fewer functions and has a much lower potential as innovations enabler. According to Irani (2008) "IS investments often differ in nature from other capital investments as there is a substantial human and organizational interface. In addition, they are characterized by being high-risk, having erratic cash flows, timing several, and often have significant intangible costs". It is therefore interesting to examine whether the above fundamental difference between ICT capital and non-ICT capital results in differences in the mediation role of BPR and TQM on their relationships with business performance.

Finally, it should also be noted that this empirical investigation has been conducted in a national context quite different from the ones of the big and highly developed countries, where most similar studies have been conducted: the national context of Greece, which is a small country, with a small size of internal market and small average firm size, and does not belong to the highly technologically and economically developed countries, though it has made considerable progress in the last fifteen years and has become a full member of the European Economic and Monetary Union. The results of this study are useful to researchers, practitioners, managers, firms, consulting companies and ICT vendors interested in business process change and ICT business value maximization.

Chapter 4 consists of six sections. This introduction is followed by a review of the relevant literature (section 4.2). In Section 4.3 the research hypotheses of this study are formulated, while in Section 4.4 the methodology and data are described. In section 4.5 the data analysis and its results are presented. The final section 4.6 includes the conclusions, limitations and proposed future research directions.

4.2 Literature Review

There is considerable literature emphasizing the innovative potential of ICTs as catalysts and enablers of big improvements of existing business processes and work practices, which, in turn, can lead to high levels of business benefits and performance improvements (e.g. Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 2000, Bresnahan et al 2002, OECD 2004). Brynjolfsson and Hitt (1996) regard as one possible explanation for the "ICT Productivity Paradox" that a period of learning how to utilize and exploit ICTs and

how to make the appropriate process adjustment and restructuring was necessary for the firms, before they can reap the full benefits that their ICT investments could offer. Brynjolfsson and Hitt (2000) argue that most of the existing work practices and business processes have been developed in the past and reflect the historically high cost of communication and information processing; since modern ICTs can reduce dramatically both these costs, they can be key enablers and facilitators of new enhanced business processes and work practices, which lead to big productivity increases, initially by reducing costs and subsequently by enabling firms to increase output quality through the design of new products of the improvement of important intangible aspects of existing products, such as convenience, timeliness, quality, etc. In the same direction Bresnahan et al (2002) emphasize that ICTs change the way that human work is measured, controlled and reported; also work will be restructured in order to allocate routine, well-defined tasks associated with symbols processing to computers and separate and redesign tasks that require human skills; furthermore, ICTs enable an individual worker to have all the required information for completing a bigger part of a process, so historical fragmentation of many processes can be dramatically reduced resulting in large efficiency gains. OECD (2004), based on many studies that have been conducted in its member states, concludes that achieving benefits from ICT investments is not straightforward, but requires 'complementary investments' and changes in business processes, organization and human capital; they also emphasize that these ICT-related changes are not easy, but require a process of search and experimentation, where some firms succeed and grow and some others fail and disappear.

Concerning BPR in particular, there is extensive literature supporting its strong relationship with ICTs and proposing many different ways of using them for enabling and supporting BPR (Hammer 1990, Grover et al 1993, Davenport 1993, Tapscott and Caston 1993, Martinsons 1995, Gunasekaran and Nath 1997, Champy 2002a, Champy 2002b, Attaran 2003, Pantazi and Georgopoulos 2006). Hammer (1990), in one of the first papers that introduced the concept of BPR, argues that businesses should not simply embed outdated processes in 'silicon and software', but on the contrary should exploit the innovation capabilities offered by the ICTs for totally redesigning their processes, finally summarizing his recommendations in a widely cited dictum 'don't automate, obliterate'. Davenport (1993) proposes nine modes of using ICT for supporting BPR: automational, informational, sequential, tracking, analytical, geographical, integrative, intellectual and disintermediating. Tapscott and Caston (1993) argue that ICTs can support radical BPR through their potential to facilitate the flow of information between globally distributed processes and ensure the availability of consistent information all over the firm. Martinsons (1995) argues that ICTs constitute a key enabler of BPR because of their capability to surmount both time and distance constraints. He also states that digital communication technologies can increase the degree of collaboration and coordination, while shared digital information resources can decrease the degree of mediation and 'the number of handoffs'; furthermore, ICT-based BPR can result in the elimination of unnecessary labor and intermediaries, and enable parallel processing of previously sequential tasks. Gunasekaran and Nath (1997) argues that ICTs can be very useful for simplifying most business process and reducing considerably the number of their activities, and for achieving cross-functional process level optimization rather than departmental level optimization. Also, they propose ways for using ICTs for reengineering the basic business processes: order flow, strategic process, product design and production, marketing/sales, services, accounting and personnel management. Champy (2002a, 2002b) suggests that ICTs

can be of critical importance for redesigning and improving dramatically not only the internal processes of firms, but also the processes of transaction and cooperation with their customers, suppliers and partners, which is termed as 'X-Engineering' (with 'X' denoting the crossing of organizational boundaries). Attaran (2003) based on a literature review and a theoretical analysis concludes that ICTs can greatly help in meeting the objectives of BPR in three ways: by providing information across functional boundaries and establishing easy communication, by improving the process performance and also by supporting the modeling of processes, the redesign and optimization of them and the assessment of the consequences of various types of BPR. Gregor et al (2006) based on survey data from 1050 Australian firms of varying sizes and industries reached the conclusion that an important benefit for firms from the use of ICTs is the organizational transformation they cause, which constitutes an important component of the overall ICT business value.

Also, there are several empirical studies based on large datasets providing evidence of a positive effect of BPR on business performance (Guimaraes and Bond 1996, Altinkemer et al 1998, Bertschek & Kaiser2001, Black & Lynch 2004, Arvanitis 2005, Tai and Huang 2007, Altinkemer et al 2007). Guimaraes and Bond (1996) using data collected through a survey of 135 USA manufacturing organizations found that the degree of BPR is positively associated with the benefits that the organization derives from it and also its positive impact on organizational performance. Altinkemer et al (1998) analyzed the content of the annual reports and also the financial performance data of 25 companies that had successfully implemented BPR projects, and found that BPR is positively correlated with improvements in the sales per employee, but not in other financial performance measures. Tai and Huang (2007) investigated empirically the relationship between BPR and business performance based on firm-level data from a sample of 103 industries in Taiwan. Their findings clearly showed that BPR has a clear and positive impact on organizational performance concerning the achievement of basic organizational objectives; they also found that the more globally BPR is applied within the organization, the better its impact on organizational performance. Altinkemer et al (2007) investigated whether ICT-based BPR affects various measures of firm performance by analyzing data of the period between 1984 and 2004 from 116 large USA firms; based on these data they estimated regression models, which led to the conclusion that firms' performances remain unaffected during the implementation period of the BPR projects, and there are positive returns in two to three years after the end of the implementation period.

At the same time in the relevant literature there are many case studies reporting creative and innovative usage of ICTs for enabling BPR, which resulted in significant business-level benefits (e.g. Davenport and Nohria 1994, McKenney and Clark 1995, Lucas et al 1996, Rangan & Dell 1998, O'Neill and Sohal 1999, Hunter et al 2000, Attaran 2003), though BPR failures are reported as well (Altinkemer et al 1998, Sarkera and Lee 1999, Al Mashari and Zairi 2000, Altinkemer et al 2007).

However, there are only a very small number of empirical investigations based on large datasets of the mediating effect of BPR on the relationship between ICT and business performance (Grover et al 1998, Albadvi et al 2007). Grover et al (1998) investigated whether the relationship between ICT diffusion and perceived ICT-related productivity improvement is mediated by the perceived extent of ICT-related process change; using data collected through a survey from 313 senior ICT executives of USA service and manufacturing firms (over half of them having more than 2500 employees) they con-

structed regression models, from which they concluded that for some types of ICTs the perceived extent of the process change they cause mediates the relation between ICT diffusion and perceived ICT-related productivity improvement. Albadvi et al (2007) empirically tested the hypothesis that the relationship between ICT and firm performance is mediated by the extent of ICT-based BPR of the abovementioned basic business processes identified by Gunasekaran and Nath (1997); using data collected through a survey from 112 car components manufacturers from Iran they constructed regression models that provide support to this hypothesis.

Concerning the other basic business process change paradigm, TQM, there is considerable literature supporting its relationship with ICTs and developing utilization directions in order to support TQM initiatives (Giffi et al 1990, Weston 1993, Flynn et al 1994, Forza 1995a and 1995b, Aiken et al 1996, Miller 1996, Sobkowiak and LeBleu 1996, Kock and McQueen 1997, Counsell 1997, Dewhurst et al 2003, Martinez-Lorente et al 2004, Rodriguez et al 2006). Giffi et al (1990) argue that computers play a critical role in quality management, since they can significantly support statistical process control, reduce the effort required by production personnel to collect and analyze quality data and also shorten the reaction time between process data collection and implementation of corrective actions. Weston (1993) claims that TQM relies heavily on ICTs, since they can provide a feedback mechanism and facilitate communication and implementation of advanced quality management techniques and methods. Flynn et al (1994) emphasize the importance of provision of 'quality information', such as charts showing defect rates, machine breakdowns, schedule compliance, etc. Forza (1995a and 1995b) from an empirical study in 34 industrial plants found that quality management practices are 'information intensive' and are significantly correlated with each other and can be significantly supported by eight basic quality 'information flows': quality performance feedback to managers and superintendents, visible and timely feedback on quality (e.g. defects rate, machines breakdown frequencies, etc.), information on internal quality inspections and audits, visible information on machines (e.g. maintenance, operation, setup, etc.), information tools for the identification of causes of non-quality, documentation on production procedures, information exchange with customers on quality and information from suppliers on quality; however, he found weak correlations between ICT and the above eight basic quality 'information flows.

Dewhurst et al (2003) through a multiple case study of 14 Spanish companies found that ICTs can effectively support TQM in improving customer and supplier relationship, increasing process control, facilitating teamwork, facilitating inter-departmental information flow, improving design process and skills, applying preventive maintenance, introducing ISO 9000, measuring quality costs and improving the decision process in quality departments. Martinez-Lorente et al (2004) based on data from 442 large Spanish industrial firms examine the effect of ICT on TQM and also the impact of both on firm performance; one of their basic conclusions was that there are positive statistically significant correlations between the extent of ICT adoption and the extent of implementing all the eight basic TQM dimensions they examined. Rodriguez et al (2006) from the analysis of the same data reached to the conclusion that the use of ICT for supporting these eight basic TQM dimensions generates statistically significant positive gains in both quality and operational performance. Many publications describe specific ICT applications, which can support important aspects of TQM (e.g. Aiken et al 1996, Miller 1996, Sobkowiak and LeBleu 1996, Kock and McQueen 1997, Counsell 1997).

Also, many empirical studies based on large datasets have provided evidence of a positive effect of TQM on various measures of business performance (Easton and Jarrell 1994, Reed et al 1996, Hendricks and Singhal 1997, Fynes and Voss, 2002; Montes et al. 2003; Kaynak 2003, Martinez-Lorente et al 2004, Fuentes-Fuentes et al 2004, Demirbag et al 2006, Prajogo and Sohal 2006, Sila 2007). Easton and Jarrell (1994) examined the effect of TQM on financial performance based on a sample of 108 TOM practicing USA firms by comparing their financial performance with a 'benchmark performance', which is an estimate of their performance in case they had not adopted TQM; they found that TQM leads to improvement of financial performance, which is stronger for firms having more mature TQM programs.

Hendricks and Singhal (1997) explored the hypothesis that implementing effective TQM improves operating performance; for this purpose they examined the changes during a nine years' period of a number of operating performance measures of 463 quality awards winner firms (most of them located in USA) and compared them with the corresponding ones of a sample of similar control firms. They concluded in that the former outperform the latter on several operating income-based measures and sales growth, while they also have higher capital expenditures and also higher growth in employment and total assets. Fynes & Voss (2002), using a quantitative approach investigated not only the relationship between TQM and performance but also its moderators; based on data from 200 manufacturing companies of the electronics sector of Ireland they reached to the conclusion that TQM practices impact upon quality performance, manufacturing performance and business performance, while the relationship between TQM practices and quality performance is moderated by the strength of relationships with customers. Martinez-Lorente et al (2004), in their abovementioned empirical study, conclude also that the extent of TQM implementation has a positive and statistically significant correlation with operational and quality performance, but its correlation with profitability on sales turnover and profitability per employee is not statistically significant.

Moreover, Fuentes-Fuentes et al (2004) examined the effect of external environment characteristics on TQM and at the same time the impact of the latter on organizational performance; using data collected through a survey of managers responsible for quality in 273 firms they found out that dynamism, munificence and complexity influence the degree of TQM implementation, while the latter had an impact on various dimensions of organizational performance. Demirbag et al (2006) investigated empirically the relationship between TQM and organizational performance in a sample of 163 SMEs in the Turkish textile industry; they found that TQM practices have a strong effect on non-financial performance and due to it, a weaker effect on financial performance. Prajogo & Sohal (2006) investigated quantitatively the relationships between organization strategy, TQM and organization performance; using data collected through a survey of 194 middle/senior managers from Australian firms they found that TQM is associated with differentiation strategy, as well as it partially mediates the relationship between differentiation strategy and three performance measures (product quality, product innovation and process innovation).

Despite the existing literature described above, there is a dearth of empirical investigations on the mediating effect of TQM on the relationship between ICT and business per-

formance. Only from the abovementioned empirical study of Martinez-Lorente et al (2004), whose main objective was the investigation of the effect of ICT on TQM, it is concluded that some measures of perceived ICT usage have a direct effect on some perceived measures of operational and quality performance, as well as an indirect effect on them through the perceived extent of TQM implementation.

4.2.1 Summary of literature review and conclusions

In conclusion, the role and the potential of business process change as mediator in the relationship between ICT and business performance have been extensively discussed and analyzed in the relevant literature based on a rich theoretical argumentation, but have been empirically investigated only to a very small extent. Furthermore, the few previous empirical studies that have been conducted on this topic have the following drawbacks:

- they focus mainly on the mediating effects of BPR on the relationship between ICT and business performance, but neglect TQM, even though it represents a widely adopted paradigm of business process change,
- they are not based on theoretically sound models,
- they use mainly subjective measures of business performance (usually perceptions of upper management) as dependent variables,
- as independent variables are used various mainly subjective measures of ICT usage/diffusion and BPR/TQM, but some other important independent variables (not associated with ICT or BPR/TQM) are omitted, which affect substantially the selected measures of business performance, such as non-ICT capital, labor, etc.; such an omission of important independent variables may introduce biases in the estimation of the coefficients of the constructed models, especially in cases where the omitted variables are correlated to some extent with the included ones (e.g. Greene 2003, Gujarati 2003),
- the extent of BPR or TQM implementation is measured through only one item, even though they constitute quite abstract and multidimensional concepts,
- each of these few empirical studies on this topic deals with the mediation effect either of BPR or of TQM on the relationship between ICT and business performance, so there is no empirical study investigating both these mediation effects in the same sample of firms, allowing thus for a comparison between the mediation effects of BPR and TQM,
- finally, there are no empirical studies comparing ICT capital with non-ICT (regular)
- capital in this respect (i.e. to what extent their impact on business performance is mediated by BPR or TQM), even though the fundamental differences between these two types of capital have been identified in previous literature (e.g. Bresnahan and Trajtenberg 1995, Melville et al 2007, etc.).

4.3 Research hypotheses, method and data

Taking into account the abovementioned gaps of previous research, our first research hypothesis concerns the mediation effect of BPR on the relationship between ICT invest-

ment and business performance. One of the basic arguments of the first 'classical' papers and books that introduced the BPR concept (e.g. Hammer 1990, Davenport & Short 1990, Hammer & Champy 1993, Davenport 1993) was that the existing business processes of most organizations have been designed in the past before the emergence of ICT and are based on two 'assumptions': the high costs of communication and information processing and the dominant 'paper-based' mode of office work at that time; however, the emergence of ICT reduced dramatically communication and information processing costs and enabled new electronic 'paperless' modes of office work, so these assumptions are not valid any more. For those reasons they argue that significant organizational benefits and performance improvements can be achieved if existing business processes are redesigned exploiting the capabilities offered by ICTs and taking into account the 'new assumptions' that ICTs have created: the low costs of communication and information processing and the new electronic paperless mode of office work; so they expect that a significant part of the positive impact of ICT on organizational performance will be due to the changes of existing processes that ICT will cause. Additionally, there will be cost reductions, better products and services for the customers and higher efficiency. Subsequently there has been considerable literature in this direction, as mentioned in section 4.2, providing a rich theoretical argumentation concerning the important capabilities offered by ICTs for improving dramatically the existing business processes and work practices, and through these improvements achieving higher business performance (e.g. Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 1998, Brynjolfsson & Hitt 2000, Bresnahan et al 2002, OECD 2004, Melville et al 2004). The fundamental reason behind these capabilities is the nature of ICT, which are 'general purpose technologies', i.e. they are highly multifunctional, flexible, adaptable and pervasive, so they can be used in many different ways and for various purposes, and enable radical innovations in processes and products in many different sectors (Bresnahan and Trajtenberg 1995, Melville et al 2007). Besides, as analyzed in section 4.2, there is extensive literature supporting the relationship between ICT and BPR (Grover et al 1993, Tapscott and Caston 1993, Martinsons 1995, Gunasekaran and Nath 1997, Champy 2002a, Champy 2002b, Attaran 2003, Pantazi and Georgopoulos 2006); ICT can enable and support radical improvements and simplifications of business processes, abolition of processes that can be fully automated and performed by computers without human intervention, creation of new horizontal interdepartmental processes, workgroups and roles focusing on particular customers, products or projects. At the same time there are several empirical studies that provide evidence of a positive effect of BPR on business performance (Guimaraes and Bond 1996, Altinkemer et al 1998, Bertschek & Kaiser 2001, Black & Lynch 2004, Arvanitis 2005, Tai and Huang 2007, Altinkemer et al 2007). For all the above reasons, we expect that BPR mediates the relationship between ICT investment and business performance, so our first hypothesis is:

Hypothesis 4.1: The extent of BPR mediates the relationship between ICT investment and business performance

We expect that the relationship between ICT investment and business performance, for which there is considerable empirical literature providing evidence that it is statistically significant and positive (Brynjolfsson & Hitt 1996, Dewan & Min 1997, Stolarick 1999, Devaraj & Kohli 2000, Preslac 2003, OECD 2004, Arvanitis 2005), is partially mediated by BPR; this means that we expect a direct effect of ICT investment on business performance as well, that corresponds to all the other mechanisms through which ICT affects

business performance beyond BPR (e.g. through automation of processes that have not changed). Therefore the above Hypothesis 4.1 is analyzed in the following three hypotheses:

Hypothesis 4.1.1: ICT investment has a statistically significant effect on the extent of BPR
Hypothesis 4.1.2: The extent of BPR has a statistically significant effect on business performance
Hypothesis 4.1.3: ICT investment has a statistically significant direct effect on business performance

Our second group of research hypotheses concerns the mediation effect of TQM on the relationship between ICT investment and business performance. As mentioned in section 4.2, there is considerable literature arguing that TQM activities are data intensive and can be significantly supported and enhanced through the use of ICT (Giffi et al 1990, Weston 1993, Flynn et al 1994, Forza 1995a and 1995b, Aiken et al 1996, Miller 1996, Sobkowiak and LeBleu 1996, Kock and McQueen 1997, Counsell 1997, Dewhurst et al 2003, Martinez-Lorente et al 2004, Rodriguez et al 2006); in particular, the use of ICT can significantly reduce the effort required by production personnel to collect, analyze and disseminate quality data, and also support and enhance important TQM activities, such as statistical process control, measurement and monitoring of customers' and employees' satisfaction, cooperation with suppliers for quality monitoring and improvement, work simplification and operation of quality improvement teams. The existing ICT infrastructure of most firms can (usually with minor adaptations or small scale extra developments) provide valuable data that support and enhance important TQM activities, e.g. the production subsystem can provide products' quality data, which can support and enhance significantly statistical quality control, quality improvement teams and programmes of continuous quality improvements, the procurements subsystem can provide data for monitoring suppliers' quality, the sales subsystem can provide useful data concerning returns from customers due to unacceptable quality, etc.

At the same time TQM is associated with several sources of business performance improvement (Reed et al 1996, Fuentes-Fuentes et al 2004), such as increase of sales (by becoming more customer-oriented and paying more attention to customers' needs and satisfaction, which results in retaining existing customers and attracting new ones), reduction of costs (by employing quality monitoring and control methods, and also by cooperating with suppliers for incoming materials' quality improvement, which result in reduced processes variation and lower defects' percentages) and higher employees' morale and satisfaction (by offering them opportunities to participate in quality improvement teams, express opinions that are taken into account, take initiatives and receive feedback concerning the outcomes, and also by systematically measuring and monitoring their satisfaction). As mentioned in section 4.2, there are many empirical studies that provide evidence of a positive effect of TQM on various measures of business performance (Easton and Jarrell 1994, Reed et al 1996, Hendricks and Singhal 1997, Fynes and Voss, 2002; Montes et al. 2003; Kaynak 2003, Martinez-Lorente et al 2004, Fuentes-Fuentes et al 2004, Demirbag et al 2006, Prajogo and Sohal 2006, Sila 2007). For the above reasons we expect that TQM mediates the relationship between ICT investment and business performance, so our second hypothesis is:

Hypothesis 4.2: The extent of TQM mediates the relationship between ICT investment and business performance

For the same reasons explained above Hypothesis 4.2 is analyzed in the following three hypotheses:
Hypothesis 4.2.1: ICT investment has a statistically significant effect on the extent of TQM
Hypothesis 4.2.2: The extent of TQM has a statistically significant effect on business performance
Hypothesis 4.2.3: ICT investment has a statistically significant direct effect on business performance

Furthermore, as mentioned in the introduction, it would be interesting to investigate the above questions not only for ICT investment, but also for non-ICT investment ('regular capital') as well, and make a comparison between ICT investment and non-ICT investment regarding the above aspect: to what extent their relationship with business performance is mediated by BPR and TQM. Despite the growing investment of firms in ICTs, non-ICT investment constitutes in most sectors the biggest part of firms' total investment, so it is worth dealing with it as well. Most of the empirical studies that have been conducted in order to investigate the effect of firms' ICT investment on their business performance have also dealt with the effect of non-ICT investment as well, and provide much evidence of a positive and statistically significant contribution of non-ICT investment to business performance (e.g. Brynjolfsson and Hitt 1996, Stolarick 1999, Preslac 2003, etc.). However, ICT assets are much more closely associated with business processes (supporting and influencing them significantly) in comparison with non-ICT assets (e.g. production machinery, buildings, etc.), which do not support directly business processes, so they do not influence them significantly. Furthermore, while ICT, as mentioned above, are 'general purpose' technologies, ICT assets are not, so they can serve much fewer functions, and are much less flexible and adaptable to different uses in comparison with ICT; for this reason they have a much lower potential for facilitating and enabling radical innovations in processes (e.g. radical improvements, simplifications or even abolitions of business processes, etc.) than ICT (Bresnahan and Trajtenberg 1995, Melville et al 2007). Therefore we do not expect that BPR will be associated with non-ICT investment and mediate its relationship with business performance. Thus our third hypothesis (which we do not expect to be supported) will be:

Hypothesis 4.3: The extent of BPR mediates the relationship between non-ICT investment and business performance
Similarly, hypothesis 4.3 is analyzed in the following three hypotheses (expecting that the first of them 4.3.1 will not be supported, but the other two, 4.3.2 and 4.3.3, will be supported):
Hypothesis 4.3.1: Non-ICT investment has a statistically significant effect on the extent of BPR
Hypothesis 4.3.2: The extent of BPR has a statistically significant effect on business performance (it is the same as Hypothesis 1.2)
Hypothesis 4.3.3: Non-ICT investment has a statistically significant direct effect on business performance

On the other hand, we expect that non-ICT investment might be associated with the continuous and evolutionary business process changes that TQM includes. According to the structural contingency theory (Donaldson 2001), which has been successfully used in the past in IS and TQM studies (e.g. Sila 2007, Morton & Hu 2008), organizational effectiveness results from fitting characteristics of the organization, such as its structure and processes, to some contingencies that reflect its situation; the most important of these contingencies are environment, strategy, size and technology. These contingencies have a significant impact on the formulation of organizations' structure and processes; also, organizations have to adapt to the structure and processes over time in order to fit changing contingencies. In this sense investments in non-ICT assets (e.g. sophisticated and complex production equipment) result in changes in the production technology, which, as mentioned above, constitutes an important contingency, so they give rise to appropriate adaptations of structures and processes, in order to maximize the value that these new assets generate. In particular, these new non-ICT assets generate additional costs (e.g. maintenance, depreciation, etc.), so it is necessary to exploit them as much as possible by reducing downtime and defective products, and also by achieving the highest possible value and quality for the customer; for achieving these goals we expect that firms will tend to adopt to a higher extent various TQM practices, such as statistical quality control, permanent quality improvement teams and continuous quality improvement, and also pay more attention to customers' needs and satisfaction.

Even though these new non-ICT assets are usually characterised by high complexity, we expect that firms will use them for simplifying the work of their employees (e.g. by using to the highest possible extent the automation and alerting capabilities of these assets), in order to reduce labour costs and errors resulting in lower quality. Furthermore, new non-ICT assets usually need more inputs (e.g. materials) with higher quality from external suppliers, so we expect that firms will tend to have more cooperation with their suppliers for achieving the required high quality of these inputs. For the above reasons we expect that TQM might be associated with non-ICT investment and mediate its relationship with business performance, so our fourth hypothesis will be:

Hypothesis 4.4: The extent of TQM mediates the relationship between non-ICT investment and business performance
Similarly, hypothesis 4.4 is analyzed in the following three hypotheses:
Hypothesis 4.4.1: Non-ICT investment has a statistically significant effect on the extent of TQM.
Hypothesis 4.4.2: The extent of TQM has a statistically significant effect on business performance (it is the same as Hypothesis 4.2.2)
Hypothesis 4.4.3: Non-ICT investment has a statistically significant direct effect on business performance (it is the same as Hypothesis 4.3.3)

For conducting this empirical investigation we have used the log-transformed version of the Cobb-Douglas production function, presented in chapter 3 (equation 3.2):

$$\ln VA = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(CK) + u_t$$

By normalizing both sides of equation 3.2 by the number of employees (n) and then adding the BPR and TQM respectively as mediators in the relationships of ICT investment

and non-ICT investment with business performance (based on the arguments presented in the previous section), we formulated the two basic hypothesized models of this study, which are shown in Figures 4.1 and 4.2. In both these models business performance is measured by the log-transformed value added per employee (labour productivity). It is a fundamental measure of business performance, as it incorporates the value of the products and services a firm produces (taking into account both their quantity and their quality as it is reflected by their unit prices), the value of the materials and services it buys from external suppliers and also the number of employees; another important advantage it offers is that it is supported by a sound theoretical foundation as to the basic variables affecting it (the Cobb-Douglas production function). For those reasons labour productivity has been used as dependent variable in many empirical studies of the effect of ICT and organizational change on business performance (Bertschek & Kaiser2001, Black & Lynch 2004, Arvanitis 2005). ICT investment is measured by the log-transformed value of ICT equipment (hardware, software and networks) per employee, while non-ICT investment is measured by the log-transformed value of non-ICT assets (= total value of assets minus value of ICT equipment) per employee.

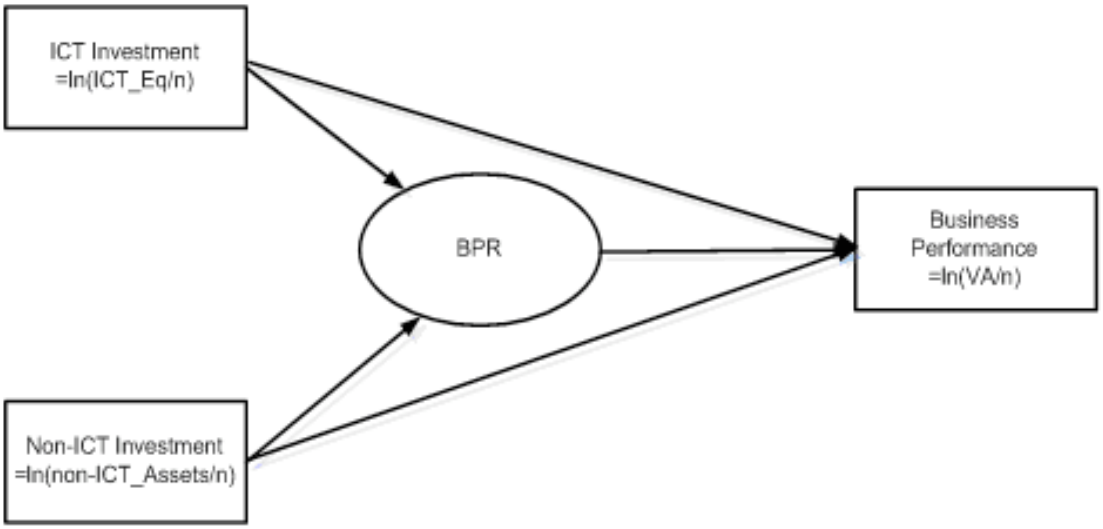


Figure 4.1: The hypothesized model concerning the mediating effect of BPR on the relationships of ICT investment and non-ICT investment with business performance

The extent of BPR and TQM constitute more complicated and multidimensional concepts, which cannot be measured by just single variables. Therefore they have been treated as constructs, with BPR including 9 measures (items) and TQM seven. Each of these items assesses the extent of having performed a basic BPR activity in the last 5 years. This scale has been developed based on a review of the relevant literature. The items concerning process improvement, simplification and abolition were mainly based on Hammer and Champy (1993), since they were among the fundamental BPR activities proposed by them, while the items regarding the cross-functional processes and workgroups, employee empowerment and supervision decrease were taken from Gunasekaran and Nath (1997). Finally the items concerning new horizontal process coordination roles (case management) and customer-focused processes were based on Al Mashari and Zairi (2000) whereas the ones concerning redesign of processes were taken

from Champy (2002). The conceptualization resources of the BPR construct are shown in Appendix 4.

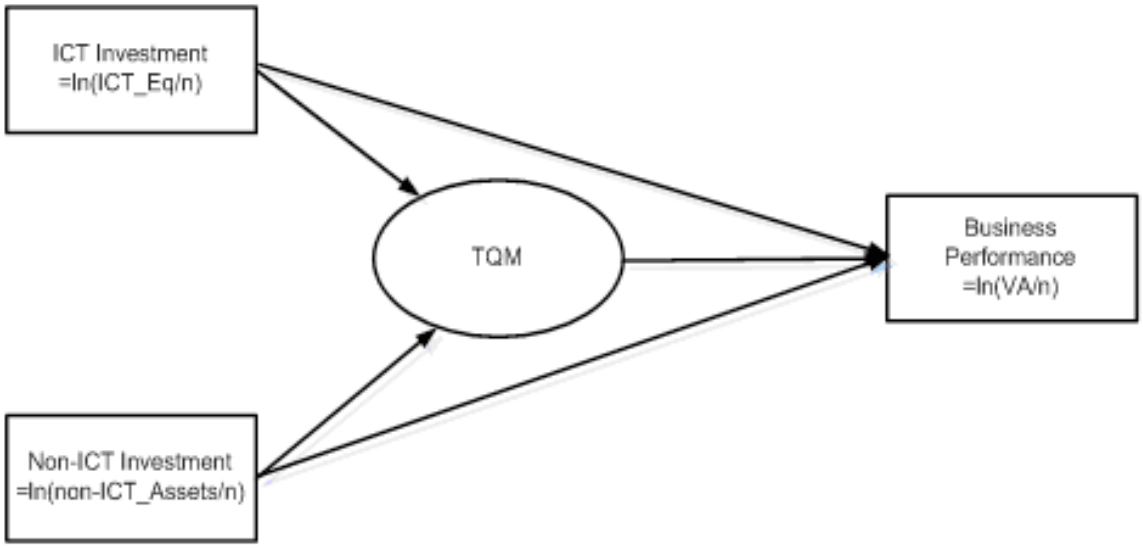


Figure 4.2: The hypothesized model concerning the mediating effect of TQM on the relationships of ICT investment and non-ICT investment with business performance

The extent of TQM is measured through a seven-item scale, also shown in Appendix 4; for the TQM construct, the item regarding methods of statistical quality control was conceptualized by Dewhurst et al (2003), whereas the ones about quality improvement teams and work simplification were taken from Lawler et al (1992). Additionally items about measurement of customer as well as employee satisfaction were borrowed from Anderson et al (1994). Supplier relationship was conceptualized from Flynn et al (1994) whereas continuous quality improvement from Dean and Bowen (1994). The instrument measuring BPR is shown in the Appendix of chapter 3 (Appendix A).

The validity and reliability of both these multi-item scales has been tested using the methods proposed by the relevant statistical literature (e.g. Chin 1998, Boudreau et al 2001, Straub et al 2004, Kline 2005) as described in 4.5.2. For testing the research hypotheses presented in section 4.3 we estimated the models shown in Figures 4.1 and 4.2 following the structural equations modelling (SEM) approach (Kline 2005), using firm-level data we collected through a questionnaire-based survey among Greek firms, which has been presented in chapter 3. The particular questions used in this chapter are 1-7.

4.4 Data analysis and results

4.4.1 Descriptives

The means and standard deviations of the above nine BPR and seven TQM variables, as well as the overall BPR and TQM variables (calculated as averages of the corresponding BPR and TQM variables respectively), are shown in Table 4.1. We remark that the mean of the overall BPR variable is 2.95, so we can conclude that Greek firms have adopted

BPR to a moderate extent; from the means of the nine BPR variables we can see that the most extensively adopted BPR activities are process improvement (3.64), process customer-centric redesign (3.42) and process simplification (3.33). Concerning TQM, the mean of the overall variable is 3.18, so we can conclude that the adoption of TQM by Greek firms is a little higher than moderate, and also slightly higher than the adoption of BPR; the means of the seven TQM variables show that the most extensively adopted TQM activities are continuous quality improvement (3.79), cooperation with suppliers for quality improvement (3.44) and measurement of customer satisfaction (3.38).

BPR activity	**Description**	**Mean**	**Standard Deviation**
BPR_1	Process simplification	3.33	1.01
BPR_2	Process improvement	3.64	0.90
BPR_3	Horizontal (interdepartmental) process creation	2.94	1.20
BPR_4	Process abolition	2.70	1.06
BPR_5	Process customer-centric redesign	3.42	1.02
BPR_6	Interdepartmental workgroup creation	2.60	1.17
BPR_7	Process coordinator role creation	2.62	1.15
BPR_8	Job enrichment - increase of decision making competences	2.91	1.04
BPR_9	Supervision decrease	2.38	1.03
BPR_{AV}	Average of BPR items (variables)	2.95	0.82
TQM activity	**Description**	**Mean**	**Standard Deviation**
TQM_1	Use of statistical quality control	2.90	1.35
TQM_2	Permanent quality improvement teams	2.75	1.42
TQM_3	Measurement of customer satisfaction	3.38	1.29
TQM_4	Cooperation with suppliers for quality improvement	3.44	1.22
TQM_5	Work simplification for quality improvement	3.25	1.12
TQM_6	Systematic measurement of employees' satisfaction	2.79	1.18
TQM_7	Continuous quality improvement	3.79	1.14
TQM_{AV}	Average of TQM items (variables)	3.18	0.99

Table 4.1: Means and standard deviations of the BPR and TQM items (variables).

4.4.2 Measurement Models

The two models shown in Figures 4.1 and 4.2 were estimated using a covariance-based structural equation modelling (SEM) approach based on maximum likelihood (ML) implemented through the AMOS 7 software (Byrne 2001). Initially the measurement model was examined; in particular, content validity, construct validity and reliability of the BPR and TQM multi-item constructs were assessed. Content validity concerns the degree to which the items selected to measure a construct capture the whole essence of it in a representative manner (Boudreau et al 2001, Straub et al 2004). Taking into account that, as mentioned in the previous section 4.4, both BPR and TQM multi-item scales have been developed through extensive review of the relevant literature, and reviewed by three highly experienced ICAP experts, their content validity can be concluded. Construct validity concerns the extent to which the selected items for a given construct, considered together and compared to the items of other latent constructs constitute a reasonable operationalization of it (Boudreau et al 2001, Straub et al 2004). Its most important dimen-

sions are convergent and discriminant validity. Convergent validity is evidenced when the items that have been selected as reflecting a construct "converge" by showing statistically significant high correlations with one another and with the construct. Convergent validity of the BPR and TQM constructs was tested by examining the estimated measurement models parts of the above two models, which connect the two constructs with their corresponding items. For each of these two constructs the loadings of its items, which are shown in Table 4.2, were all statistically significant and exceeded the 0.6 cut off level suggested by Chin (1998). The above results indicate convergent validity for both constructs.

BPR Model		**TQM Model**	
Indicator	**Loading**	**Indicator**	**Loading**
BPR_1	0.724	TQM_1	0.600
BPR_2	0.700	TQM_2	0.673
BPR_3	0.784	TQM_3	0.823
BPR_4	0.699	TQM_4	0.805
BPR_5	0.706	TQM_5	0.800
BPR_6	0.781	TQM_6	0.751
BPR_7	0.748	TQM_7	0.824
BPR_8	0.724		
BPR_9	0.676		

Table 4.2: Item loadings for the BPR and TQM constructs.

Discriminant validity of the BPR and TQM constructs was tested by performing factor analysis with varimax rotation using the SPSS 15.0 software. Despite the fact that the two constructs do not appear in the same model (the BPR construct appears in the model of figure 4.1, while the TQM construct appears in the model of figure 4.2), we would like to ensure that the items of each of these two constructs do not correlate highly with the other construct, and there is therefore a clear discrimination between the two constructs. In particular, we examined the factors structure behind the 16 items of these two constructs (i.e. the 9 BPR items and the 7 TQM items). The results show that there is one factor F1 characterized by high loadings of the BPR items and much lower loadings of the TQM items, and another factor F2 characterized by high loadings of the TQM items and much lower loadings of the BPR items, as we can see in Table 4.3. The results indicate discriminant validity for the two constructs.

BPR and TQM activities	**BPR**	**TQM**
Creation of new horizontal (inter-departmental) processes (that cross more than one departments)	**0,725**	0,319
Creation of new inter-departmental units/workgroups (e.g. customer or product-focused)	**0,686**	0,363
Creation of new horizontal coordination roles (process coordinators) for monitoring and coordinating the efficient and faster execution of process crossing more than one department.	**0,761**	0,246
Simplification of processes	**0,718**	0,141
Improvement of processes	**0,697**	0,295
Abolition of processes	**0,791**	0,195

Redesign of processes so that they become customer-focused	**0,789**	0,148
Job enrichment - increase of decision making competences authorization for employees involved in some processes	**0,725**	0,230
Decrease of the intension of supervision and of the number of supervisors in some processes	**0,711**	0,120
Use of statistical quality control methods	0,069	**0,729**
Permanent quality improvement teams	0,297	**0,713**
Systematic measurement-monitoring of customer satisfaction	0,188	**0,835**
Cooperation with suppliers for quality improvement	0,197	**0,789**
Work simplification for quality improvement	0,306	**0,766**
Systematic measurement-monitoring of employees satisfaction	0,263	**0,731**
Continuous quality improvement	0,301	**0,781**

Table 4.3: Discriminant validity of BPR and TQM measurement items

Finally the reliability of each construct, which concerns the extent to which its items, taken together, constitute an error-prone operationalization of it (Boudreau et al 2001, Straub et al 2004), was examined. For this purpose Cronbach's Alpha was calculated for each construct using the SPSS 15.0 software; the resulting values (0.914 for the BPR construct and 0.906 for the TQM construct) exceeded the minimum acceptable level of 0.7 recommended by the relevant literature (Gefen et al 2000, Straub et al 2004), confirming therefore the reliability of both constructs.

Therefore, it can be concluded that BPR and TQM multi-item constructs are characterized by content validity, construct validity and reliability.

4.4.3 Structural Models

As a second step we examined the fit indices of both structural equation models. In Table 4.4 their main goodness-of-fit indices are shown, which quantify to what extent the specified models fit the observed data. We can see that both models have satisfactory values of the incremental fit indexes (≥ 0.9) as well as of the RMSEA (≤ 0.08), in accordance with the suggestions of the relevant literature (Browne and Cudeck 1993, Gefen et al 2000, Straub et al 2004). Therefore, we can conclude that both models show a satisfactory and acceptable fit with the data, and proceed to examining their path coefficients.

	BPR Model	**TQM Model**
Chi-Square	113.79	37.45
RMSEA	.071	.028
Incremental Fit Indices		
NFI	.927	.969
RFI	.900	.954
IFI	.957	.994
TLI	.940	.992
CFI	.956	.994

Table 4.4: Fit indexes for the BPR and TQM models.

In Figure 4.3 we can see the statistically significant path coefficients of the BPR structural model. We remark that both paths from ICT investment to BPR and from BPR to business performance are statistically significant (0.137 and 0.159 respectively), therefore hypotheses 4.1.1 and 4.1.2 are supported. The statistical significance of those two paths indicates a clear mediating effect of BPR on the relationship between ICT investment and business performance. Also the direct path from ICT investment to business performance is statistically significant and stronger (0.328), so hypothesis 4.1.3 is also supported. This means that ICT investment has an important direct contribution to business performance as well. The above results provide support for hypothesis 4.1, leading to the conclusion that BPR has a partial (but not complete) mediation effect on the relationship between ICT investment and business performance. This finding is consistent with conclusions of previous relevant studies (Albadvi et al 2006, Grover et al 1998). We also remark that the indirect effect of ICT on business performance through BPR (equal to 0.137x0.159=0,022) is much weaker than the direct one (0,328). This means that in the Greek national context only a small part of the effect of ICT on business performance is through enabling and facilitating BPR that has a positive impact on business performance (equal to 0,022/(0,328+0,022)=6,2% of the total effect).

Concerning non-ICT investment, we can see that the path from it to BPR is not statistically significant, while on the contrary the path from it to business performance is significant (0.103). Therefore hypotheses 4.3.2 and 4.3.3 are supported, whereas hypothesis 4.3.1 is not, in agreement to our expectations (section 4.3). These results do not provide support for hypothesis 4.3, and lead to the conclusion that BPR is not significantly associated with non-ICT investment and does not have a mediation effect on its relationship with business performance.

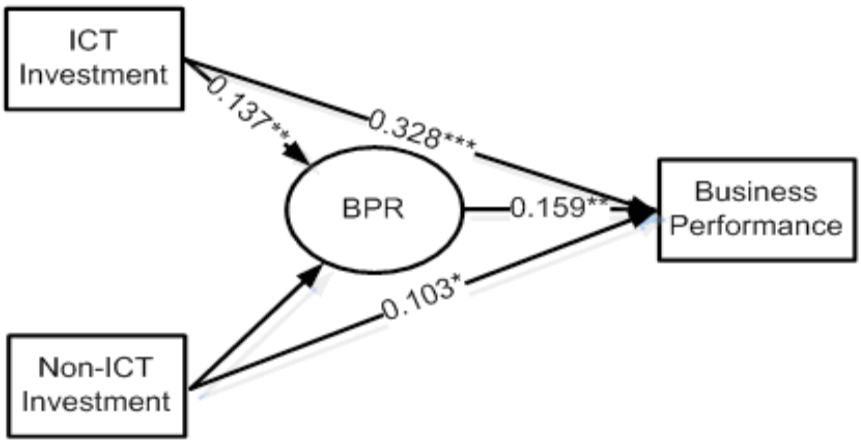


Figure 4.3: The BPR structural model

The above conclusions indicate an important difference between ICT and non-ICT capital concerning their relation to BPR and also the mediation role of BPR in their relationships with business performance. As mentioned in the introduction ICT capital is a 'general purpose' technology (e.g. Bresnahan and Trajtenberg 1995, Melville et al 2007, etc.) characterised by flexibility and adaptability and can be used in many different ways and for various purposes; on the contrary non-ICT capital is not a 'general purpose', being

characterised by much lower flexibility and adaptability to different ways of use, so it can serve much fewer functions. Also, ICT capital is closely associated with most business processes of a firm, supporting and influencing them significantly, while non-ICT capital is not. These fundamental differences between ICT capital and non-ICT capital result, as our empirical results indicate, in differences concerning their relation to BPR: while ICT capital enables and supports the radical and discontinuous improvements and simplifications of business processes that BPR includes, this does not happen with non-ICT capital; for this reason BPR partially mediates the relationship between ICT capital and business performance, but not the relationship between non-ICT capital and business performance.

In Figure 4.4 we can see the statistically significant path coefficients of the TQM structural model. We remark that the path from ICT investment to TQM is not statistically significant, while on the contrary, the path from TQM to business performance, as well as the direct path from ICT investment to business performance (as in the BPR structural model shown in Figure 4.3) are statistically significant (0.172 and 0,345 respectively); thus hypothesis 4.2.2 and 4.2.3 are supported, while 4.2.1 is not supported. Therefore the effect of ICT investment on the extent of TQM practices is not statistically significant, but TQM practices enhance business performance; it should be noted that this positive and statistically significant relationship found between TQM and business performance is consistent with the conclusions of the previous relevant empirical studies on the effect of TQM on business performance reviewed in 4.2.3. However, the above results indicate that TQM does not have a mediation effect on the relationship between ICT investment and business performance, so hypothesis 4.2 is not supported. This finding is not in agreement with the conclusions of the only empirical study conducted on this issue by Martinez-Lorente et al. (2004), who found a mediation effect of TQM on the abovementioned relationship; however, we should take into account that their study included only manufacturing firms, so their ICT assets are much less important for them in comparison to their non-ICT assets, while the present study includes firms from 27 different sectors covering both manufacturing and services.

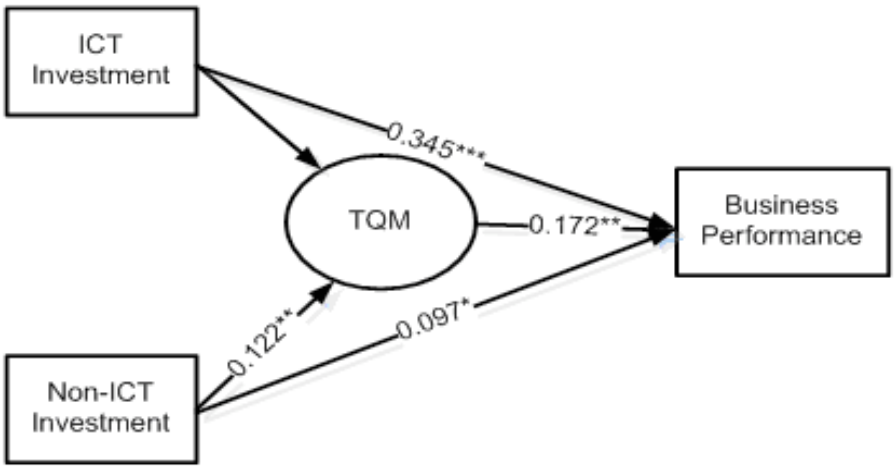


Figure 4.4: The TQM structural model

Finally, we remark that the path from non-ICT investment to TQM is statistically significant (0.122), so hypothesis 4.1 is supported; taking also into account that the path from TQM to business performance is significant as well (0,172, providing support to hypoth-

esis 4.2, which is the same as hypothesis 2.2), we can conclude that TQM has a mediating effect on the relationship between non-ICT investment and business performance, providing thus support for hypothesis 4. Also, we remark that the direct path from non-ICT investment to business performance is statistically significant (0.097) in this model as well (as it was in the BPR structural model shown in Figure 4.3), which confirms that non-ICT investment has a direct contribution to business performance; therefore hypothesis 4.3 is also supported. The above results lead to the conclusion that TQM has a partial (but not complete) mediation effect on the relationship between non-ICT investment and business performance. We also remark that the indirect effect of non-ICT capital on business performance through TQM (equal to 0,122x0.172=0,021) is weaker than the direct one (0,097); so we can conclude that in the Greek national context a medium to small part of the effect of non-ICT capital on business performance is through enabling and facilitating TQM that has a positive impact on business performance (equal to 0,021/(0,097+0,021)=17,8% of the total effect).

The above conclusions reveal another important difference between ICT and non-ICT capital concerning their relation with TQM and also the mediation role of TQM in their relationships with business performance. As mentioned in section 4.3, according to the structural contingency theory (Donaldson 2001), organizations tend to fit their structure and processes to some important contingencies, such as environment, strategy, size, and technology. Our empirical results indicate that investments in non-ICT assets, such as sophisticated and complex production equipment, cause considerable changes in the production technology (which constitutes an important contingency), so they result in appropriate adaptations of structures and processes, such as the ones that TQM includes, aiming at maximizing the business value that these new non-ICT assets generate. For instance, the additional costs that these assets generate (e.g. depreciation, maintenance, etc.) necessitate the highest possible exploitation of them by reducing downtime and defective products, so they result in a higher degree of adoption of statistical quality control, permanent quality improvement teams and continuous quality improvement; also, the higher capabilities offered by these additional assets necessitate the optimal exploitation of them for creating value for the customer, resulting in higher level of attention to customers' needs and satisfaction. Furthermore, new non-ICT assets usually need more and higher quality inputs from external suppliers (e.g. various materials), which increase the degree of cooperation with suppliers for achieving high quality of these inputs.

On the contrary, as our empirical results indicate, the acquisition of more ICT assets do not significantly affect the degree of adopting TQM practices, such as statistical quality control, permanent quality improvement teams, continuous quality improvement, cooperation with suppliers for inputs' quality improvement, etc. Therefore, it can be concluded that while non-ICT capital acts as a driver of the evolutionary and continuous changes of business processes that TQM includes, this does not happen with ICT capital; for this reason TQM partially mediates the relationship between non-ICT capital and business performance, but not the relationship between ICT capital and business performance.

4.5 Conclusions, limitations and further research directions.

There is extensive literature arguing that the most beneficial aspect of ICT is its potential as catalysts and enablers of big improvements of existing business processes, which can

lead to big increases of business performance. In this direction the role of business process change as a mediator in the relationship between ICT and business performance has been widely discussed and emphasized in the relevant literature based on a rich theoretical argumentation in the literature; however, it has been empirically investigated only to a very small extent, with main emphasis on one of business process paradigms: BPR. Chapter 4 contributes to filling this empirical research gap. i) It empirically investigates and compares the mediation effects of the two main paradigms of business process change, BPR and TQM, on the relationship between ICT investment and business performance; ii) it empirically investigates and compares the mediation effects of BPR and TQM on the relationship between non-ICT investment (in 'regular capital', such as mechanical equipment, physical structures, etc.) and business performance, and proceeds to a comparison between ICT investment and non-ICT investment in this respect; iii) it is based on a sound and established theoretical foundation from the area of microeconomics, the Cobb-Douglas production function, so it includes all the fundamental independent variables; iv) BPR and TQM are measured through multi-item scales, which have been developed based on extensive reviews of the relevant literature and then tested in terms of validity and reliability using the methods proposed by the relevant statistical literature; and finally v) it uses objective measures of business performance, ICT investment and non-ICT investment.

From this empirical investigation it has been concluded that BPR partially mediates to a small extent the relationship between ICT investment and business performance, while TQM does not exhibit such a mediation effect; ICT investment has a positive effect on the extent of BPR but not on the extent of TQM, while both BPR and TQM have a positive effect on business performance. These results indicate that in the Greek national context ICT assets are to a small extent enablers and facilitators of BPR that enhances business performance; on the contrary they do not act as enablers and facilitators of TQM. From the similar analysis performed for non-ICT investment it has been concluded that TQM partially mediates to a small to medium extent the relationship between non-ICT investment and business performance, while BPR does not exhibit such a mediation effect; non-ICT investment has a positive effect on the extent of TQM, but not on the extent of BPR. These results indicate that, in the Greek national context, non-ICT assets are to a small to medium extent enablers and facilitators of TQM that enhances business performance; on the contrary they do not act as enablers and facilitators of BPR. Also, the above findings shed light on the differences between ICT investment and non-ICT investment as enablers and facilitators of business process change; each of them seems to drive a different type of business process change: ICT investment as a 'general purpose' technology drives the radical and discontinuous BPR, while non-ICT investment drives the evolutionary and continuous TQM.

Chapter 4 includes interesting research implications. First, it offers an insight into the differences between the two main business process change paradigms, BPR and TQM, as to their relations with the ICT capital and non-ICT capital, and also their mediation role in the relations of these two types of capital with business performance. Second, it offers an insight into the differences between ICT capital and non-ICT capital as enablers and facilitators of business process change. Third, it provides a useful framework, which is based on a sound and mature foundation from the area of microeconomics, the Cobb-Douglas production function, for empirically investigating relations between ICT capital,

non-ICT capital, business process change and business performance; this framework can be useful for the future empirical research required in this area. Fourth, it has developed and tested multi-item scales for measuring the extent of BPR and TQM, which are based on extensive reviews of the relevant literature, which can be used in future empirical research concerning the impact and the antecedents of BPR and TQM.

There are also interesting managerial implications. ICT capital should not be used for simply automating existing business processes, but for redesigning them exploiting the capabilities offered by ICTs and taking into account the 'new assumptions' they create: low costs of communication and information processing, electronic paperless modes of office work and decreasing time and space limitations. In particular, ICT should be used for radical improvements and simplifications of business processes, abolition of processes that can be fully automated and performed by computers without human intervention and creation of new horizontal interdepartmental processes, workgroups and roles that focus on particular customers, products or projects. For this purpose firms should exploit to the highest extent the nine modes of using ICT for supporting BPR proposed by Davenport (1993): automational, informational, sequential, tracking, analytical, geographical, integrative, intellectual and disintermediating. On the other hand TQM seems to be more related to non-ICT assets, since the traditional assets (e.g. production equipment) should be systematically monitored, measured and controlled so that firm output reaches the expected levels and the value generated for the firm can be maximized. For this reason the 'hard' investment in non-ICT capital should be combined with 'soft' investment in TQM practices, such as statistical quality control, permanent quality improvement teams, continuous quality improvement, cooperation with suppliers for inputs' quality improvement, systematic measurement and monitoring of customers' satisfaction, work simplification focused on errors' reduction and quality improvement and also systematic measurement and monitoring of employees' satisfaction.

While the abovementioned contributions are significant, it has some limitations, which provide space for further research. First, it has been based on a sample of Greek firms, so its results may have been influenced by characteristics (e.g. technological, economic, cultural, social, etc.) of the Greek national context. As mentioned in the introduction, Greece is a small country (with about eleven million population), with a small size of internal market and small average firm size; it does not belong to the highly technologically and economically developed countries, but it has made considerable progress in the last twenty years and has become a full member of the European Economic and Monetary Union. Also, from a cultural viewpoint, we examined the scores of Greece in the four main dimensions of national culture proposed by Hofstede (2005) - Power Distance Index, Individualism, Masculinity and Uncertainty Avoidance Index – focusing on the Uncertainty Avoidance Index (UAI), which we expect to be the main national culture dimension that affects business-process change. From Geert Hofstede's website (http://www.geert-hofstede.com/) we can see that the UAI score for Greece is very high (112), much higher than the other European countries, especially the northern ones (e.g. the UAI score is 80 for Italy, 90 for France and Spain, but 38 for United Kingdom and 30 for Sweden); this indicates that the national culture of Greece is risk-averse, which might affect negatively business process change and its relations with ICT capital, non-ICT capital and business performance.

For the above reasons, it would be interesting to investigate the mediation effects of these two main business change paradigms, BPR and TQM, on the relationships of ICT and non-ICT investment with business performance, in other national contexts as well, which are characterized by bigger internal market size, higher technologic and economic development, and also less risk-averse culture. Second, the present study uses only one business performance measure, value added per employee (labour productivity), though fundamental (as it incorporates the value of the products and services a firm produces, the value of the materials and services it buys from external suppliers and also the number of its employees, which is supported by a sound and established theoretical foundation from the area of microeconomics, the Cobb-Douglas production function), and widely used in many empirical studies of the effect of ICT and organizational change on business performance. So it would be interesting to conduct similar empirical studies using more financial and non-financial measures of business performance as dependent variables.

CHAPTER 5

The Moderating Role of BPR and TQM on ICT Business Value

5.1 Introduction

As mentioned in the previous chapter, research on the relationship between ICT investment and business performance has shown a contradiction over the years. Earlier studies did not find evidence about a statistically significant association between ICT investment and business performance (e.g. Roach 1987, Strassman 1990, Brynjolfsson 1993, Loveman 1994, Strassman 1997), whereas more recent ones have provided substantial evidence that ICT investment has a positive and statistically significant impact on business performance (e.g. Brynjolfsson & Hitt 1996, Stolarick 1999, Preslac 2003). Therefore current research in this domain focuses on the identification and investigation of 'ICT complementary factors', which, if combined with ICT, can increase this positive impact and in general the business value that ICT generates (Melville et al 2004, Arvanitis 2005, Wan et al 2007). The most widely ICT complementary factor discussed in the literature is business process change; its potential as a moderator of ICT business value has been emphasized by the relevant literature based on a rich argumentation (e.g. Hammer 1990, Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 1998, Brynjolfsson & Hitt 2000, Bresnahan et al 2002, OECD 2004, Melville et al 2004).

Business Process Reengineering (BPR) and Total Quality Management (TQM) constitute the two main paradigms of business process change. However there are significant differences between them: BPR is radical, revolutionary and follows an one-time approach, while on the contrary TQM is incremental, evolutionary and continuous. Both of them rely to a large extent on ICT, as described in more detail in the section 5.2.

The relevant literature has examined the moderating role of BPR on ICT business value only to a very small extent using large datasets (Grover et al 1998, Devaraj & Kohli 2000), while the moderating effect of TQM on ICT business value has not been empirically investigated. Even these very few empirical studies of the moderating role of BPR, as described in the following section 5.2, are not based on theoretically sound models including all the fundamental variables; also, they are measuring the extent of BPR in a simplistic way using only one item (i.e. through one simple question), which may result in reduced measurement reliability. Therefore further empirical research is necessary concerning the moderating effects of those two different business process change paradigms on ICT business value in various sectoral and national contexts, based on sound theoretical foundations, large datasets, models including all fundamental variables, as well as using appropriate multi-item constructs for measuring both BPR and TQM with high levels of reliability. This would be the only way in order to draw sound conclusions as to what extent the abovementioned expectations of the literature are realized. The results of this research will be useful to both the business and the ICT management community and to the research community.

In the present chapter we attempt to fill this research gap by presenting an empirical investigation and comparison of the moderating effect of BPR and TQM on the business value generated by ICT, which is quantified in an objective manner as the contribution of ICT investment, to firm value added, using firm-level data from 271 Greek firms. As in the previous chapter, multi-item BPR and TQM constructs are developed based on the BPR and TQM literature, and their validity and reliability is tested using the methods proposed by the relevant statistical literature (e.g. Chin 1998, Straub et al 2004, Kline

2005). Based on those constructs, moderated regression models of firm value added have been constructed, including all the fundamental independent variables, founded on the Cobb-Douglas production function, which constitutes a sound and mature theoretical foundation from the domain of microeconomics. In a similar manner the particular BPR and TQM activities with significant moderating effects will be identified.

In the following Section 5.2 previous relevant research is briefly reviewed. Then in section 5.3 the research hypotheses, method and data are described. Data analysis and results of this study are presented in Section 5.4, while in the final section 5.5 the conclusions and limitations of this study are discussed and further research directions are proposed.

5.2 Literature review

There is considerable literature arguing that ICT can be used for enabling big transformations of existing business processes, which can result in high levels of business benefits and significant increase of business performance (e.g. Hammer 1990, Hammer & Champy 1993, Davenport 1993, Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 1998, Gunasekaran & Nath 1997, Brynjolfsson & Hitt 2000, Bresnahan et al 2002, OECD 2004, Melville et al 2004, Pantazi & Georgopoulos 2006). Michael Hammer (1990), one of the founders of BPR, in his highly influential paper 'Re-engineering Work: Don't Automate, Obliterate' states that 'Instead of embedding outdated processes in silicon and software, we should obliterate them and start over. We should "reengineer" our businesses: use the power of modern information technology to radically redesign our business processes in order to achieve dramatic improvements in their performance'. In the same direction Brynjolfsson and Hitt (1996) argue that one of the explanations of the widely discussed in the 90s "ICT Productivity Paradox" is that firms needed a period of learning how to utilize and exploit ICT and how to make the appropriate process adjustments before they could reap the full benefits that ICTs can offer. In a more recent work they argue that, since most of the existing business processes have been designed in the past before the emergence of ICT, they reflect the high costs of communication and information processing and the dominant manual mode of office work at that time; they conclude that since modern ICTs can reduce dramatically communication and information processing cost and enable new electronic modes of office work, they can be enablers and facilitators of new enhanced business processes, which can lead to big productivity increase (Brynjolfsson and Hitt, 2000). Bresnahan et al (2002) conclude that the three most important elements of modern economy are ICT, workplace reorganization and new products and services, which are closely associated and exhibit high levels of complementarity. There is also considerable literature reporting case studies of firms that have successfully used ICTs for reengineering their processes and finally achieving significant benefits and higher business performance (e.g. Davenport and Nohria 1994, O'Neill and Sohal 1999, Hunter et al 2000, Attaran 2003).

However, the moderating role of BPR on ICT business value has only to a very small extent been empirically investigated using large datasets. Grover et al (1998) have investigated empirically whether the perceived extent of ICT-related process change has a moderating effect on the relationship between ICT diffusion and perceived ICT-related productivity improvement, using data collected through a survey from 313 senior ICT exec-

utives of USA large service and manufacturing firms (over half of them having more than 2500 employees) and based on them constructing moderated regression models. Their main conclusions were that ICT diffusion has a positive impact on the perceived ICT-related productivity improvement, and that the perceived extent of ICT-related process change moderates this relationship only for the client/server technologies. This study used subjective single-item measures of ICT-related process change and ICT-related productivity improvement (based on perceptions of firms' managers).

Devaraj & Kohli (2000) have empirically investigated (in a health care organization context) the effect of the expenses made for a particular decision support system on four measures of hospitals' performance (net patient revenue per day, net patient revenue per admission, mortality rate and customer satisfaction) as well as the moderating role of BPR perceived effectiveness on these relationships. Using monthly data from USA hospitals they constructed moderated regression models of these four performance variables. From these models it has been concluded that the expenses for this particular decision support system have a positive impact on all these four performance variables, and that BPR perceived effectiveness moderates three of these relationships (with the exception of the one concerning the mortality rate). This study used a subjective single-item measure of BPR effectiveness (based on perceptions of hospitals' managers).

Concerning TQM, there is considerable literature describing how ICT can be used for supporting it, making it more efficient and increasing the business value it generates (Giffi et al 1990, Weston 1993, Flynn et al 1994, Forza 1995a and 1995b, Kock & McQueen 1997, Dewhurst et al 2003). Giffi et al (1990) argue that computers play a critical role in quality management, since they can significantly support statistical process control, reduce the effort required by production personnel for collecting and analyzing quality data and also shorten the reaction time between the collection of process data and the implementation of corrective actions that might be required, having the potential to increase in these ways the efficiency and the business benefits of quality management.

In the same line Forza (1995a and 1995b) from an empirical study in 34 industrial plants in Italy found that quality management practices can be significantly supported by eight basic quality information flows: quality performance feedback to managers and superintendents, visible and timely feedback on quality (e.g. defects rate, machines breakdown frequencies, etc.), information on internal quality inspections and audits, information on machines (e.g. maintenance, operation, setup, etc.), information for the identification of causes of non-quality, documentation on production procedures, information exchange with customers and suppliers on quality; so he concluded that supporting these information flows through ICT can contribute to improving quality performance. However he did not succed in empirically establishing a link between TQM practices and IT proposing that the contribution of IT should be further investigated by developing adequate measures especially with reference to its use. Those companies who apply TQM perceive a larger impact of IT on their TQM dimension (Martinez-Lorente et al.; 2004).

Dewhurst et al (2003) through a multiple case study of 14 Spanish companies found that ICTs can effectively support TQM in improving customer and supplier relationship, increasing process control, facilitating teamwork, facilitating inter-departmental information flow, improving design process and skills, applying preventive maintenance, intro-

ducing ISO 9000, measuring quality costs and improving the decision process in quality departments, resulting finally in higher quality, operational and financial performance.

From the literature reviewed regarding moderating effects of BPR it is concluded that the abovementioned studies measure business performance with subjective (non-financial) measures which may be adopted by various researchers especially during the last years, however they have serious limitations. Hyvonen (2007) notes that "while there has been extensive interest in the role of contemporary measures to assist in developing differentiation strategies including customer-focused strategies, survey evidence suggests that financial measures remain important to managers". It should also be noted that in the regression models of both these studies only independent variables associated with ICT capital and BPR have been included. However other fundamental independent variables, which according to basic microeconomic theory (e.g. Nicholson 1998) affect substantially business performance, such as variables associated with non-ICT capital, labor, etc, have not been included. This omission of important independent variables, according to the relevant econometric modeling literature (e.g. Greene 2003, Gujarati 2003), may cause significant inaccuracies and introduce biases in the estimated coefficients of the constructed regression models.

The reviewed literature on the role of TQM on the ICT-business perofrmance relationship revealed an absence of empirical evidence. Rodriquez et al. (2006) note that few authors have provided convincing evidence on the effects of IT on TQM and business performance. Due to this lack of clear evidence concering this relationship, the moderating effect of TQM on ICT business value has not been empirically investigated.

This study tries to bridge those research gaps by investigating, at the same time, the moderating effects of the two main business process change paradigms, BPR and TQM, on ICT business value in various national and sectoral contexts. This investigation will be conducted with the same dataset using sound theoretical foundations, which include all the fundamental independent variables. BPR and TQM, which constitute highly abstract and multidimensional concepts, are being estimated through multi-item scales with high levels of reliability.

5.3 Research hypotheses, method and data

In this direction the research objective of this study is to empirically investigate and compare the moderation effects of BPR and TQM on the business value generated by ICT, which is quantified in an objective manner as the contribution of firm ICT investment to firm value added. So our first research hypothesis concerns the moderation effect of BPR on the relationship between ICT investment and firm value added. As mentioned in the previous section 5.2, most of the existing business processes of firms have been designed in the past before the emergence of ICT; their design has been based on two assumptions: the dominant manual mode of office work and the high costs of communication and information processing at that time (Hammer 1990, Hammer & Champy 1993). These assumptions are not valid today due to the emergence of ICT, which enable new electronic modes of office work and reduce dramatically communication and information processing costs. For this reason automating those existing business processes using ICT will result in a suboptimal level of business benefits from ICT; the optimal level of benefits from

ICT will be achieved only if it is combined with a redesign of business processes based on the 'new assumptions' that ICT have generated: the low costs of communication and information processing and the new electronic mode of office work. In this direction there is considerable literature, as mentioned in section 5.2, arguing that ICT can be enablers and facilitators of new enhanced business processes, which can lead to big increase of business performance (e.g. Hammer 1990, Hammer & Champy 1993, Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 1998, Gunasekaran & Nath 1997, Brynjolfsson & Hitt 2000, Bresnahan et al 2002, OECD 2004, Melville et al 2004, Pantazi & Georgopoulos 2006). For the above reasons we expect that the combination of ICT investment with BPR will result in more beneficial ways of using ICT and in more valuable applications, and will thus increase the contribution of ICT investment to firm value added. Therefore our first hypothesis is:

Hypothesis 5.1: The extent of BPR moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1 should be also examined for every single BPR activity, as well:
Hypothesis 5.1.1: The extent of process simplification moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.2: The extent of process improvement moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.3: The extent of horizontal process creation moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.4: The extent of process deletion moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.5: The extent of process redesign in order to become more customer focused moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.6: The extent of horizontal workgroup development moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.7: The extent of process coordinator roles development moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.8: The extent of job enrichment moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.1.9: The extent of supervision decrease moderates positively the contribution of ICT investment to firm value added.

The second hypothesis concerns the moderation effect of TQM on the relationship between ICT investment and firm value added. TQM practices are data intensive, so they can be significantly supported and enhanced through the use of ICTs. In particular, the use of ICT can significantly support and enhance the basic TQM practices, such as statistical process control, preventive maintenance, cooperation with customers and suppliers on quality, teamwork, design of products, introduction of ISO 9000, collection and analysis of quality data, inter-departmental information flow, etc, and increase of the business benefits these practices offer. In this direction there is considerable literature, as mentioned in section 5.2, describing how ICT can be used for supporting TQM and making it more efficient, so that a higher level of business benefits can be achieved (Giffi et al 1990, Weston 1993, Flynn et al 1994, Forza 1995a and 1995b, Kock & McQueen 1997, Dewhurst et al 2003). For these reasons we expect that the combination of ICT investment with TQM will result in more beneficial ways of using ICT and in more valuable

applications, increasing thus the contribution of ICT investment to firm value added. Therefore our second hypothesis is:

Hypothesis 5.2: The extent of TQM moderates positively the contribution of ICT investment to firm value added.
Similarly, hypothesis 5.2 will also be examined for every TQM activity separately:
Hypothesis 5.2.1: The extent of using statistical quality control methods moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.2.2: The extent of operating permanent quality improvement teams moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.2.3: The extent of systematic measurement of customer satisfaction moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.2.4: The extent of cooperating with suppliers for quality improvement moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.2.5: The extent of work simplification for quality improvement moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.2.6: The extent of systematic measurement of employee satisfaction moderates positively the contribution of ICT investment to firm value added.
Hypothesis 5.2.7: The extent of continuous quality improvement moderates positively the contribution of ICT investment to firm value added.

The basic theoretical foundation we used for testing the above two hypotheses was the Cobb-Douglas production function (Nicholson, 1998). It constitutes a sound and mature foundation from the area of microeconomics, which includes all fundamental variables that affect firm output, and has been extensively used in the past for estimating the contribution of firm inputs, including ICT capital (e.g. see Brynjolfsson & Hitt 1996, Stolarick 1999, Preslac 2003), to firm output. In particular, we have used an extended form of the-Cobb Douglas production function (see equation 3.1 in Chapter 3), in which the capital is divided into computer capital and non-computer capital:

$$VA = e^{\beta_0} L^{\beta_1} K^{\beta_2} CK^{\beta_3} \qquad (3.1)$$

where VA is the yearly firm value added (= yearly sales revenue minus yearly expenses for buying materials and services), and L, K and CK are the yearly labour expenses, the value of the non-computer capital and the value of the computer capital respectively (described in chapter 3). By log-transforming (3.1) we obtain the following linear form of it:

$$\ln VA = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(CK) \qquad (3.2)$$

In order to investigate the moderating effect of the above two business process change paradigms, BPR and TQM, on the contribution of ICT to firm output, we have added an 'interaction term' (Aiken & West 1996, Venkatraman 1989, Gujarati 2003), which is equal to the product of the corresponding business process change factor F (i.e. extent of BPR or extent of TQM) to ln(CK):

$$\ln VA = \beta_0 + \beta_1 \ln(L) + \beta_2 \ln(K) + \beta_3 \ln(CK) + \beta_4 \ln(CK) \cdot F \qquad (3.3)$$

As mentioned in the previous chapters the extent of BPR and TQM constitute highly abstract and multidimensional concepts, which cannot be measured by only one item, so it

was decided to measure them as multi-item constructs based on structural equation modelling (SEM; Kline, 2005) principles. The extent of BPR has been measured through a nine-item scale whereas the extent of TQM through a seven-item scale (Appendix 4).

The above hypotheses 5.1 and 5.2 were tested by estimating initially model (3.2) and then model (3.3) for F equal to the extent of BPR (calculated as the average of the above nine BPR items) and then to the extent of TQM (calculated as the average of the above seven TQM items) and examining the statistical significance of the corresponding interaction terms. For hypotheses 5.1.1-5.1.9 and 5.2.1-5.2.7 we estimated model (3.3) for F equal to the extent of implementing a particular BPR or TQM activity each time (i.e. 9+7=16 times).

For the estimation of the above regression models we used data collected through a survey among Greek companies, which was conducted in cooperation with ICAP, one of the largest business information and consulting companies of Greece (see chapter 3). The particular questions of this survey concerning the financial data of the company and the extent of its BPR and TQM activities that have been used in this study are shown in Appendix A (questions 1-7).

5.4 Data analysis and results

Table 5.1 presents some descriptives for the BPR and TQM acivities (see also Appendix A), in order to show the extent of their deployment and use. For example process improvement, process redesign and process simplification are the most extensively used BPR activities in a total of nine. On the other hand cooperation with suppliers for imporving quality of goods produced, measurement of customer satisfaction as well as work simplification for quality enhancement are the most famous TQM activities used by Greek firms.

BPR activities	**Description**	**Mean**	**Std. Deviation**
BPR_1	Process simplification	3,33	1,01
BPR_2	Process improvement	3,64	0,90
BPR_3	Horizontal process creation	2,94	1,20
BPR_4	Process abolition	2,70	1,06
BPR_5	Process redesign	3,42	1,02
BPR_6	Workgroup creation	2,60	1,17
BPR_7	Process coordinator role creation	2,62	1,15
BPR_8	Job enrichment	2,91	1,04
BPR_9	Supervision decrease	2,38	1,03
TQM activities		**Mean**	**Std. Deviation**
TQM_1	Use of quality control	2,90	1,35
TQM_2	Process improvement teams	2,75	1,42
TQM_3	Measurement of customer satisfaction	3,38	1,29
TQM_4	Cooperation with suppliers	3,44	1,22

TQM_5	Work simplification	3,25	1,12
TQM_6	Measurement of employee satisfaction	2,79	1,18
TQM_7	Continuous quality improvement	3,79	1,14

Table 5.1: Descriptives for the BPR and TQM activities.

5.4.1 BPR and TQM construct validity and reliability assessment

Initially we tested the construct validity of the above BPR and TQM multi-item constructs, focusing on its two most important dimensions: convergent and discriminant validity. Convergent validity of the BPR and the TQM constructs was tested through confirmatory factor analysis (Straub et al 2005, Kline 2005). In particular, we hypothesized each of them to be a latent factor reflected by its items (i.e. BPR reflected by its corresponding 9 items and TQM reflected by its corresponding 7 items) and we estimated the corresponding two models using the AMOS 7 software (Byrne 2001); their goodness-of-fit indices and item loadings are shown in tables 5.2 and 5.3 respectively.

	BPR	**TQM**
Chi-Square	89.65	25.2
RMSEA	.101	.059
Incremental Fit		
NFI	.939	.978
RFI	.909	.964
IFI	.955	.989
TLI	.932	.982
CFI	.955	.989

Table 5.2: Goodness-of-fit indexes for the BPR and TQM models

BPR		**TQM**	
Indicator	Loading	Indicator	Loading
BPR_1	.722	TQM_1	.600
BPR_2	.698	TQM_2	.673
BPR_3	.783	TQM_3	.824
BPR_4	.694	TQM_4	.804
BPR_5	.706	TQM_5	.798
BPR_6	.781	TQM_6	752
BPR_7	.751	TQM_7	.825
BPR_8	.729		
BPR_9	.676		

Table 5.3: Item loadings of the BPR and TQM constructs.

From table 5.2 we can see that for both models the incremental fit indexes are within the limits recommended by Gefen et al (2000) (≥ 0.9); RMSEA for the TQM model is within the limits recommended by Browne and Cudeck (1993) (≤ 0.08), while for the BPR model

it is a little higher. The item loadings of these two constructs shown in table 5.3 are all statistically significant and exceed the 0.6 minimum acceptable level suggested by Chin (1998). Taking into account all the above results we conclude that both constructs are characterised by convergent validity.

Next, discriminant validity of the BPR and TQM constructs was tested by performing factor analysis with varimax rotation using the SPSS 15.0 software. As well as the reliability of the above BPR and TQM constructs was tested by calculating their Cronbach's Alpha coefficients. The same procedure has been followed as in chapter 4 (table 4.3) and is not going to be repeated again. The results clearly indicate discriminant validity and reliability of the two constructs.

5.4.2 Moderating effects

Having confirmed the validity and reliability of the BPR and TQM constructs we proceeded to the investigation of the moderating effects of BPR and TQM on ICT business value, which is quantified as the contribution of firm ICT investment to firm value added, by estimating regression models (3.2) and (3.3). In these models were additionally included two dummy variables controlling for firm size: D_Large (it is equal to 1 for large firms having more than 250 employees and 0 for all other firms) and D_Medium (it is equal to 1 for medium firms having more than 50 and less than or equal to 250 employees and 0 for all other firms). In table 5.4 we can see the results from the estimation of the model of equation (3.2). We can see that the coefficients of labour, non-computer capital and computer capital are all positive and statistically significant, so we conclude that all these three inputs make a positive contribution to firm value added.

Dependent variable : ln (VA)				
Independent variable	Coefficient	Standard Error	Standardized Coefficient	Significance
Constant	4.204	0.685		0.000
ln (L)	0.474	0.054	0.454	0.000
ln (K)	0.083	0.034	0.105	0.015
ln (CK)	0.248	0.043	0.275	0.000
D_Large	0.773	0.226	0.194	0.001
D_Medium	0.397	0.157	0.108	0.012

Table 5.4: Regression model for the impact of labour, non-computer capital and computer capital on firm value added

In Table 5.5 we can see the results from the estimation of the model of equation (3.3) for F equal to the extent of BPR measured by the average of the abovementioned nine BPR items. We remark that the coefficients of labour, non-computer capital and computer capital remain all positive and statistically significant, and also that the coefficient of the interaction term between computer capital and BPR is positive and statistically significant. This result indicates that the extent of BPR moderates positively the contribution of ICT investment to firm value added and provides support for hypothesis 5.1. In particular, this model indicates that the contribution of ln(CK) to ln(VA) is equal to (0.202 +

0.013*BPR)*ln(CK), so if the extent of BPR takes its lowest value being equal to 1 (corresponding to not performing at all any of the nine considered BPR activities) this contribution is equal to 0.215*ln(CK); however, if BPR takes its highest value being equal to five (corresponding to a very large extent of performing all these BPR activities) this contribution will be higher and equal to 0.267*ln(CK). Therefore, if ICT investment is combined with extensive BPR, the contribution of ln(CK) to ln(VA), which equals to the output elasticity of the computer capital (see Brynjolfsson et al 1996, Nicholson 1998), will increase by (0.267/0.215)-1=0.242, i.e. by 24.2%, in comparison with the case of having ICT investment without any BPR at all.

Dependent variable : ln (VA)				
Independent variable	Coefficient	Standard Error	Standardized Coefficient	Significance
Constant	4.350	0.685		0.000
ln (L)	0.479	0.054	0.458	0.000
ln (K)	0.077	0.034	0.097	0.023
ln (CK)	0.202	0.049	0.224	0.000
ln (CK)*BPR	0.013	0.006	0.085	0.051
D_Large	0.750	0.225	0.188	0.001
D_Medium	0.365	0.157	0.099	0.012

Table 5.5: Regression model for the impact of labour, non-computer capital, computer capital and interaction between computer capital and extent of BPR on firm value added

Table 5.6 shows the results from the estimation of the model of equation (3.3) for F equal to the extent of TQM measured by the average of the abovementioned seven TQM items. We remark that the coefficients of labour, non-computer capital and computer capital again remain all positive and statistically significant, and that the coefficient of the interaction term between computer capital and TQM is positive and statistically significant. This result indicates that the extent of TQM moderates positively the contribution of ICT investment to firm value added and provides support for hypothesis 5.2. In particular, this model indicates that the contribution of ln(CK) to ln(VA) is equal to (0.201 + 0.014*TQM)*ln(CK), so if the extent of TQM takes its lowest value being equal to 1 (corresponding to not performing at all any of the seven considered TQM activities shown in the Appendix) this contribution is equal to 0.215*ln(CK); however, if TQM takes its highest value being equal to five (corresponding to a very large extent of performing all these TQM activities) this contribution will be higher and equal to 0.271*ln(CK). In conclusion, if ICT investment is combined with extensive TQM, the contribution of ln(CK) to ln(VA), which equals to the output elasticity of the computer capital as mentioned above, is going to increase by (0.271/0.215)-1=0.26 (i.e. 26%) in comparison with the case of having ICT investment without any TQM at all.

Dependent variable: ln (VA)				
Independent variable	Coefficient	Standard Error	Standardized Coefficient	Significance
Constant	4.214	0.675		0.000

ln (L)	0.488	0.054	0.467	0.000
ln (K)	0.070	0.033	0.090	0.036
ln (CK)	0.201	0.046	0.223	0.000
ln (CK)*TQM	0.014	0.005	0.104	0.006
D_Large	0.771	0.222	0.193	0.001
D_Medium	0.373	0.155	0.101	0.017

Table 5.6: Regression model for the impact of labour, non-computer capital, computer capital

A comparison betwen the moderating effects of BPR and TQM on the contribution of ICT investment to firm value added leads to the conclusions that they are of similar magnitude, since the small difference between the coefficients of the corresponding interaction terms in the models of Tables 5.5 and 5.6 (0.013 and 0.014 respectively) is much lower than their standard errors (0.006 and 0.005 respectively).

Furthermore, in order to identify the BPR and TQM activities, which have the major influence in business performance creation, we ran the above regression models for F equal to the extent of implementing each BPR and TQM activitiy seperately (total 16 regression models). The results showed that 5 BPR and 5 TQM activities were significant and moderate positively the effect of ict investments on business performance (table 5.7). We note that the coefficients of labor, non-computer capital and computer capital were significant in all models. More particularly, process creation, development of workgroups, creation of coordinator roles, process simplification and process abolition were the BPR activities that affect significanly business performance if combined with ICT investments, providing thus support for hypotheses 5.1.1, 5.1.2, 5.1.3, 5.1.4, and 5.1.6. On the other hand hypotheses 5.1.5, 5.1.7, 5.1.8, and 5.1.9 were not supported. Regarding TQM, the establishment of quality improvement teams, measurement of customer satisfaction, cooperation with suppliers, work simplifiction and measurement of employee satisfaction were found to have a moderating effect on performance. Therefore hypotheses 5.2.2-5.2.6 were supported whereas 5.2.1 and 5.2.7 were not.

The extent of the moderating effect for each activity can be calculated as in the previous regression models (tables 5.6 and 5.7). For example for BPR_1 the contribution of ln (CK) to ln (VA) equals to (0.190+0.013*BPR_1)*ln (CK). If the extent of implementing BPR_1 takes the lowest value (equals to 1) this contribution equals to 0.203*ln (CK). On the other hand if the extent of implementing BPR_1 takes the highest possible value (equals to 5) the contribution will become equal to 0.255*ln (CK). Therefore if ICT investment is combined with extensive process simplification, its contribution will increase by 0.255/0.203-1=0.26 (i.e 26%) in comparison to the case of not going under process simplification at all. In a similar manner we calculated the positive contribution for each significant BPR and TQM activity (as shown in the fifth column of table 5.7). As we can see process simplifiction and process improvement are the two BPR activities with the largest moderating effect. For TQM our results show that the measurement of employee satisfaction, as well as work method simplification are the activities that moderate the impact of ICT on performance at most.

Dependent variable: ln(VA)					**Coefficient**		
BPR Activity	**Coefficient**	**Standard Error**	**Standardized Coefficient**	**Contribution**	**ln(L)**	**ln(K)**	**ln(CK)**
BPR_1	.013	.005	.103**	.26	.479	.081	.190

BPR_2	.013	.006	.092**	.25	.480	.081	.191
BPR_3	.010	.005	.085**	.18	.480	.074	.211
BPR_4	.009	.005	.069*	.14	.472	.076	.216
BPR_5	-	-	-	-	-	-	-
BPR_6	.009	.005	.073*	.16	.477	.075	.221
BPR_7	-	-	-	-	-	-	-
BPR_8	-	-	-	-	-	-	-
BPR_9	-	-	-	-	-	-	-
TQM Activity							
TQM_1	-	-	-	-	-	-	-
TQM_2	.007	.003	.071**	.12	.483	.076	.224
TQM_3	.008	.004	.074**	.14	.484	.076	.221
TQM_4	.008	.004	.072**	.14	.478	.073	.222
TQM_5	.012	.004	.099***	.21	.481	.072	.212
TQM_6	.015	.004	.127***	.27	.494	.074	.209
TQM_7	-	-	-	-	-	-	-

Table 5.7: Regression models for the impact of each BPR and TQM activities on business performance.

5.5 Conclusions, limitations and further research directions

Chapter 5 presents an empirical investigation and comparison of the moderating role of the two basic process change paradigms, BPR and TQM, on the business value generated for firms by their ICT investments, which aims at contributing to filling the existing research gap on this issue. It also provides useful managerial hints regarding the most widely accepted and used, as well as the most influential BPR and TQM activities. In order to achieve a reliable measurement of BPR and TQM, since they constitute highly abstract and multidimensional concepts, multi-item constructs have been developed based on the relevant literature; their validity and reliability has been tested using the methods proposed by the relevant statistical literature with positive results. Then, based on those constructs, moderated regression models with objective measures of business performance (firm value added) and ICT (value of firm ICT hardware-software and networks) have been constructed, founded on the Cobb-Douglas production function and including all the fundamental independent variables.

The results have shown that both BPR and TQM have considerable positive moderating effects of similar magnitude on the relationship between ICT investment and firm value added. These findings are consistent with the results of the two previous empirical studies of the moderating effect of BPR on ICT business value (Grover et al. 1998, Devaraj and Kohli 2000). It should be noted that the findings of this study confirm the theoretical expectations and arguments of the relevant literature, which have been mentioned in the Introduction, that BPR constitutes an important 'ICT complementary factor', which, if combined with ICT, can increase the positive impact and in general the business value that ICT generates. Another important contribution is the identification of the 'most valuable' BPR and TQM activities by constructing regression models with each activity separately. The results show that process simplification and improvement as well as horizontal process creation are the BPR activities that have shown to contribute most in business

performance if combined with ICT investments. On the other hand systematic measurement of employee satisfaction, simplification of working tasks and cooperation with suppliers are the TQM activities that add value to firms.

This chapter contributes to the very limited empirical literature on the moderating effect of business process change on ICT business value, based on a reliable measurement of BPR and TQM and on theoretically sound models based on the Cobb-Douglas production function and including all the fundamental independent variables. Also the multi-item BPR and TQM constructs that have been developed and tested in this study with positive results, and in general the whole adopted approach, could provide useful directions for future empirical research concerning impacts and complementarities of BPR and TQM. Moreover, the multi-item BPR and TQM measurement approach developed in this study allows for the empirical investigation of differing impacts and complementarities of different types of BPR and TQM activities.

Concerning the business and ICT management community, this study has significant ICT management implications, providing useful directions for increasing the value and the benefits that organizations can gain from their ICT investments. In particular, it shows that ICT should not be used simply as a tool for automating existing business processes, which have usually been designed in the past before the emergence of ICT and have been based on the two 'old assumptions': the dominant manual mode of office work and the high costs of communication and information processing at that time. On the contrary, ICT should be used in an innovative manner for creating and supporting new business processes and practices, such as those proposed by the BPR and TQM literature, based on the 'new assumptions' that ICT have generated: the low costs of communication and information processing and the new electronic mode of office work. Such an innovative approach will result in more beneficial ways of using ICT assets in more valuable applications, so it will increase the benefits and business value generated by ICT investment.

The results of this study provide useful direction for managers who decide to invest in information and communication technologies. It is clear that a change management perspective (either BPR or TQM, since both seem to have a similar moderating effect, if implemented properly) should be adapted in order for the new investments to bring about the expected results. If BPR is chosen, existing complex processes should be simplified and problematic or costly ones should be improved since the existence of ICT enables such changes. Processes should be redesigned in a horizontal structure in order to be more effective. In a case of quality program employee satisfaction should be systematically measured and evaluated working methods should become clearer and cooperation with suppliers should be the edge of a good relationship building with stakeholders. We should note however, that managers are aware, if not completely, of what is best for their organizations, since the extent of implementing the above practices, according to their reportings, is satisfactory (table 5.1). However those directions could be quite useful especially for developing econmies (like Greece) where the majority of organizations concerns small and medium enterprises (SME's).

The basic limitation of this study is that it is based on data from Greek firms, so its results might, at least to some extent, reflect the characteristics of the Greek national economic and cultural context (e.g. lower level of economic development, smaller firm size, smaller

size of domestic market, lower level of competition and lower ICT penetration and Internet usage in comparison with the other member-states of the European Union). Another limitation is that only one business performance measure has been used (firm value added). So further empirical research is required concerning the moderation effects of BPR and TQM on ICT business value in various national and sectoral contexts, using more financial indicators of business performance as well as non-financial ones.

CHAPTER 6

Strategy, ICT and non-ICT Investment, Process Change and Business Performance: An Empirical Investigation

6.1 Introduction

In a dynamic and highly competitive environment firms nowadays are struggling to prevail and gain competitive advantage. In an era where information plays the most crucial role, one of the major concerns is the way of information handling. Consequently, the focus is transferred more and more intensively on information technologies (IT) and their ability to handle information and, therefore, businesses are realizing great amounts of investments in ICT. However competitive advantage is not gained simply by investing in ICT. In other words enhanced business performance is not only dependent by the amount of investment in iCT's, but also by other factors as well.

The relationship between ICT investment and business performance has been studied in depth in the previous chapters. The "productivity paradox" phenomenon (Brynjolfsson, 1993) has been broadly analyzed by researchers and answers have been provided (Brynjolfsson and Hitt, 1996; Stolarick, 1999; Devaraj and Kohli, 2000). The main reason for it has been found to be the inability of firms to exploit the full potential of ICT by asjusting and improving existing business processes based on the capabiities offered by ICTs. According to Bryjolffson and Hitt (2000) the most beneficial aspect of ICTs is that they are catalysts and enablers of big improvements of existing business processes and work practices, which in turn lead to high levels of benefits. For this reason they expect that the main mechanism of business value creation from ICT investment will not be the simple automation of existing business processes, but the IT-enabled change and improvement of them, which can lead to quite satisfactory business benefits. The most widely known and used process change approaches are business process reengineering (BPR) and total quality management (TQM).

The positive effects of ICT investments, BPR and TQM on business performance have been extensively mentioned by the existing literature (OECD 2004, Altinkemer et al 2007, Sila 2007). However little is known about the antecedents of ICT investments, i.e the factors that make managers take such decisions. Among those factors is business strategy. It is a fact that business performance is closely related to the strategy of the firms and is measured according to the particular strategic choices of each (Lorsch, 2002; Kaplan, 1987). Langefeld and Smith (1997) define strategy as "a pattern of decisions about the organizations' future, which take on meaning when it is implemented through the organizations' structure and processes". Another definition is offered by Tallon (2007), who conceptualizes business strategy as "the determination of the basic long-term goals of an enterprise and the adoption of courses of action and allocation of resources necessary for carrying out these goals".

Business environment is nowadays characterized by great uncertainty and variability. In such a context, business strategy sets the path on which an organization will walk in order to fulfill its objectives. This can only be achieved through the appropriate utilization of the resources owned by firms. Some authors (e.g Podsakoff et al., 2006), relate strategy to the ways firms exploit their assets (resources) in order to achieve performance. The problem therefore of choosing strategy is a problem of resource allocation and the decision will be reflected on the final outcome. According to Stieglitz and Klaus (2007) due to firms having different resources as well as opportunities to innovate and immitate, they differ in their potential strategic paths. It is anticipated that organizations posses and require different combinations of strategic resources and the fit between these resources and

strategy type will have varying performance impacts (Hughes and Morgan, 2008). An essential managerial task is the strategic direction of investments into new complementarity resources and of the associated learning processes to prevent the pre-market appropriation of innovative rents and preserve the firm's competitive advantages. (Stieglitz and Klaus, 2007).

According to Hogue (2004) the organizational literature suggests that improved business performance requires an organizational structure, information systems and management style that are related to a specific firm strategy. Existing literature has studied the intervening roles of BPR and TQM in the ICT-performance relationship. It has also studied, the role of IT in strategy implementation and their effect on business performance (Theodorou and Florou, 2008. However BPR and TQM have been studied separately, as distinct process change paradigms. Additionally performance is influenced by non-ICT investment as well, its "traditional" capital, especially in the industry sector. It would be therefore interesting to study the effects of strategy on both ICT and non-ICT capital, process change (expressed through BPR and TQM), and, finally the contribution of all to business performance.

In chapter 6 we attempt to cover all the abovementioned research gaps by empirically investigating the abovementioned relationships. Moreover, the mediating effects of BPR and TQM in respect to strategy are also going to be examined using objective measures of both, through the construction of structural equation models that include all the fundamental variables. These models are based on the Cobb-Douglas production function, as in the previous chapters. This empirical investigation has been conducted in the national context of Greece, a developing country with small size of internal market and small average firm size. A detailed analysis on the particular characteristics of developing countries can be found in Hipkin (2004).

In the following Section 6.2 the relevant literature is briefly reviewed. In Section 6.3 the research hypotheses, method used and data collection process are described, while in Section 6.4 the data analysis and the results of this study are presented. Finally in section 6.5 the main conclusions are outlined and future research directions are proposed.

6.2 Literature review

6.2.1 Strategy

Strategy research has identified various different typologies and categories, based on different criteria. The two most widely known and broadly used are the ones by Porter (1980) and Miles and Snow (1978). Porter (1980, 1985) described three generic strategies: cost leadership, differentiation, and focus. In order to gain a low-cost position relative to competitors a firm should emphasize in aggressive construction of efficient-scale facilities, vigorous pursuit of cost reductions from experience, tight cost and overhead control, avoidance of marginal customers accounts, and cost minimization in areas like RnD, service, sales force, advertizing and so on. A differentiation strategy focuses on creating and providing products or services that customers perceive as unique and valuable as compared to those of its competitors. The focus strategy concentrates on a narrow

segment and within that segment attempts to achieve either a cost advantage or differentiation. The premise is that the needs of the group can be better serviced by focusing entirely on it. A firm using a focus strategy often enjoys a high degree of customer loyalty, and this entrenched loyalty discourages other firms from competing directly (Porter, 1980).

Miles and Snow (1978) recognized three successful organizational types: defenders, prospectors and analyzers. Prospectors constantly seek out new technological and product-market opportunities to exploit for first-mover advantages. This requires significant capacities to learn and distribute information rapidly in order to be attentive to customers. Analyzers follow a second-but better strategy. They tend to closely monitor competitors' activities in making strategic decisions. Defenders seek to maintain a secure niche in a stable product-market, focusing on a few products and on cost control (Hughes and Morgan, 2008). A detailed literature review of the various strategy typologies that have been presented by researchers is included in chapter 2.

6.2.2 Strategy, ICT investment and business performance

Relevant literature has empirically investigated the ways strategy affects business performance. It is evident that the choice of a strategy will affect particular processes within the organization, which will in turn activate specific mechanisms in the value chain, being reflected in different performance measures each time (financial or non-financial). According to Hyvonen (2007) many authors suggest that the relationship between IT and firm performance should be investigated within a strategic framework. Folowing this argument existing literature has investigated the ways a particular business strategy type affect performance measures. Perrera et al. (1997) and Hyvonen (2007) find a significant association between customer-focused strategies and the use of non-financial performance measures, but not a link to organizational performance. This finding implies that not all business performance measures are suitable to measure the result of a selected business strategy. In other words the ultimate target of a strategy should determine the measures managers should use to investigate its effectiveness. According to Langefeld and Smith (1997) performance measures should support the focus of the strategy-be it cost, quality or delivery.

Mencug et al (2007) pose that the evaluation of a strategy may be realized in terms of efficiency and effectiveness. For instance a marketing differentiation strategy demands an atmosphere in which employees have more autonomy to be effective, whereas a low cost strategy typically demands tight controls on operational functions, which enhance efficiency. Supporting this notion Gupta (1987) claimed that subjective performance is positively associated with effectiveness in organizations following a build or differentiation strategy. Therefore market-driven firms emphasize low-cost processing strategies more than their counterparts who engage purely in a customer or competitor orientation. Innovation differentiation strategies effectively contribute to growth in terms of firms' performance. Marketing differentiation, unlike innovation differentiation, does not try to create a unique position in the minds of customers on the basis unique product features but rather works to deliver greater exchange value through branding, advertising, sales force, and other unique marketing techniques. An innovation differentiation strategy enhances effective firm performance, whereas cost leadership contributes to efficient firm perform-

ance. Only a marketing differentiation strategy strengthens both effective and efficient firm performance. On the other hand Langefield and Smith (1997) support that more open, flexible, organic performance measures appear to suit more product differentiation and build types of strategies. Finally, firms that desire to be prospectors and defenders at the same time (ie analyzers) may receive handsome rewards if they invest in marketing differentiation strategies.

The relationship between strategy and ICT has been a quite interesting research topic during the last years. The great amounts invested in ICT arise serious concerns regarding how those investments will be exploited in the best way in favor of the organizations. During the last years research has focused on the "particular circumstances" under which ICT investment leads to organizational performance. Among those "circumstances" is business strategy (Mahmood and Mann, 1993). The choice of a particular strategy should concentrate IT resources and capabilities of the firm to a specific orientation. According to Porter (2001) information technology has become a powerful tool for strategy. According to Tallon (2007) the nature of business strategy is also a factor in firm's ability to realize value from IT investment.

For other researchers strategy and ICT are viewed from the "business value" perspective. Brynjolfsosn and Hitt (1995) claim that firm idiosyncrasies, a quintessential form of which is business strategies, account for half of the productivity gains imputed to IT. According to Chan et al (1997) "companies that appear to perform best are companies in which there is alignment between realized business strategy and realized IS strategy. Tallon (2007) mentions that firms with a narrow strategic focus realize less value from IT than those that espose a broad or multifocused strategy. The locus and the level of IT business value are sensitive to the type of strategic foci underlying a business strategy. However existing literature does not clearly show the kind as well as the strength of the effect of business strategy on performance (Hogue, 2004, Prajogo and Sohal, 2006).

6.2.3 ICT-non-ICT investment, process change and business performance

The relationships between ICT-non-ICT investment, BPR/TQM (as approaches of business process change) and business performance has been described in detail in chapters 2, 4 and 5. ICTs offer the potential to act as catalysts and enablers of big improvements in existing business processes and work practices, which in turn can lead to higher levels of business benefits. Bresnahan et al (2002) note that ICTs will generally change the way that human work is measured, controlled and reported; also work will be restructured in order to allocate routine, well-defined tasks associated with symbols processing to computers and separate and redesign tasks that require human skills. Their main conclusion is the three most important elements of modern economy are ICT, workplace reorganization and new products and services, which are basic closely associated and complementary, and their combination results in the demand of more skilled labor by firms (skill-biased changes). OECD (2004), based on many studies that have been conducted in its member states, concludes that achieving benefits from ICT investments is not straightforward, but requires 'complementary investments' and changes in business processes, organization and human capital; Those 'complementary investments' are realized in this dissertation through BPR and TQM, which are considered as the most important change paradigms. Regarding the relationship between BPR and performance, there are several empirical

studies based on large datasets providing evidence of a positive effect of BPR on performance (Guimaraes and Bond, 1996; Altinkemer et al. 1998; Tai and Huang, 2007; Gregor, et al. 2006).

On the other hand, the relationship between TQM and ICT has also been broadly recognized by researchers (Martinez-Lorente et al 2004, Rodriguez et al 2006), identifying the critical role that computers play in quality management, since they can significantly support statistical process control, reduce the effort required by production personnel to collect and analyze quality data and also shorten the reaction time between process data collection and implementation of corrective actions. ICTs can effectively support TQM in improving customer and supplier relationship, increasing process control, facilitating teamwork, facilitating inter-departmental information flow, improving design process and skills, applying preventive maintenance, introducing ISO 9000, measuring quality costs and improving the decision process in quality departments (Dewhurst et al. 2003). Also, many empirical studies based on large datasets provide evidence of a positive effect of TQM on various measures of business performance (Easton and Jarrell, 1994; Hendricks and Singhal, 1997; Fynes & Voss, 2002; Demirbag et al. 2006). TQM practices impact upon quality performance, manufacturing performance and business performance, while the relationship between TQM practices and quality performance is moderated by the strength of relationships with customers.

6.2.4 Summary of literature review and conclusions

The existing literature has dealt with the mediating roles of BPR and TQM in the relationship between ICT/non-ICT investment and business performance. It has also studied the notion of strategy and has identified its positive contribution to performance, as well. However those studies have been conducted in various national contexts using various sample sizes. A study where all the abovementioned concepts are studied for the same country and with the same dataset is still missing. Additionally none of the existing studies, according to our knowledge, have seen business strategy as an antecedent of ICT investments and business transformation, at the same time. Authors agree in that there is a growing acceptance of the need to review IT impacts at the process level by virtue of the argument that the first-order impacts of IT spending occur at the process level (Barua et al. 1995, Melville at al. 2004). The impact on processes is mirrored in the extent of business transformation throughout the organizations. Also all reviewed studies undermined the role of non-ICT investment ('traditional' assets) in business performance, despite the fact that it constitutes the largest proportion of a firm's capital.

The reviewed literature does not include any investigation on the relationship between business strategy and process change. Only some incomplete references regarding this issue have been identified regarding the connection of strategy to several aspects of TQM. In particular Demirbag et al (2006) mentions that the relationship between TQM practices and performance is moderated by the strength of relationships with customers, which is considered as a TQM dimension. Prajogo & Sohal (2006) investigated quantitatively the relationships between organization strategy, TQM and organization performance; they found that TQM is associated with differentiation strategy, and also partially mediates the relationship between differentiation strategy and performance.

As a conclusion we could say that a deeper investigation is required in order to realize the importance of selecting a particular strategy and the impact of this choice on the internal mechanisms of the firms: ICT and non-ICT utilization, process transformation and business performance.

6.3 Research Hypotheses, Method and Data

The first set of hypotheses regards the ICT-business performance relationship. We have also included in our investigation non-ICT investment (the 'traditional' assets) as well, in order to make a comparison between ICT investment and non-ICT investment regarding the above aspects. The reason for doing this is that despite the growing investment of firms in ICTs, non-ICT investment constitutes in most sectors the biggest part of firms' total investment. Various empirical studies conducted in order to investigate the contribution of firms' ICT investment to their business performance have also dealt with the contribution of non-ICT investment as well, and have provided evidence of a positive and statistically significant contribution of non-ICT investment to business performance (e.g. Brynjolfsson and Hitt 1996, Stolarick 1999, Preslac 2003, etc.). However, ICT assets are much more closely associated with business processes (supporting and influencing them significantly) in comparison with non-ICT assets.

Hypothesis 6.1: ICT Investment has a positive and significant effect on business performance.
Hypothesis 6.2: non-ICT Investment has a positive and significant effect on business performance.

As mentioned in the literature review, there is also considerable literature proposing specific ways for using ICTs in order to support BPR and achieve higher business performance (Grover et al 1993, Davenport 1993, Tapscott and Caston 1993, Gunasekaran and Nath 1997, Champy 2002a, Champy 2002b, Attaran 2003). Similarly, there are several empirical studies providing evidence for a positive effect of TQM on business performance (e.g. Martinez-Lorente et al 2004, Demirbag et al 2006, etc.). As a consequence of the above, we make the following research hypotheses:

Hypothesis 6.3: The extent of BPR has a positive and significant effect on business performance.
Hypothesis 6.4: The extent of TQM has a positive and significant effect on business performance.

As described in section 6.2 there are many theoretical arguments in the literature concerning the important capabilities offered by ICTs for improving dramatically the existing business processes and work practices, and through these improvements for achieving high levels of business benefits (e.g. Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 1998, Brynjolfsson & Hitt 2000, Bresnahan et al 2002, OECD 2004, Melville et al 2004). Therefore we expect that ICT investment is positively related to BPR. We pose the same hypothesis for non-ICT investment.

Furthermore, while the ICTs are 'general purpose' technologies, which can be used for many different functions and can be easily adapted to new needs and processes, non-ICT

investments (e.g. for production machinery, buildings, etc.) do not offer this flexibility. For this reason we do not expect that non-ICT investment leads to BPR implementation in order to contribute to better performance. On the other hand we expect that TQM might have a mediation effect on the ICT-performance relationship (thus non ICT leads to TQM): high investment in non-ICT assets (e.g. sophisticated and complex production machinery) can act as a driver for adopting various TQM practices, such as statistical quality control, quality improvement teams aiming to continuous improvement, cooperation with suppliers for quality improvement, monitoring of customers' satisfaction, etc., in order to increase the value generated for the firm from these expensive assets. Taking the above into account our next four hypotheses will be:

Hypothesis 6.5: ICT investment has a positive and significant effect on the extent of BPR.
Hypothesis 6.6: Non-ICT investment has a positive and significant effect on the extent of BPR.
Hypothesis 6.7: ICT investment has a positive and significant effect on the extent of TQM.
Hypothesis 6.8: Non-ICT investment has a positive and significant effect on the extent of TQM.

The gaps of the previous research, as mentioned in the previous section, inspired us to empirically investigate the role of strategy in the relationship between ICT investment and business performance, with BPR and TQM (the main process change paradigms) acting as mediating factors in this relationship. As mentioned in section 6.2 previous studies have identified a possible connection between strategy and ICTs (Mahmood and Mann, 1993; Kettinger et al, 1995; Porter, 2001). Tavakolian (1989), Chan et al (1997) and Li and Ye (1999) suggest links between advanced ICTs and highly differentiated strategies. On the other hand Bouwens and Abernethy (2000) explain the reasons ICTs are important for customer-focused strategies to be implemented. The selection of a particular strategy by the firm requires the support of a particular ICT as well as non-ICT equipment.

We have constructed two basic models (which are going to be separated into six hypothesized models, as will be shown later), for BPR and for TQM, in order to acquire comparable results, as shown in figure 6.1.

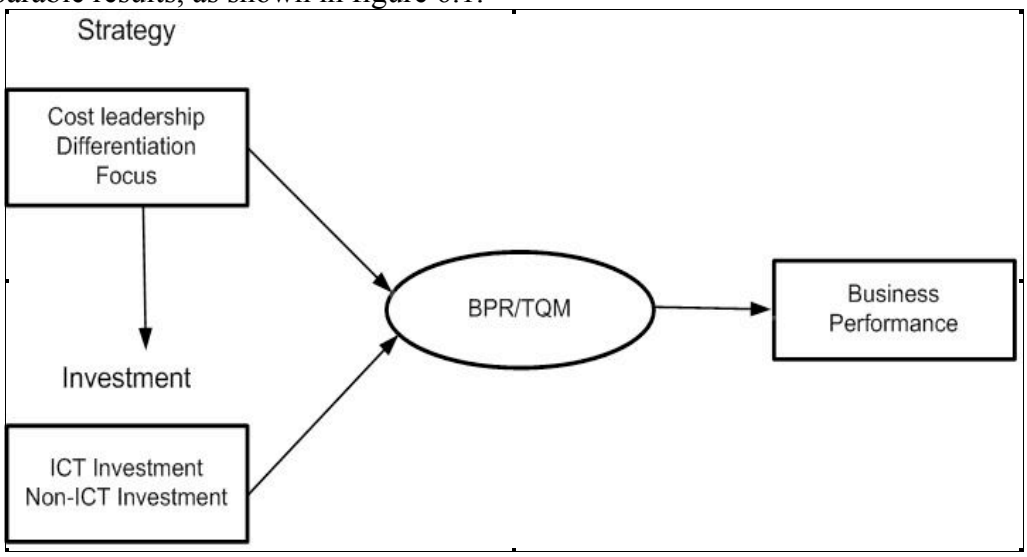


Figure 6.1: The hypothesized BPR and TQM models.

The present study uses Porter's strategy typology (1985). The classification of business strategies in cost leadership, product differentiation, and focus, is considered by many authors to be conceptually valid and is academically well accepted (Jermias, 2008). According to Kim et al (2004) there are two additional reasons for using this particular typology: First, Porter's framework of generic strategies is inherently tied to firm performance. Second, Porter's framework overlaps with other typologies. For example, Porter's strategy of differentiation resembles Miles and Snow's (1978) prospector strategy, and Porter's strategy of cost leadership is similar to Miles and Snow's defender and Hambrick's (1983) and Dess and Davis's (1984) cost leadership strategies. Porter's strategy of focus is very much like Miller and Friesen's (1986) niche innovator strategy.

Previous studies (Porter 1980, Porter and Millar 1985, Ward 1987, Klouwenberg et al 1995, Mattson et al 2000, Cragg et al, 2002) have emphasized that all three business strategies proposed by Porter, in order to be successful, require support by the appropriate ICT and non-ICT capital, which may differ according to the particular strategy a firm follows. For instance, a cost leadership strategy requires IS oriented towards the automation to the highest possible extent of firms' processes, in order to minimize the number of employees, to improve the exploitation and management of the resources, as well as to control and reduce costs. On the contrary, a differentiation strategy requires IS oriented towards the achievement of the quality features of firms' products or services that have been chosen as the basis for its differentiation, the design of better products or services, as well as the measurement of customers' satisfaction. Finally, a focus strategy, which aims at producing specialized products or services focusing on the needs of particular customer groups, requires IS oriented towards analysing the particular needs of those groups. We therefore expect that:

Hypothesis 6.9: The extent of implementing a low-cost strategy has a positive and significant effect on ICT Investment.
Hypothesis 6.10: The extent of implementing a differentiation strategy has a positive and significant effect on ICT Investment.
Hypothesis 6.11: The extent of implementing a focus strategy has a positive and significant effect on ICT Investment.
Hypothesis 6.12: The extent of implementing a low-cost strategy has a positive and significant effect on non-ICT Investment.
Hypothesis 6.13: The extent of implementing a differentiation strategy has a positive and significant effect on non-ICT Investment.
Hypothesis 6.14: The extent of implementing a focus strategy has a positive and significant effect on non-ICT Investment.

The relationship between business strategy and the business transformation paradigms we are dealing with, BPR and TQM, has not been empirically investigated by the relevant literature, to the best of our knowledge. However the impacts as well as the routes of BPR and TQM imply a close connection, which should therefore be empirically investigated. As Jaworski and Kohli (1993) very spotly denote "both reengineering and TQM approaches share certain principles and adopt a process perspective, so it is possible to make some general propositions on managing change that will enable a company to reinvent its competitive advantage".

The main driving forces of BPR (as described by Hammer and Champy, 1993) are: cus-

tomers, competition, and change. According to Altinkemer et al (1998) the primary reasons companies go through process change are cost cutting and customer satisfaction. Furthermore Kallio et al (1999) mention, among others, that the key characteristics of BPR are performance improvements, business benefits, and customer orientation. On the other hand some benefits TQM offers (as reported by Seetharaman, et al.; 2006) are reduced operating costs, continuous improvement, and customer satisfaction. The conclusion drawn from the above is that BPR and TQM offer benefits that are related with the choice of strategy type. The relationship thus between those two process change paradigms and strategy should be investigated. The following six hypotheses regard the abovementioned relationships:

Hypothesis 6.15: The extent of implementing a low-cost strategy has a positive and significant effect on the extent of BPR.
Hypothesis 6.16: The extent of implementing a differentiation strategy has a positive and significant effect on the extent of BPR.
Hypothesis 6.17: The extent of implementing a focus strategy has a positive and significant effect on the extent of BPR.
Hypothesis 6.18: The extent of implementing a low-cost strategy has a positive and significant effect on the extent of TQM.
Hypothesis 6.19: The extent of implementing a differentiation strategy has a positive and significant effect on the extent of TQM.
Hypothesis 6.20: The extent of implementing a focus strategy has a positive and significant effect on the extent of TQM.

Regarding the relationship between business strategy and firm performance existing research has shown that the result of a selection of any strategy type should be measured by particular metrics (Perrera et al., 1997; Hyvonen 2007). It should be really interesting to investigate whether there exists a direct effect of a selected strategy on firm financial performance. Consequently our last three hypotheses would be:

Hypothesis 6.21: The extent of implementing a low-cost strategy has a positive and significant effect on business performance.
Hypothesis 6.22: The extent of implementing a differentiation strategy has a positive and significant effect on business performance.
Hypothesis 6.23: The extent of implementing a focus strategy has a positive and significant effect on business performance.

As in the previous chapters the above hypotheses were tested by estimating the 6 models (based on the model of figure 6.1) using the structural equations modelling (SEM) approach (Kline 2005). The particular questions regarding research hypotheses 6.1-6.23, are shown in Appendix A (questions 1-8). Table 6.1 shows the means for the nine BPR and seven TQM items. In the last two columns the overall BPR and TQM means (which have been calculated as the average of the items' means) are shown, as well the means for the variables computer capital, non-computer capital, and firm performance.

BPR and TQM have been modelled as constructs, including 9 and 7 items respectively (see chapter 4). The hypothesized models include all the fundamental variables, based on the Cobb-Douglas production function (Nicholson, 1998). Business performance is measured with the metric value added, similarly to chapters 4 and 5. According to Hyvonen

(2007) “while there has been extensive interest in the role of contemporary measures to assist in developing differentiation strategies including customer-focused strategies, survey evidence suggests that financial measures remain important to managers”. This is the main reason why we decided to use value-added, a widely accepted and used performance measure (Arvanitis, 2005).

It is obvious that the model of figure 6.1 implies six hypothesized models in total, according to the three strategy types (low-cost, differentiation and focus) and the two process change paradigms (BPR and TQM), with 23 research hypotheses, in total.

6.4 Data analysis and results

6.4.1 Measurement models

The six models based on the model shown in figure 6.1 were estimated using a covariance-based SEM approach (maximum likelihood) through the AMOS 7 software (Burne, 2001). First of all we tested construct validity and reliability for the BPR and TQM constructs in the six models. Convergent validity of the BPR and TQM constructs was tested by examining the six measurement models (i.e the regression coefficients of the items of the BPR and TQM multi-item constructs). The results, shown in table 6.2, indicate convergent validity for both constructs, exceeding the cutoff level of 0.6 suggested by Chin (1998). We should mention that the loadings of the item TQM_1 for the three strategic directions, which are slightly below the abovementioned level. Therefore they are also accepted since they are very close to 0.6.

	BPR item loadings				**TQM item loadings**		
Indicator	**cost**	**differ**	**var**	**Indicator**	**cost**	**differ**	**var**
BPR_1	.753	.754	.756	TQM_1	.591	.592	.591
BPR_2	.683	.683	.683	TQM_2	.671	.673	.675
BPR_3	.773	.773	.775	TQM_3	.823	.822	.821
BPR_4	.698	.695	.693	TQM_4	.806	.804	.804
BPR_5	.717	.717	.718	TQM_5	.799	.800	.800
BPR_6	.810	.810	.811	TQM_6	.751	.751	.751
BPR_7	.725	.726	.724	TQM_7	.823	.825	.825
BPR_8	.700	.701	.697				
BPR_9	.666	.666	.664				

Table 6.1: Item loadings of the BPR and TQM constructs for the six hypothesized models.

Discriminant validity for the BPR and TQM constructs was also tested (it is the same procedure as in chapters 4 and 5); even though these two constructs do not appear in the same model (BPR is included in three models whereas TQM in the other three), we would like to be assured that the items of each of these two constructs do not correlate highly with the other construct, so that there is a clear discrimination between the two constructs. For this purpose we performed a factor analysis with varimax rotation using the SPSS 15.0 software. In particular, we examined the factor structure behind the 16 items of these two constructs (i.e. the 9 items of BPR and the 7 items of TQM). The results are shown in

table 4.3 of chapter 4. We can see there is one factor, characterized by high loadings of the BPR items and much lower loadings of the TQM items, and another factor characterized by high loadings of the TQM items and much lower loadings of the BPR items. These results indicate the discriminant validity of the two constructs.

Finally the reliability of each construct, which concerns the extent to which its items, taken together, constitute an error-prone operationalization of it (Straub et al 2004), was examined. For this purpose the Cronbach's Alpha of each construct was calculated using the SPSS 15.0 software, with very satisfactory results (0.914 for the BPR construct and 0.906 for the TQM construct) exceeding the minimum acceptable level of 0.7 recommended by the relevant literature (Gefen et al 2000, Straub et al 2004), confirming therefore the reliability of both constructs.

6.4.2 Structural models

As a second step we examined the fit indices of both structural equation models. Table 6.3 shows several fit Indices for the six hypothesized models, which quantify how well the specified models fit the observed data. We can see that those models have a satisfactory fit for the incremental fit indexes (≥ 0.9), according to the suggestions of Gefen, et al; (2000), as well as for RMSEA (≤ 0.08), as suggested by Browne and Cudeck (1993).

BPR	**Chi-square**	**NFI**	**RFI**	**IFI**	**TLI**	**CFI**	**RMSEA**
cost	84.35	.947	.921	.979	.969	.979	.047
Differ	91.30	.943	.915	.975	.963	.975	.052
Var	85.60	.947	.922	.979	.969	.979	.048
TQM							
cost	50.93	.958	.939	.989	.984	.989	.036
Differ	50.15	.959	.940	.990	.985	.990	.034
Var	49.22	.960	.942	.991	.986	.991	.033

Table 6.2: Model fit for the six hypothesized models

After examining construct validity, reliability and model fit, the final step was to examine the structural models, i.e. the paths between the constructs and (or) the other variables in the hypothesized models. Figures 6.2-6.7 show the results for each hypothesized model. Starting from Figure 6.2, which examines the role of implementing a low-cost strategy and following a BPR process change approach, we can see that the extent of implementing a low-cost strategy does not seem to have any effect on ICT/non-ICT investment, BPR or business performance. ICT investment has a significant and strong direct effect on business performance (.328), and a small mediating effect through BPR (.141*.167=.025). Non-ICT investment has also a direct effect on performance (.104) whereas it doesn't have one on BPR. Therefore hypotheses 6.1, 6.2, 6.3, and 6.5 are supported by the results whereas hypotheses 6.6, 6.9, 6.12, 6.15, and 6.21 are not.

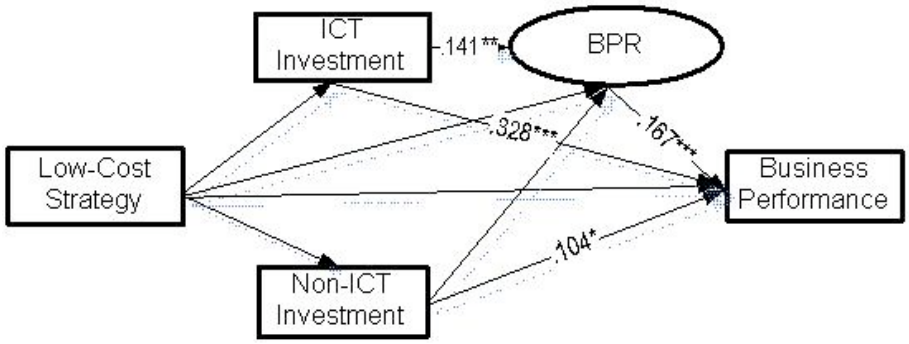


Figure 6.2: The low-cost strategy-BPR structural model

Figure 6.3 depicts the second structural model, which includes the extent of implementing a differentiation strategy and business process reengineering. Choosing a differentiation strategy affects firm performance not directly, but through BPR implementation, at a level of 2% (.114*.174). Hypotheses 6.16 is therefore supported (hypothesis 6.3 has been found to be supported in the structural model of figure 6.2 and will therefore not be mentioned again) whereas hypothesis 6.10 is not. On the other hand this strategy type does not have an impact on non-ICT investments, rejecting thus hypothesis 6.13. The mediating effect of BPR on the relationship between ICT investment and business performance is also clear, as expected, as well as the positive and significant effect of non-ICT investment on performance, results, which are in agreement with our findings in figure 6.2.

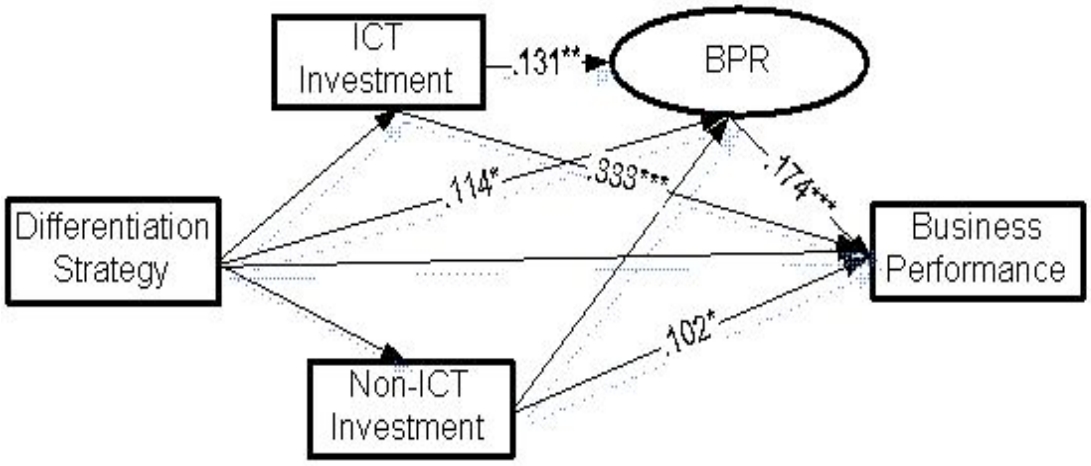


Figure 6.3: The differentiation strategy-BPR structural model

As far as the role of a focus strategy implementation is concerned (Figure 6.4), results show that it directly, positively and significantly affects firm performance at a level of

13.8% as well as through the extent of BPR implementation, at a level of 4.2%. Those results offer us support for hypotheses 6.17 and 6.23. A focus strategy, on the other hand, does not influence the amounts of ICT and non-ICT investments, rejecting thus hypotheses 6.11 and 6.14.

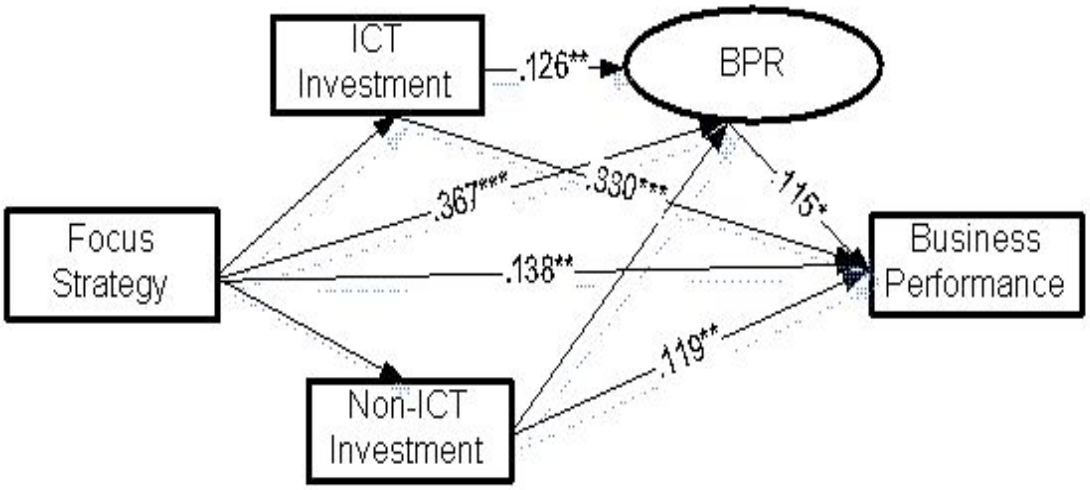


Figure 6.4: The focus strategy-BPR structural model

After examining the structural models regarding the combination of the three strategy types and BPR, we have repeated the same procedure with TQM, as well, constructing consequently three more hypothesized models, the results of which are shown in figures 6.5-6.7.

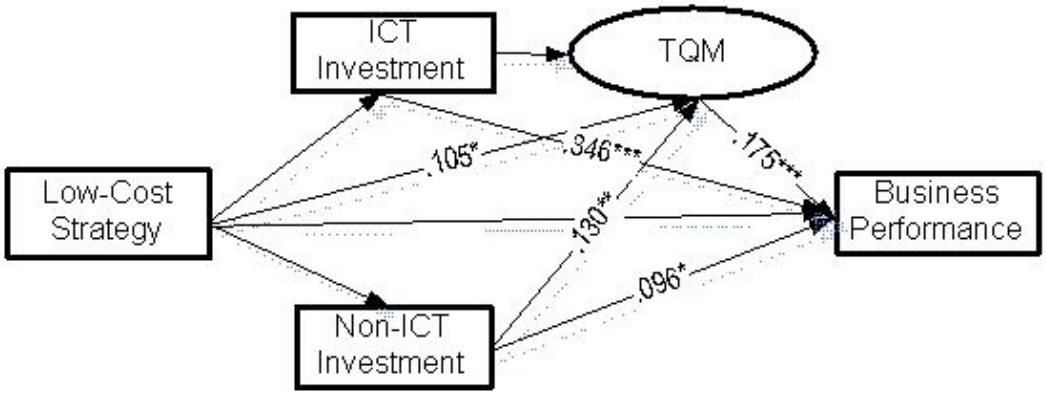


Figure 6.5: The low-cost strategy-TQM structural model

Starting from the model including low cost strategy and TQM (figure 6.5) we can see that a low cost strategy affects significantly TQM (path loading: .105) whereas the later has a direct effect on business performance (.175). This implies a small mediating effect of TQM in the relationship between low cost strategy and performance (equal to .018). Hypotheses 6.4 and 6.18 are thus supported. This is the only way for a low-cost strategy to affect the final business outcome, meaning that there is no direct effect, leading thus to a rejection of hypothesis 6.2. Moreover, a low cost strategy does not affect neither ICT/non-ICT investment nor does it directly influence business performance. On the other hand ICT and non-ICT investment affect performance, findings that are consistent

with the ones from figure 6.2. TQM is not caused or affected by ICT investment (hypothesis 6.7 is rejected) whereas it is affected by non-ICT investment (path loading: .130) (hypothesis 6.8 is supported). This indicates a mediating role of TQM in the relationship between non-ICT investment-firm performance with an (mediating) effect equal to 2%.

The structural model of figure 6.6 shows the hypotheses regarding the relationships between differentiation strategy-ICT/non-ICT investment. A differentiation strategy affects firm performance through TQM implementation. The size of the indirect effect is .020. Hypothesis 6.19 is therefore supported whereas there has been no evidence found for a direct effect, leading us to the rejection of hypothesis 6.22. The mediating role of TQM in the non-ICT-business performance relationship is also shown in figure 6.6.

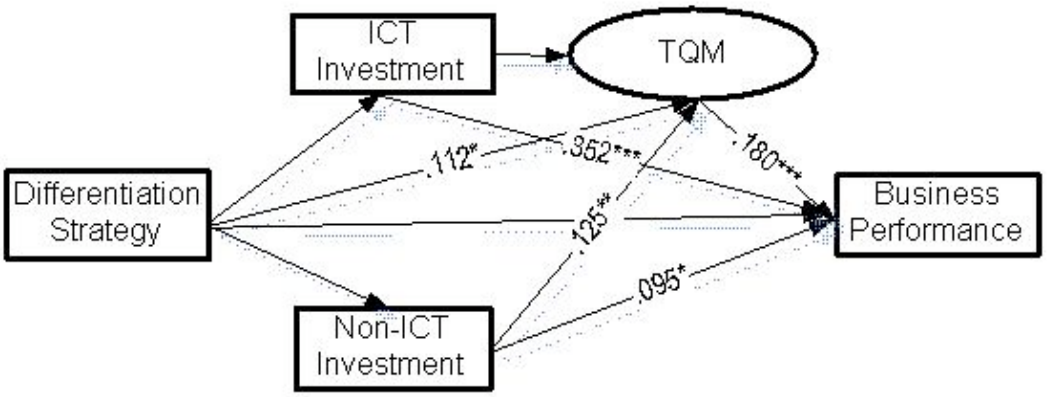


Figure 6.6: The differentiation strategy-TQM structural model

The sixth and last structural model regards the choice of a focus strategy and a TQM process change approach. As we can see in figure 6.7 a focus strategy has a direct impact on business performance (.142) (hypothesis 6.23 has been supported in figure 6.4) as well as an indirect one through TQM (equal to .04). Hypothesis 6.20 is therefore accepted (as well as hypothesis 6.4 which has been supported in figure 6.5).

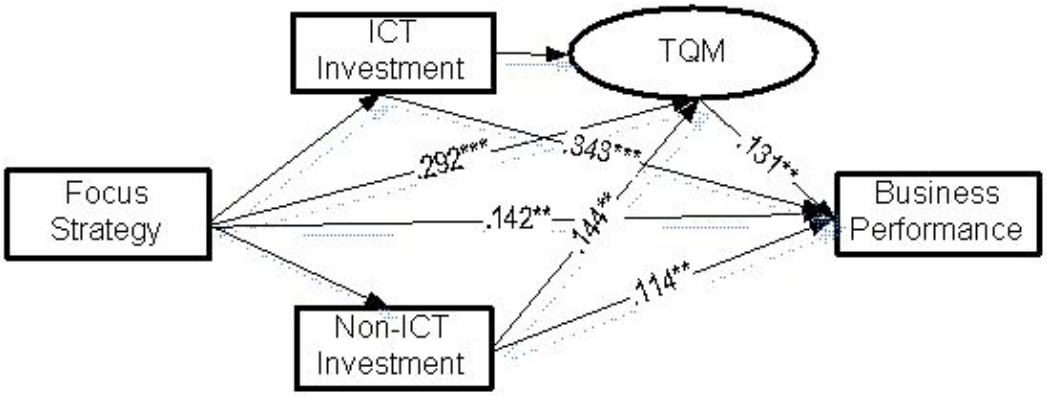


Figure 6.7: The focus strategy-TQM structural model

6.5 Discussion

Having examined all the models, and identified all the significant and insignificant paths we can extract some useful conclusions. A low cost strategy doesn't have any effect on ICT/non-ICT investment and BPR. It indicates an effect on business performance only through TQM. This seems reasonable since in order to gain a low cost position relative to competitors, a firm should minimize its investments, emphasize in cost reductions and conduct strict controls. TQM offers the tools for such controls and slight process adjustments in order to achieve a better outcome, whereas BPR, due to its rapid and intensive nature, demands some investment which is not accordant to cost reduction. Our findings regarding the effect of a low cost strategy on financial performance are in agreement with previous studies (Porter, 1980; Mencug et al., 2007).

A differentiation strategy does not have a direct impact on financial performance in neither of the two models (Figures 6.3 and 6.6). However our findings show that firms that have chosen to follow this direction may enhance their performance if they conduct some process change either through BPR or through TQM in order to offer products or services that customers regard as unique and special. According to Day (1994) a marketing differentiation strategy works to deliver greater exchange value through branding, advertising, sales and other unique marketing techniques. In this respect marketing differentiation refers to the market-sensing and customer-linking capabilities that firms use to connect customers to the firm and should therefore contribute to sales growth and market share growth (effectiveness measures), which cannot be depicted in financial performance. However the implementation of BPR and TQM reveal a small proportion of value created by differentiation strategy represented in financial business performance enhancement.

Regarding the effect of a focus strategy on business performance the findings are really interesting: we can clearly see in both models (Figures 6.4 and 6.7) a clear direct effect of about 14% as well as an indirect effect of BPR and TQM (both equal to .04). According to Porter (1980) the focus strategy concentrates on a narrow segment and within that segment attempts to achieve either a cost advantage or differentiation. A firm using a focus strategy often enjoys a high degree of customer loyalty, being able to pass higher costs on to customers since close substitute products do not exist, achieving thus financial benefits. The (partial) mediating role of BPR and TQM could be explained by the fact that product or service customization necessitates process changes in order to create value. The findings of this study related to focus strategy are not consistent with previous studies (Perrera et al., 1997; Hyvonnen, 2007), which have not identified a significant association between customer-focused strategies and financial performance.

Furthermore the results of this study indicate a clear direct effect of ICT investment on business performance (equal to about .33 in all models, Figures 6.2-6.7) and a small indirect effect through BPR. According to these results we could infer that BPR is a partial mediator in the relationship between ICT investment-business performance, finding which is consistent with conclusions of previous studies (Albadvi et al 2006, Grover et al 1998). We also remark that the direct effect of ICT on business performance is stronger than the indirect one through BPR. This means that in the Greek national context a small part of the effect of ICT on business performance is through enabling and facilitating process redesign and improvement, which has a positive impact on business performance.

The implementation of quality management practices affects positively firm performance (Figures 6.5-6.7) but is not necessitated by ICT investment. This means that, in contrast with BPR, TQM is not a mediator in the ICT investment-business performance relationship. However it is mediating the relationship between non-ICT investment and performance, since a positive and significant effect has been found on the relationships between non-ICT investment-TQM and TQM-business performance. It should be noted that this finding is consistent with conclusions of previous studies (e.g. Martinez-Lorente et al 2003, Prajogo and Sohal 2001, etc.) as well as with the findings of chapters 4 and 5.

The difference in the mediation role of BPR and TQM on the relationship between non-ICT investment and business performance could be explained considering that BPR initiatives focus on process change mostly through the employment of new technologies (ICT capital), so they are greatly facilitated and supported by ICTs, but they are not much affected by non-ICT capital and the rest of the firm's infrastructures. On the contrary, TQM is highly related to the firm's non-ICT capital, mainly to production equipment, since it concerns the systematic measurement and control of production processes and infrastructures in order to increase their contribution to firm performance. Consequently, firm making high non-ICT investments (e.g. in sophisticated and complex production machinery) tend to adopt to a larger extent various TQM practices as a complementary 'soft investment'. In particular, they tend to adopt statistical quality control, quality improvement teams aiming at continuous improvement, cooperation with suppliers for quality improvement (since more sophisticated and complex production equipment usually need higher quality materials), monitoring of customers' satisfaction, etc., in order to increase the value generated for the firm from these expensive assets; also they aim at work simplification in order to balance the increased complexity caused by highly sophisticated and complex production equipment.

6.6 Conclusions, limitations and further research directions

Chapter 6 deals with the empirical investigation of the whole network of relations between business strategy (at a first level), ICT investment, BPR, TQM and non-ICT investment (at a second level) and business performance (at a third level). It utilizes a sound theoretical foundation from the area of microeconomics, the Cobb-Douglas production function. The measurement of BPR and TQM (which have been chosen as the main process change paradigms) is realized through a multi-item scale, which has been developed through an extensive review of the relevant BPR and TQM literature and validated in terms of validity and reliability.

The findings suggest that the choice of business strategy defines the final outcome and/or the need for ICT/non-ICT and other complementarity investments in order to enhance business performance. A low-cost strategy necessitates the implementation of quality management practices whereas a differentiation strategy produces value for the firm through process transformation (BPR or TQM, with similar levels of effect on business performance). On the other hand a focus strategy, in the Greek national context, seems to have the greatest influence on the firm outcome, since it affects performance directly and indirectly, through business transformation (BPR or TQM). Business strategy does not have a causal relationship with firm investments, meaning that the latter is not affected by the former. This could be translated as no matter what type of strategy a firm follows, in-

vestments (in ICT and non-ICT) should be realized in order to enhance performance. Process reengineering and quality management are necessary practices for improving performance by implementing a business strategy and/or by realizing investments.

As basic limitation we could mention the context under which this study has been conducted (Greek national context), which may be an obstacle for generalizations. Greece does not belong to the highly developed countries, though it has made considerable progress in the last twenty years, having become a member of the European Economic and Monetary Union. Moreover it is characterized by small size of internal market as well as small average firm size. Culturally it is not characterized by risk-taking mentality, as shown by its high Uncertainty Avoidance Index (UAI) (value: 112) in comparison to other European countries and USA, according to Geert Hofstede estimation (http://www.geert-hofstede.com/). This fact may negatively affect the attitude towards undertaking process change initiatives (through the BPR or TQM approaches). Therefore it would be useful to conduct similar empirical studies in other national contexts as well and compare the findings.

A second limitation of this study is that it measures business performance through one measure, value added per employee (labour productivity). Even though it is a fundamental one, since it incorporates the value of the products or services produced by a firm, the value of the materials or services it buys from suppliers, as well as the number of its employees, and despite the fact that it is widely used by researchers, it would be interesting to conduct similar empirical studies using multiple financial (ROI, ROA) and non-financial (sales growth, customer satisfaction, etc) measures of business performance. However the reason for using value added is that it stems from a very well grounded theory (the Cobb-Douglas production function) and has been widely used as a surrogate indicator of business performance. Our future research steps also regard the examination of the external environment (competition, buyers, suppliers, etc) and how it affects the choice of business strategy, and finally, through the same vale creation process, business performance.

CHAPTER 7

Business Environment: The Effect of External Forces on Capital Investment, Process Change and Firm Performance

7.1 Introduction

In a continuously evolving and competitive environment firms nowadays realize enormous investments in information and communication technologies (ICTs) aiming at acquiring the necessary resources and capabilities, which will enable them to gain competitive advantage among rivals, support their strategic orientations, and achieve better financial performance. The era of the 'productivity paradox' has passed for good and answers concerning the contribution of ICTs to business performance have been given. Recent research has been focused on the complementarity investments firms must realize in order to utilizing their ICT assets in a productive and efficient manner. However, it is also of critical importance to go beyond the organizational boundaries and investigate how the external environment affects firms in terms of investments in ICT and other complementarities, having as final objective to identify the effects of all those factors on business performance and capture the whole value creation process.

The positive and significant relationship between business strategy and performance has been shown and described in detail in chapter 6. Due to the fact that existing literature has also proven the positive link between external environment of the firms and strategy, it is of high importance to investigate the ways external factors influence the resources and capabilities of the organizations as well as cause changes in their structure and processes. Thus we will examine the relationship between the external environment and ICT/non-ICT investments, which constitute the resources of the organizations. Furthermore the extent of BPR and TQM, as the main expressions of business process and structural transformation, will be investigated evoked by the influence and the pressures of the external environment.

Chapter 7 contributes to the existing literature by empirically investigating the role of the various forces of the external business environment in the business value creation process, and their effect on ICT, non-ICT and the other complementarity investments, such as process change. In accordance to the previous chapters, it moves one step backwards (see Figure 2.3, Chapter 2), beyond the boundaries of the firms, focusing more on the context under which organizations operate and on the manners it adds value to the business. The empirical investigation has taken place in the national context of Greece and has used the same sample and method, as in the chapters (4 and 6).

Starting from a definition, as business environment could be regarded anything that affects but does not belong to an organization, in other words its surroundings. The environment has an impact on the strategy, decisions, processes and performance of the firms. It could be distinguished into two categories: the micro environment, consisting of different types of stakeholders - customers, employees, suppliers, board of directors and creditors, and the macro environment, which includes factors which are beyond the control of the business, social, tehnological, economical and political (Karagiannopoulos et al, 2005). Changes in the micro environment will directly affect and impinge on the firm's activities. Changes in the macro environment will indirectly affect the business but will nonetheless affect it. External environment describes the factors that affect the organization but do not belong to it. Figure 7.1 shows how organizations are connected to their surroundings and the role of external environment, which can be divided into industry (where the competition takes place) and macro environment (implying the national, economic, politic, and social boundaries of a particular economy).

Dess and Beard (1984) distinguished the following three factors characterizing external environment: munificence, complexity, and dynamism. Munificence relates to the scarceness of environmental resources that support firm's growth within a given industry. Environmental complexity reflects the heterogeneity and concentration of environmental elements. Environmental dynamism refers to the rate of change and degree of instability of the environment. Rapid change, short product lifecycles and processes of creative destruction are typical characteristics of dynamic environments. Organizational theory has established several dimensions of environmental characteristics: uncertainty, directness, change, dynamism, homogeneity, complexity and munificence (Aldrich, 1979; Duncan, 1972).

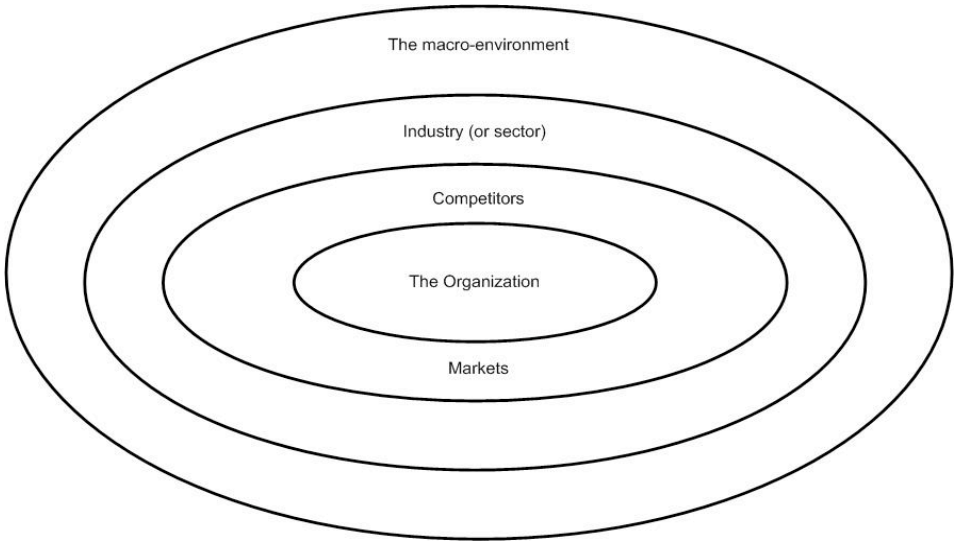


Figure 7.1. The organization and the effects of the external environment.

The main characteristic of the environment is the existence of other firms, which compete each other to gain competitive advantage. Competitive environment can be characterized by various dimensions, including market turbulence, demand uncertainty, buyer power, market growth, competitive hostility, competitive intensity, technology turbulence, and supplier power (Porter, 1985). Miller (1987) uses the term environmental competitiveness to reflect the number of competitors, and of areas in which there is competition. Jaworski and Kohli (1993) use the term competitive intensity, which reflects the behaviour, resources and ability of competitors to differentiate their products or services.

The most influential work however, is the one of Porter (1980), who introduced the five forces model and has been described in detail in Chapter 2 (section 2.6). According to this model the forces evoking industry competition, and thus affect firm performance, are: threat of entry, the power of buyers, the power of suppliers, threat of substitute products, and rivalry among existing competitors.

7.1.1 RBV

In the current dynamic and competitive environments firms have to realize the changes and keep up. However managers complain that strategic planning is too static and too

slow (Collis and Montgomery, 2008), compared to the changes required. In order for a solution to be found a lot of approaches have been developed. Since late 80's firms have started implementing quality management, and process reengineering projects, competing on capabilities and using more systematically firm-level developed knowledge. However the theory that explains best how a company's resources drive its performance in a competitive environment is the resource-based view (RBV, Barnley, 1991). Resources could be defined as "the wide variety of tangible and intangible factors from reputation to inter-organizational relationships in place" (Galbreath and Galvin, 2008).

The RBV posits that the key point for gaining competitive advantage is the best possible exploitation of the available resources. In terms of strategy a resource is valuable if it is hard to copy, it depreciates slowly, is controlled by the company (and not by customers, suppliers or other stakeholders), cannot be easily substituted and it is better than competitors' similar resources (Collis and Montgomery, 2008). The RBV combines the internal analysis of phenomena within companies (a preoccupation of many management gurus since the mid-1980s) with the external analysis of the industry and the competitive environment (the central focus of early strategy approaches) in order to explain in clear managerial terms why some competitors are more profitable than others, how to put the idea of core competence into practice and how to develop diversification strategies that make sense (Collis and Montgomery, 2002). Its main characteristic is that it does not see firms' high returns as the result of a favourable industry structure, but rather as a result of their access to unique, or otherwise costly-to-copy resources (Stoelhorst and Raaij, 2002).

One of the greatest debates of management-related literature concerns the extent of the impact of industry structure and firm factors on business performance. The most crucial point of the debate regards the importance of external factors (industry structure) compared to internal factors (resources) and the extent of their impact on business performance. The reason for this debate was the existence performance variation even between firms operating in the same sector and/or of similar size. Interest in industry structure as a variable for explaining performance variation has been expressed since the middle of the last century (Bain, 1954) as a research topic of industrial organization (I/O). However, a complete and widely accepted framework had not been developed until 1980 when Porter managed to offer a tool for explaining how exogenous factors impact firms in a given industry. Stoelhorst and Van Raaij (2004) note that Porter's framework has concentrated the focus of much attention in the extant literature, particularly with respect to analyzing performance differentials.

In chapter 6 the strong link between strategy and performance has been identified. In this chapter an attempt will be made to explore the role of the competitive environment on the management of the firms' resources and finally on performance. Following the resource-based view we intend to investigate how firms receive the messages of the external environment and how do they choose to respond. In particular we will examine the various forms of external environment pressures in respect to the amount of investments (in ICT and non-ICT) firms realize in order to acquire the necessary resources and capabilities to face those external pressures, the extent of organizational transformation (expressed via BPR and TQM), as well as their direct and indirect effect on business performance.

After having presented the main dimensions of business environment, according to Porter's theory, the next section (7.2) presents a literature review regarding its relationship

with the abovementioned variables (business strategy, ICT-non ICT investments, BPR, TQM and performance). Section 7.3 includes the development of research hypotheses, whereas in section 7.4 data analysis and results are presented. Finally, section 7.5 contains the conclusion, the main limitation and the future research direction of the particular empirical investigation.

7.2 Literature Review

7.2.1 Environment-BPR

As mentioned throughout this dissertation, there are many options for business tranformation, the main of which BPR and TQM. Which option a company chooses to adopt is not only dependent on internal factors to the organization but also on factors belonging to the external environment of the firms, such as the type of industry, rate of change, competition, market opportunities etc (Keeble, 1995).

There is not much empirical work done concerning the effect of external environment to the extent of BPR. However, the dynamic nature of the external environment is very likely to force changes in the structure and processes of the organizations, in order to be able to compete and prevail among rivals. One of the main reasons for BPR in organizations is the influence of the external environment. The major changes in markets, technologies, and degree of competition imply the need for enterprises to change their organizational and managerial arrangements (Francis and MacIntosh, 1997)**.** According to Agrawal and Haleem (2003) "environment changes are much faster than organizations". Therefore firms must realize those changes and make the necessary follow-ups.

The advantage of the organizations, compared to the past, is access to ICTs. "BPR is now coming to the fore in a different business environment. Certainly, the technological infrastructure is now very different, offering capabilities that were not feasible in the past" (Brian and Ciaran, 1996). If firms do not follow the environmental changes they will be left behind from those that will do. The success of a BPR project is alos highly dependent on the environment. According to Agrawal and Haleem (2003), who studied the effect of culture and environmental pressures on the factors of successful implementation of BPR projects, those two factors play an important role in the success of such projects.

The environment-BPR relationship stems also from the fact that-by definition-some of the basic dimensions of BPR regard not only the orgnization but also its environment. The transformation or deletion of some processes may be influenced by customers, suppliers or other partners.

7.2.2 Environment-TQM

Similarly to BPR, a connection also exists between external environment and TQM. The idea lies within the aspect that the environment is recognized as a vital source of resources and constraints. The term 'boundaryless organization', which has been extensively used in the TQM literature, supports this idea. "TQM blurs the boundaries between the organization and the environment. Entities previously regarded as outsiders (e.g. sup-

pliers, customers) are now considered part of organizational processes" (Spencer, 1994). There is also literature referring to the relationship between external environment and TQM. Since 1967 Lawrence and Lorsch had identified that the success of TQM is a function of the interrelationship among internal organizational states and processs and external environment demands. Dean and Evans (1994) argued about the relationship between TQM and competitive advantage, which implies that, in order to implement TQM, one must examine the idioms of the environment, and more particular, the competition.

TQM by definition regards the relationship of the firm with its environment. Some of its main activities, measurements of customer satisfaction, cooperation with suppliers and other partners reveal a close relationship. Hung (2007) investigated, among others, the effect of environmental changes on TQM practices in pursuing innovation performance, through a case study on a leading global firm. His results showed that innovation initially had no effect on sales when the business environment was unchanged despite of marketing/sales efforts, but the innovation was a critical success after business environment changes created value for the innovation's claims. Realizing how TQM practices lead to quality and innovation performance and how business environment is important for the dynamic process above, he suggests that executives should make features of innovation from TQM practices as open and scalable as possible to match emerging social demands, or to consider trends of the business environment when developing solutions in TQM practices.

7.2.3 Environment-performance

The relationship between external business environment and performance has been investigated by existing literature to a satisfactory extent. Previous studies have investigated this link not only directly but also indirectly, through other variables (mainly business strategy).

Badri et al (2000) used a path analytic framework to study the effects of environment on the choice of operations strategy and performance for a sample of manufacturers in United Arab Emirates. Environment has been measured through six variables: business cost, labour availability, competitive hostility, government laws, political environment and dynamism in the market. For strategy they used the commonly used manufacturing operations strategies taxonomy, which identifies four strategy dimensions: cost, quality, delivery and flexibility. Finally performance was measured through objective measures (low and high performers). Their results indicate that a relationship exists between environment and strategy selection, and that environmental concerns in mature and emerging manufacturing industries are not similar, and hence, should be considered. Furthermore they found that successful firms operating in dynamic environments are more likely to emphasize in flexibility, quality and delivery performance, rather than cost reduction strategies.

Sila (2007) investigated the impact of contextual (institutional and contingency) factors on TQM implementation and performance. They found that the implementation of TQM practices was similar across subgroups of companies within each contextual factor, meaning that TQM and TQM-performance relationships are not context-dependent.

Hogue (2004) investigated the role of the choice of performance measures on the relationship between a) strategic priorities and performance and b) environmental uncertainty and performance, using survey data from 52 manufacturing companies. The results revealed the existence of a significant and positive association between strategy choice and performance, whereas no evidence was found regarding a significant relationship between environmental uncertainty and performance. Moreover, Galbreath and Galvin (2008) explored the relative importance of distinct resources and industry structure variables in explaining firm-level performance variation, in a sample of 285 Australian firms. The results of their study demonstrated that resources are more important than industry structure, and that in service firms resources are found to be much more important to explaining performance variation than in manufacturing firms. Another interesting finding was that in both manufacturing and services firms, intangible assets and capabilities explain performance variation while, tangible resources do not.

On the other hand, Gao et al. (2007) studied the moderating effect of environment in the relationship between strategic orientation and business performance. The conclusion from his research were that the effect of customer orientation on performance becomes positive as demand uncertainty increases, and it becomes negative at high levels of demand uncertainty, whereas the effect of competitor orientation on business performance is not affected by the extent of competitive intensity. Moreover technology orientation has a negative effect on business performance at lower levels of technological turbulence, but the effect changes to positive with an increasing level of technological turbulence. Finally, Porter (2008) clearly supports the above-mentioned relationship by stating that "understanding the competitive forces, and their underlying causes, reveals the roots of an industry's current profitability while providing a framework for anticipating and influencing competition (and profitability) over time.

7.2.4 Summary of literature review and conclusions

As we can see from the existing literature review, there are a lot of studies describing the relationship between external environment and business performance. Similarly, there are studies relating environmental dimension with business change (BPR, TQM or other form). However our literature review has not conveyed empirical studies on the relationship between environment and ICT. In accordance to this finding McAfee and Brynjolffsson (2008) state that "much attention has been paid to the connection between productivity growth and the increase in IT investment. But hardly any has been directed to the nature of the link between IT and competitiveness".

All in all, to the best of our knowledge, there is a serious gap in the literature regarding a study, which integrates all those variables (which have been sporadically mentioned) into one single model. In other words, a study regarding the interplay between external environment, ICT/non-ICT investment, BPR or TQM (as business transformation paradigms) and performance, is missing.

7.3 Research Hypotheses, Method and Data

Bearing in mind the conclusions from the literature review we formulated our research

hypotheses, which can be summarized by the theoretical model of figure 7.2.

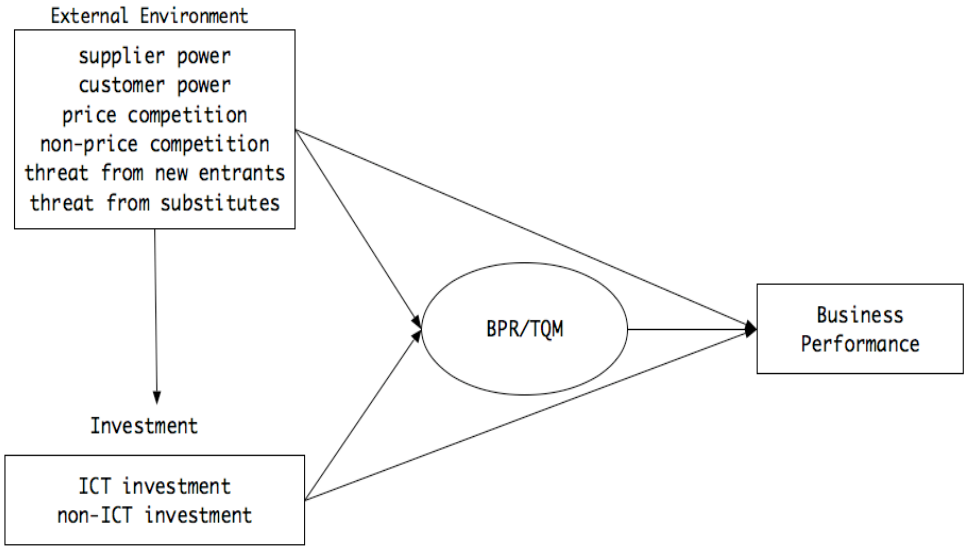


Figure 7.2: The theoretical model of the effects of the external environment on ICT, non-ICT, BPR, TQM and performance.

The model posits that the various forces of the competitive environment affect the extent of investments in ICT and non-ICT, the extent of business transformation (BPR or TQM), and, finally, business performance. Actually, from this model emerge 12 theoretical models, if we consider each environmental force (six in total) each time with BPR and then with TQM. In the hypothesized models we have decided to cover the various dimensions of the external environment by using Porter's five forces model, described in the introduction as well as in chapter 1. The first reason for choosing this theory is that it is a well-grounded theory, widely used in the past in numerous studies (Galbreath and Galvin, 2008; Collis and Montgomery, 2008). Porter (2008) summarizes the advantages of the five forces model: "The competitive forces reveal the drivers of industry competition. A company strategist who understands that competition extends well beyond existing rivals will detect wider competitive threats and be better equipped to address them. At the same time, thinking comprehensively about an industry's structure can uncover opportunities: differences in customers, suppliers, substitutes, potential entrants, and rivals that can become the basis for distinct strategies yielding superior performance. In a world of more open competition and relentless change, it is more important than ever to think structurally about competition". The second reason is related to our decision of choosing Porter's strategy typology in chapter 6. Since the two approaches are closely related to each other (Miller, 1988), the reliability of the results will be greater.

At this point we should also note that the threat from competitors has been divided into two categories: price competition (e.g discounts, special offers, etc) and non-price competition (advertizing, promotion, etc). This is a common practice since those two categories of competition have different routes and provide us with additional information. Based on the above we formulated our hypotheses.

The first set of hypotheses regards the ICT-business performance relationship. We have also included in our investigation non-ICT investment (the 'traditional' assets) for com-

parison purposes between ICT investment and non-ICT investment regarding the above aspects. The reason for doing this is that, despite the growing investment of firms in ICTs, non-ICT investment constitutes in most sectors the biggest part of firms' total investment.

Hypothesis 7.1: ICT Investment has a positive and significant effect on business performance.
Hypothesis 7.2: non-ICT Investment has a positive and significant effect on business performance.

There is also considerable literature proposing specific ways for using ICTs in order to support BPR and achieve higher business performance (Grover et al 1993, Davenport 1993, Tapscott and Caston 1993, Gunasekaran and Nath 1997, Champy 2002a, Champy 2002b, Attaran 2003). Similarly, there are several empirical studies providing evidence for a positive effect of TQM on business performance (e.g. Martinez-Lorente et al 2004, Demirbag et al 2006, etc.). As a consequence of the above we make the following research hypotheses:

Hypothesis 7.3: The extent of BPR has a positive and significant effect on business performance.
Hypothesis 7.4: The extent of TQM has a positive and significant effect on business performance.

Regarding the relationship between ICT/non-ICT investment and BPR/TQM, there are many theoretical arguments in the literature concerning the important capabilities offered by ICTs for improving dramatically the existing business processes and work practices, and through these improvements for achieving high levels of business benefits (e.g. Brynjolfsson & Hitt 1996, Brynjolfsson & Hitt 1998, Brynjolfsson & Hitt 2000, Bresnahan et al 2002, OECD 2004, Melville et al 2004). Therefore we expect that ICT investment is positively related to BPR. Furthermore, while ICTs are 'general purpose' technologies, which can be used for many different functions and can be easily adapted to new needs and processes, non-ICT investments (e.g. for production machinery, buildings, etc.) do not offer this flexibility. For this reason we do not expect that non-ICT investment leads to BPR implementation in order to contribute to better performance.

On the other hand we expect that TQM might have a mediation effect on the ICT-performance relationship (thus non ICT leads to TQM): high investment in non-ICT assets (e.g. sophisticated and complex production machinery) can act as a driver for adopting various TQM practices, such as statistical quality control, quality improvement teams aiming at continuous improvement, cooperation with suppliers for quality improvement, monitoring of customers' satisfaction, etc., in order to increase the value generated for the firm from these expensive assets. Taking the above into account, our next four hypotheses will be:

Hypothesis 7.5: ICT investment has a positive and significant effect on the extent of BPR.
Hypothesis 7.6: Non-ICT investment has a positive and significant effect on the extent of BPR.
Hypothesis 7.7: ICT investment has a positive and significant effect on the extent of TQM.
Hypothesis 7.8: Non-ICT investment has a positive and significant effect on the extent of TQM.

Hypotheses 7.1-7.8 have already been examined in chapters 4 and 6. However, they will be also investigated since they are included in the new hypothesized model (figure 7.2). Therefore they are not going to be further analyzed (in terms of literature review regarding the relationships they concern) since the reader can find all the information in the abovementioned chapters.

The relationship between external environment and investments in ICT has not been empirically investigated so as to produce safe results, as explained in section 7.2.1. McAfee and Brynjolfsson (2008), in a Harvard Business Review paper, identify the gap in the existing literature regarding the connection between the various dimensions of the external environment and ICT, by stating that "much attention has been paid to the connection between productivity growth and the increase in IT investment. But hardly any has been directed to the nature of the link between IT and competitiveness". However their study came up with optimistic findings regarding the business environment-ICT investments relationship: "During the last decades a new competitive dynamic has emerged…This accelerated competition has coincided with a sharp increase in the quantity and quality of IT investments, as more organizations have moved to bolster (or altogether replace) their existing operating models using the internet and enterprise software. They finally conclude in that "a central catalyst in competition acceleration is the massive increase in the power of IT investments", implying a close relation of the two variables. We therefore expect that:

Hypothesis 7.9: The extent of supplier power has a positive and significant effect on ICT investment.
Hypothesis 7.10: The extent of customer power has a positive and significant effect on ICT investment.
Hypothesis 7.11: The extent of price competition has a positive and significant effect on ICT investment.
Hypothesis 7.12: The extent of non-price competition has a positive and significant effect on ICT investment.
Hypothesis 7.13: The extent of threat from new entrants has a positive and significant effect on ICT investment.
Hypothesis 7.14: The extent of threat from substitutes has a positive and significant effect on ICT investment.

Similarly to the previous chapters, we will examine the same hypotheses for non-ICT investment as well, trying to identify the effect of external environment on the traditional assets of the firms (which constitute the main proportion of their total assets), as well as on business performance. The reasons for doing this, have been already been presented in detail in chapter 4 (section 4.3). Consequently, according to the above, we expect that:

Hypothesis 7.15: The extent of supplier power has a positive and significant effect on non-ICT investment.
Hypothesis 7.16: The extent of customer power has a positive and significant effect on non-ICT investment.
Hypothesis 7.17: The extent of price competition has a positive and significant effect on non-ICT investment.

Hypothesis 7.18: The extent of non-price competition has a positive and significant effect on non-ICT investment.
Hypothesis 7.19: The extent of of threat from new entrants has a positive and significant effect on non-ICT investment.
Hypothesis 7.20: The extent of threat from substitutes has a positive and significant effect on non-ICT investment.

As mentioned in section 7.2 the relationship between external environment and business transformation (the main paradigms of which are BPR and TQM) is considered among the most important research objectives by the existing literature. The dynamic nature of the external environment is very likely to force changes in the structure and processes of the organizations, in order to be able to compete and prevail among rivals. One of the main reasons for BPR in organizations is the influence of the external environment. The major changes in markets, technologies, and degree of competition imply the need for enterprises to change their organizational and managerial arrangements (Francis and MacIntosh, 1997)**.** BPR as the outcome of external environment pressures. The relationship between environment and BPR has been mentioned by Agrawal and Haleem (2003) and Brian and Ciaran (1996). Our hypothethes regarding this issue will therefore be:

Hypothesis 7.21: The extent of supplier power has a positive and significant effect on the extent of BPR.
Hypothesis 7.22: The extent of customer power has a positive and significant effect on the extent of BPR.
Hypothesis 7.23: The extent of price competition has a positive and significant effect on the extent of BPR.
Hypothesis 7.24: The extent of non-price competition has a positive and significant effect on the extent of BPR.
Hypothesis 7.25: The extent of of threat from new entrants has a positive and significant effect on the extent of BPR.
Hypothesis 7.26: The extent of threat from substitutes has a positive and significant effect on the extent of BPR.

On the other hand, there is an also close connection between external environment and TQM. Lawrence and Lorsch have identified that the success of TQM is a function of the interrelationship among internal organizational states and processs and external environment demands. Dean and Evans (1994) argued about the relationship between TQM and competitive advantage, which implies that, in order to implement TQM, one must examine the idioms of the environment, and more particular, the competition.

TQM by definition regards the relationship of the firm with its environment. Some of its main activities, measurements of customer satisfaction, cooperation with suppliers and other partners reveal a close relationship. Hung (2007) investigated, among others, the effect of environmental changes on TQM practices in pursuing innovation performance, through a case study on a leading global firm. We therefore expect that:

Hypothesis 7.27: The extent of supplier power has a positive and significant effect on the extent of TQM.
Hypothesis 7.28: The extent of customer power has a positive and significant effect on the extent of TQM.

Hypothesis 7.29: The extent of price competition has a positive and significant effect on the extent of TQM.
Hypothesis 7.30: The extent of non-price competition has a positive and significant effect on the extent of TQM.
Hypothesis 7.31: The extent of threat from new entrants has a positive and significant effect on the extent of TQM.
Hypothesis 7.32: The extent of threat from substitutes has a positive and significant effect on the extent of TQM.

Finally, a lot of research has dealt with the relationship between the forces of the external environment and business performance. Most of the reviewed studies identified a negative (direct or indirect) link (Badri et al, 2000, Sila, 2007; Hogue, 2004; Galbreath and Galvin, 2008). On the other hand, one study was found to identifying a positive one (Gao et al, 2007). In particular, powerful suppliers capture the biggest proportion of value for themselves by charging higher prices, limiting at the same time the quality of the products or services. They thus charge higher costs to firms, obliging them to transfer their increased costs to final consumers by offering their products/services in higher prices, reducing thus their profit margins. Powerful buyers can force down prices by demanding better quality and service, and generally playing industry participants off against one another, all at the expense of industry profitability.

On the other hand firms that compete in prices (e.g through discounts) or not (e.g through advertising) try to gain a better share. Rivalry among existing competitors takes various forms but has one consequence: reduction of profits. Regarding the possibility of new players in the market we could expect that new entrants to an industry bring new capacity and a desire to gain market share that puts pressure on prices, costs, and the rate of investment necessary to compete. Finally, the threat of substitutes limits an industry's profit potential by placing a ceiling on the products' prices, since customers have the ability to turn to a substitute if they judge that its price is high. According to the above thoughts, we have formulated the following hypotheses:

Hypothesis 7.33: The extent of supplier power has a negative and significant effect on business performance.
Hypothesis 7.34: The extent of customer power has a negative and significant effect on business performance.
Hypothesis 7.35: The extent of price competition has a negative and significant effect on business performance.
Hypothesis 7.36: The extent of non-price competition has a negative and significant effect on business performance.
Hypothesis 7.37: The extent of threat from new entrants has a negative and significant effect on business performance.
Hypothesis 7.38: The extent of threat from substitutes has a negative and significant effect on business performance.

The instrument used for testing the abovementioned 38 hypotheses is a part of the questionnaire, which has been used in the previous chapters and is included in Appendix A (questions 1-7 and 9). The sample and the method used for data elaboration is the same as in chapters 4 and 6 (see chapter 3). The hypothesized models are based on the Cobb-Douglas production function (Nicholsson, 1998). BPR and TQM, similarly to the previ-

ous chapters, have been measured through multi-item scales consisting of 9 items for BPR and 7 items for TQM. The particular 16 items can be also viewed in Appendix A (survey instrument). The conceptualization resources of those items have already been analyzed in chapter 4 (see Appendix B). Finally SEM has been applied for testing the measurement and structural models.

7.4 Data analysis and results

7.4.1 Measurement models

The 12 theoretical models based on figure 7.2 were estimated using SEM through the AMOS 7 software (Byrne 2001). Initially the measurement models were examined; in particular, content validity, construct validity and reliability of the BPR and TQM multi-item constructs were assessed, as described in the following paragraphs. The same procedure has taken place in chapter 4, so we are not going to present it in deep detail.

Both BPR and TQM multi-item scales have been developed through extensive review of the relevant literature, and reviewed by three highly experienced ICAP experts, ensuring therefore content validity for the two constructs included in the models. Convergent validity of the BPR and TQM constructs was tested by examining the estimated measurement models parts of the above 12 models, which connect the two constructs with their corresponding items. In all models the item loadings of the BPR and TQM are statistically significant and exceed (or equal) the cut off level of 0.6 (Chin, 1998), as table 7.1 shows.

BPR item loadings						
Indicator	**sup**	**cust**	**price**	**non-price**	**entry**	**sub**
BPR_1	.747	.746	.747	.746	.745	.744
BPR_2	.716	.717	.716	.716	.714	.715
BPR_3	.781	.783	.781	.781	.780	.781
BPR_4	.690	.689	.690	.690	.690	.690
BPR_5	.711	.712	.712	.712	.712	.711
BPR_6	.810	.807	.809	.810	.810	.810
BPR_7	.746	.745	.745	.746	.746	.746
BPR_8	.713	.714	.712	.712	.713	.713
BPR_9	.665	.665	.665	.716	.665	.666
TQM item loadings						
Indicator	**sup**	**cust**	**price**	**non-price**	**entry**	**sub**
TQM_1	.600	.600	.600	.600	.600	.600
TQM_2	.671	.673	.672	.672	.671	.673
TQM_3	.822	.823	.824	.823	.823	.823
TQM_4	.806	.804	.805	.805	.806	.804
TQM_5	.800	.800	.800	.800	.800	.801
TQM_6	.752	.751	.750	.751	.752	.751
TQM_7	.824	.823	.823	.824	.824	.824

Table 7.1. Convergent validity of the BPR and TQM constructs (sup=supplier power, cust=customer power, price=price competition, non-price=non-price competition, entry=threat from new entrants, sub=threat from substitutes).

Discriminant validity of the BPR and TQM constructs was again tested by performing factor analysis with varimax rotation using the SPSS 15.0 software. The results are ex-

actly the same as in table 4.3 (chapter 4), indicating thus discriminant validity for the two constructs. Similarly, the reliability of the two constructs was examined through Cronbach's Alpha. The resulting values (0.914 for the BPR construct and 0.906 for the TQM construct) exceeded the minimum acceptable level of 0.7 recommended by the relevant literature (Gefen et al 2000, Straub et al 2004), confirming therefore the reliability of both constructs.

7.4.2 Structural models

As a second step we examined the fit indices of the 12 structural equation models. Table 7.2 shows the main goodness-of-fit indices (incremental fit indices), which quantify to what extent the specified models fit the observed data. We can see that all models have satisfactory values of the incremental fit indexes (≥ 0.9) as well as of the RMSEA (≤ 0.08), in accordance with the suggestions of the relevant literature (Browne and Cudeck 1993, Gefen et al 2000, Straub et al 2004). Therefore, we can conclude that all models show a satisfactory and acceptable fit with the data, and proceed to examining their path coefficients.

BPR	Chi-square	NFI	RFI	IFI	TLI	CFI	RMSEA
sup	108.38	.931	.903	.965	.950	.964	.060
cust	110.01	.931	.886	.964	.939	.963	.061
price	106.19	.933	.904	.966	.952	.966	.059
non-price	105.38	.933	.905	.967	.952	.966	.058
entry	112.87	.929	.899	.962	.946	.962	.062
sub	112.30	.929	.900	.963	.946	.962	.062
TQM							
sup	47.404	.961	.932	.992	.986	.992	.030
cust	45.387	.963	.935	.994	.989	.994	.027
price	48.39	.960	.942	.991	.987	.991	.032
non-price	47.179	.961	.944	.992	.988	.992	.030
entry	51.413	.958	.939	.989	.983	.988	.036
sub	55.00	.955	.935	.986	.979	.985	.041

Table 7.2 Model fit of the 12 structural models.

The final step was to estimate the paths in the 12 structural models. As an example, the results of two structural models can be seen in figure 7.3, which shows the models of supplier power-BPR and supplier power-TQM. However, for a better presentation and analysis, the results are going to be grouped and presented together in table 7.3.

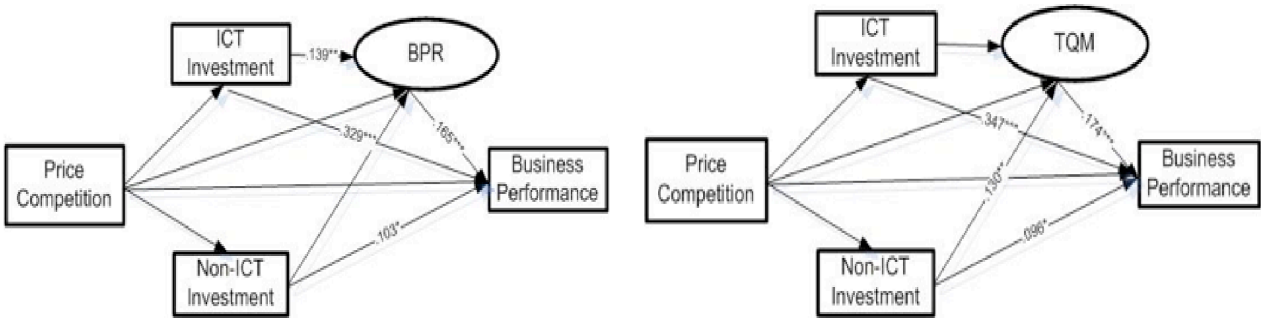


Figure 7.3 Estimated structural models of supplier power-BPR and supplier power-TQM

Table 7.3 shows the results of the 12 estimated structural models (concerning hypotheses 7.9-7.38). The first six models examine the effect of environmental forces on investment, BPR and performance. The rest use the other process change paradigm, TQM, instead of BPR. First of all, there is a clear direct effect of ICT investment on business performance equal to about 0.3 in all 12 models. Additionally ICT investment affects performance indirectly, through BPR. The magnitude of the effect of ICT investment on BPR equals to about 0.13 in all models. Non-ICT investment has a direct effect on performance (equal to about 0.1) and an indirect effect through TQM (with a magnitude of 0.130*0.175= 0.0225). The above results (the direct effects of ICT and non-ICT investments on performance and the partial mediating role of BPR and TQM on the abovementioned relationship) are consistent with our findings in chapter 4, proving for the stability of the developed models and the reliability of the data. Therefore hypotheses 7.1-7.8 are supported.

Regarding the effect of environmental forces, the extent of supplier power has a negative impact on ICT investment in both (BPR and TQM) models. This means that the higher the pressure of suppliers, the less the investments in ICT by firms. This is an expected result since powerful suppliers press down firms' profitability and leaves no space for further development through the acquisition of enhanced ICT equipment. Supplier power does not seem to affect significantly any other variable included in the model. Consequently hypotheses 7.9, 7.15, 7.21 and 7.33 are not supported. The power of customers has a significant effect on BPR equal to 0.2. This finding could be interpreted as that firms proceed to process improvement and adjustment if they feel the pressure from their customers. As mentioned above, customers have the power to demand better quality of the products offered, better services and lower prices. Firms, in order to respond to those requirements undertake BPR projects aiming at cost reduction, which will lead to profitability increase or minimization of their losses. Hypothesis 7.22 is therefore supported. Customer power does not affect ICT and non-ICT investment, and business performance, leading to the rejection of hypotheses 7.10, 7.16 and 7.34.

Similar results can be also seen in the TQM model: Customer power has a positive and significant effect (equal to 0.18) on TQM. TQM approaches are employed for better production quality control and minimization of false production in order for the firms to better respond to customer requirements without loosing great proportions of their profitability. This finding provides support for hypothesis 7.28.

As far as the effect of price competition is concerned, it doesn't seem to significantly affect neither BPR nor TQM. This finding seems rather odd since the main motive for firms

undertaking busness transformation projects (through BPR or TQM) is cost reduction, which will enable them to offer products or services in lower prices than their competitors. This finding forces us to reject hypotheses 7.11, 7.17, 7.23 and 7.35. On the other hand, competition on other factors rather than on prices implies superiority of products, services, or processes, necessitating thus investments in ICT. The direct effect of non-price competition on ICT investments (in both models) equals to about 0.11 (-0,110 in BPR and -0,115 in the TQM model), providing thus support for hypothesis 7.12. Apart from this effect, non-price competition does not affect any other variable, which leads to the rejection of hypotheses 7.18, 7.24, 7.30 and 7.36.

BPR Model				
Environment	ICT	Non-ICT	BPR	Performance
Supplier power	-.113*	-	-	-
Customer power	-	-	.201***	-
Price competition	-	-	-	-
Non-price competition	.108*	-	-	-
Threat from new entrants	-	-	-	-.110*
Threat from substitutes	-	-	.147**	-
TQM Model				
Supplier power	-.113*	-	.156**	-
Customer power	-	-	.182**	-
Price competition	-	-	-	-
Non-price competition	.108*	-	-	-
Threat from new entrants	-	-	.113*	-.115**
Threat from substitutes	-	-	.184***	-

Table 7.3 Grouped results of the effect of the external environment on ICT, non-ICT investment, BPR, TQM and business performance.

The fifth element of Porter's competitive forces theory, the threat from new entrants, seems to negatively affect business performance with direct effects of similar magnitude (-0.110 in the BPR and -0.115 in the TQM model). This finding could be interpreted as that a higher threat from new players in the market will reduce the market share of the existing ones, causing thus decreases in their income. Hypothesis 7.37 is thus supported. The threat from new entrants does not show any effects on any other variable on the BPR models. Existing players will try to react in the perspective of market share decrease, by exploiting their relations to their suppliers and customers (through various manners) and by enhancing control in the production process. Those activities imply the employment of a TQM approach and therefore prove the direct effect of the threat from new entrants on TQM (equal to 0.113). Therefore hypotheses 7.13, 7.19 and 7.25 are rejected whereas hypothesis 7.31 is supported.

Finally, the threat from substitute products or services affects significantly and positively BPR and TQM at a magnitude of 0.147 and 0.184 respectively (providing support for hypotheses 7.26 and 7.32). The threat of sales reduction forces firms to think of better and cheaper processes in operational as well as production processes. The solution is business transformation through BPR and TQM. No other variable seems to be affected, leading to the rejection of hypotheses 7.14, 7.20 and 7.38.

7.5 Conclusions, limitations and further research directions

In the previous chapters we have dealt with the role of BPR and TQM (as complementarity investments) on the relationship between (ICT and non-ICT) investment and business performance. Besides we have empirically investigated the effect of business strategy regarding the above. As mentioned in the introduction of the present dissertation, current research pays a lot of attention to the effects of external factors on organizations. After having provided trustful answers to the productivity paradox, it has been realized that, apart from internal factors, business performance is also affected by environmental factors belonging to the external business context, as well. Existing literature has dealt with the effect of external environment without investigating its role in the business value creation process, apart from the other complementarity investments.

Chapter 7 contributes to the existing literature by fulfilling the abovementioned research gap. It empirically investigates the role of the various competitive forces in the business value creation process, and their effect on ICT, non-ICT and two main complementarity investments, such as BPR and TQM. In accordance to the previous chapters, it moves one step backwards, focusing more on the context under which organizations operate and on the manners it adds value to the business (see figure 2.3, chapter 2). In particular there have been examined the effects of Porter's five competitive forces on ICT and non-ICT investment, BPR, TQM and business performance in a sample of 271 firms in Greece.

The findings are quite interesting and useful for researchers as well as for practitioners: The power of suppliers leads to decrease in ICT investments whereas in enhances TQM initiatives. Customer power necessitates process transformation (BPR and TQM) whereas non-price competition enhances investments in ICT. The threat from new entrants decreases profitability and forces firms to undertake TQM initiatives to reduce their losses. Finally the fear of competitors offering substitute products or services evokes more drastic measures, such as radical process improvement through BPR.

However, there are also some limitations. As mentioned in the previous chapters the present empirical investigation has been based on a sample of Greek firms, so its results may have been influenced by the characteristics (e.g. technological, economic, cultural, social, etc.) of the Greek national context. It is a country of a population of eleven million, with a small size of internal market and small average firm size; those characteristics possibly form a competitive environment of low or moderate intensity and effects of similar magnitude on the Greek firms. Additionally, according to Hofstede's Uncertainty Avoidance Index (http://www.geert-hofstede.com/) Greece receives a very high score, much higher than the other European countries, indicating that it is a risk-averse culture. This fact implies that Greek firms avoid taking highly risky decisions; therefore their reactions to the pressures of the various competitive forces are conservative, compared to other countries.

A second limitation that could be mentioned is that in the present chapter the relationship between external environment and strategy has not been investigated, despite the fact that there is literature providing evidence of a significant link (Gimsauskiene and Kloviene, 2008; Parnell et al, 1996; Miller, 1998). However the objective of this study was to examine the influence of the external environment to particular adding-value factors (such as in investments in ICT and non-ICT assets, BPR and TQM) and their overall impact on business performance. Nevertheless, the impact of external environment on strategy selection

has been proven and is undouptful. Future research implications regard the investigation of the same theoretical models by substituting the single-variable performance measure (value added) with a performance construct, including objective as well as subjective measures of business performance.

CHAPTER 8

Information and Communication Technologies, Human Capital, Workplace Organization and Labour Productivity in Greece and Switzerland: A Comparative Study Based on Firm-level Data

8.1 Introduction

In the modern economy, in addition to the traditional production factors (traditional physical capital and labour), some 'new' factors are gradually becoming highly important, such as human skills (often referred to as 'human capital'), workplace organization (often referred to as 'organizational capital'), information and communication technologies (ICT) and knowledge. As already mentioned in the previous chapters, in most developed and developing countries firms make big investments for acquiring and using these new production factors, so it is of critical importance to investigate their contribution to and impact on firm performance.

The impact of ICT investments on firm performance has been investigated in previous studies (productivity paradox). Additionally the contribution of human capital to economic growth at aggregate, sector and firm level has been researched and recognized by previous research (e.g., Barro, 1999; Middendorf, 2006). Recently there has been research interest for new organizational practices, such as 'employee voice' and new forms of 'work design', and their impact on firm performance (e.g., Murphy, 2002; Black and Lynch 2002). Moreover, relevant literature has indicated the existence of complementarities between ICT capital, human capital and new organizational practices, which are of critical importance for firm performance. These complementarities have been regarded as a fundamental characteristic of an emerging new 'firm paradigm' in modern economy (Milgrom and Roberts, 1990). The conclusions of those studies contain some similarities, but also several differences as well, which might be (at least to some extent) due to differences in sample composition (the samples of these studies are from different sectors and industries, in variables and models specification and also in the nature of the investigations (cross-sectional versus longitudinal). Therefore, further empirical research is required concerning the impact of ICT capital, human capital, new organizational practices, and their combinations on firm performance.

The previous chapters of the present thesis have dealt with the main complemenarity investment, namely process change, expressed and measured through the extent of BPR and TQM implementation. As mentioned in the conclusions of those chapters, a serious drawback has been the empirical investigation of the research hypotheses in only one national context (i.e Greece). In these directions this chapter presents a comparative empirical study of the effect of ICT capital, human capital, new organizational practices and their combined use, also controlling for the knowledge capital, on labour productivity in Greek and Swiss firms. Its analytical framework is that of a firm-level production function. Both the Greek and the Swiss part of this study are based on firm-level data collected through the same questionnaire in 2005 and from samples of similar composition (concerning firm size classes and sectors), and also use the same variables and models specification, so they are comparable.

The contribution of this study to the empirical literature is three-fold. First, for the abovementioned reasons, it is the first completely comparative empirical study on the above critical research questions in two quite different countries giving particular attention to the complementarity issue. Second, part of this study, is the first study of this type for Greece, whose economy is quite different from the economies of the highly developed countries, in which most of the empirical studies on these research questions have been

conducted. Third, this study takes into consideration explicitly possible endogeneity problems of the right-hand side variables in a cross-section.

Chapter 8 is structured a follows: In section 8.2 a literature review and the conceptual framework of this study are presented. Section 8.3 contains a review of the relevant empirical literature. In section 8.4 the data of both the Greek and the Swiss parts of the study are described. The patterns of use of ICT, new organizational practices and human capital in Greece and Switzerland are presented and compared in section 8.5. In section 8.6 are described the variable construction as well as the specification of the two types of econometric models we used in this study. The results of the econometric estimates are presented and discussed for both samples in section 8.7. Finally, in section 8.8 the results are summarized and comparisons between the findings from Greece and Switzerland are made and discussed.

8.2 Literature review

8.2.1 The new firm model

The last fifteen to twenty years have witnessed a constellation of important changes of the production process, such as the extensive use of computer-aided production technologies, the advances in information and communication technologies, the emerging of new ideas how to organize firms, changes in the skill requirements of labour and changes in employee preferences toward more flexible working conditions. Therefore, many authors have recently postulated a shift to a new 'firm paradigm'. Some of them focus their attention mainly on technological changes, some find the introduction of new organizational practices a central characteristic of this 'paradigm change', while a third group concentrates primarily on the shift of firm demand to high-skilled labour in the last twenty years and analyzes the determinants of this shift. In this section we briefly review some of this literature.

Milgrom and Roberts (1990) focusing mainly on manufacturing, proclaim the replacement of the "mass production model by the vision of a flexible multiproduct firm that emphasizes quality and speedy response to market conditions while utilizing technologically advanced equipment and new forms of organization" (p. 511). Changes in the production techniques and their implications for firm efficiency and performance build the main subject of their theoretical analysis. Lindbeck and Snower (2000) analyze the shift from " 'tayloristic' organization (characterized by specialization by tasks) to 'holistic' organization (featuring job rotation, integration of tasks and learning across tasks)" (p. 353). In a following paper the same authors elaborate on the idea of the "firm as a pool of factor complementarities", thus identifying factor complementarity as constitutive to the determination of a firm's boundaries (Lindbeck and Snower, 2003). Bresnahan et al. (2002) take the relative demand of skilled-labour as starting point of their analysis and consider the increased use of "complementary systems" of information technologies, workplace organization and product innovation as drivers of skill-biased technical change. One point, which is central to all types of analysis and builds a common characteristic of them, is the existence of complementarities among several factors, which mutually enhance their impact on firm performance.

8.2.2 Role of ICT

The role of ICT has been widely discussed in the previous chapters of this disseration. The benefits of ICT for a firm include savings of inputs, general cost reductions, higher flexibility and improvement in product quality. New technology may save labour or some specific labour skills; it may reduce capital needs through, for example, increased utilization of equipment, reduction of inventories or space requirements and so on. It may also lead to higher product quality or better conditions for product development. Moreover, it may increase the flexibility of the production process allowing for the exploitation of economies of scale (see e.g. Milgrom and Roberts, 1990, 1995). A specific feature of ICT is related to networking and communication. As new technologies reduce the cost of lateral communication, firms use these technologies to facilitate communication among employees and reduce co-ordination costs. Monitoring technologies can also be used to reduce the number of supervisors required in the production process. Thus, the use of ICT has direct implications for firm organization. While inventions that lead to improvements in ICT are quickly available throughout the economy, complementary organizational changes involve a process of co-invention by individual firms (Bresnahan and Greenstein, 1997). Identifying and implementing such organizational changes is difficult and costly. These adjustment difficulties lead to variation across firms in the use of ICT, its organizational complements and the resulting outcomes.

8.2.3 Role of new organizational practices

Some theories have been developed to explain why new high-skill and high-involvement workplaces may be more effective (see, e.g., Ichniowski et al., 2000). These can be divided, first, into theories that focus on the effort and motivation of workers and work groups and suggest that due to the positive worker incentives created by new organizational forms the worker performance increases. A second group of theories focuses on changes of the structure of organizations that improve efficiency (see also Aghion et al., 1999, p. 1650 for a discussion about the characteristics of recent developments in the structure of European and US companies). We concentrate here more on the second group. These theories imply that new arrangements can make organizational structures more efficient. For example, decentralizing decision-making to self-directed teams can reduce the number of supervisors and middle-level managers required while improving communication; employee involvement can eliminate or reduce grievances and other sources of conflict within the firm, thus improving performance (see Mookherjee, 2006 for a survey of the theoretical literature on decentralization, hierarchies and incentives).

Moreover, for the organizational practices there exist interdependencies with other factors and inputs. Some work design changes are associated with the introduction and diffusion of information technologies within the firm. For example, Greenan and Guellec (1994) show in a theoretical paper that the relative efficiency of a centralized mode of firm organization in which knowledge is confined to specialized workers and a decentralized one in which every worker participates in learning depends on the technological level of the firm: “whereas the centralized style is more efficient when the technological level is low, the decentralized one becomes more efficient when the technological level is higher” (p. 173).

8.2.4 Role of human capital

The shift toward skilled workers appears to have accelerated in the last twenty years. While many factors have contributed to this increase most authors think that this effect is attributable primarily to skill-biased technical change. The size, breadth and timing of the recent labour demand shift have led many to seek skill-biased technical change in the largest and most widespread new technology of the last years: the ICT (see Bresnahan et al., 2002). On the one hand, high-skilled labour is a precondition for the use of ICT; for example, training in problem-solving, statistical process controls and computer skills can increase the benefits of ICT. On the other hand, highly computerized systems not only systematically substitute computer decision-making for human decision-making in routine work, but also produce a large quantity of data, which needs high-skilled workers, managers and professionals to get adequately utilized.

8.2.5 Role of 'complementarities'

The notion of 'complementarity' has been also previously discussed in this disseration. The use of ICT, new organizational practices and human capital build a "complementary system" of activities (Bresnahan et al., 2002; p. 341ff; Milgrom and Roberts, 1995, p. 191ff.). According to Milgrom and Roberts (1990, p. 514) "the term 'complement' is used not only in the traditional sense of a specific relation between pairs of inputs but also in a broader sense as a relation among groups of activities". For example, modern advanced manufacturing techniques consist of a bundle of technology elements implying considerable complementarities among these technology elements; a standard illustration refers to the use of CAD, which leads to complementarities with other programmable manufacturing equipment. But complementarities are considered also with respect to organization and human capital. In a recent paper Lindbeck and Snower (2003) further elaborate on the idea of factor complementarity which is identified as a central element for the determination of a firm's boundaries, distinguishing four types of complementarities: two kinds of inter-factor complementarity (technological and informational complementarity), intra-factor complementarities (leading to increasing returns of scale) and complementarities among factors in the production of additional products (leading to increasing returns to scope). In this study we restrain our analysis to inter-factor complementarities.

Recent theoretical developments analyze more in depth the conditions that are necessary for complementarity (a) between ICT and decentralization and (b) between ICT and skill-upgrating. Acemoglu et al. (2006) develop a framework to analyze the relationship between the diffusion of new technologies and the decision decentralization of firms. They show that firms that recently adopted a new technology and therefore are closer to technological frontier, younger firms and firms in more heterogeneous environments are more likely to choose decentralization. Borgans and ter Weel (2006) analyzed the differences of the division of labour across firms as a result of computer technology adoption. The adoption of computer technology can lead to productivity gains either directly, e.g. through reduced production time or indirectly through improved communication possibilities among employees. Direct productivity gains induce skill upgrading, while in firms gaining from improved communication specialization increases and skill requirements fall.

Thus, what we can observe if we correlate ICT and skills is the net result of these two opposite effects. In both the above-mentioned studies the theoretical predictions are backed by some empirical evidence.

8.2.6 Production function framework

The above discussion of the literature shows that there are some common testable hypotheses with respect to the contribution of ICT, new organizational practices and human capital to firm efficiency and performance, which can be at best put together in the framework of a production function containing besides the classical production factors, labour and traditional physical capital, also the new ones, ICT capital, organization capital and human capital (see Brynjolfsson and Hitt, 2000 for a recent survey of empirical literature on this line):

- *Hypothesis 8.1: there are considerable direct positive effects of ICT, organization and human capital respectively on firm performance;*
- *Hypothesis 8.2: there are considerable indirect positive effects of these factors on firm performance, which can be traced back to complementarities among them.*

8.2.7 Summary of similar empirical literature

We review here empirical studies that investigate simultaneously the impact of ICT, organizational capital and human capital (or at least two of them) on business performance. The choice of the studies reported in Table 1 was based on following criteria: recent date of publication, consideration of at least two of the three variable blocks technology, organization and human capital in the model specification, firm-level analysis, coverage of all sectors of the economy. For a recent survey of this literature see Addison (2005).

We can see that most of these studies find a statistically significant positive effect for ICT and organizational capital, and only few of them for human capital; we remark that most USA studies did not find a statistically significant positive effect for human capital. With respect to these direct effects Swiss firms tend to give more attention to human capital than to organization relative to firms in other countries. Concerning complementarities only two of the USA studies find statistically significant complementarities between ICT and organizational capital, and also between ICT and human capital; also the Australian study shows the existence of complementarities primarily between ICT and human capital and – somewhat weaker – between ICT and organizational capital.

a) Study	ICT	ORG	HC	Complementarity
USA:				
Black/Lynch (2000)				
- cross-section	positive	positive	n.s.	n.s.
- longitudinal	positive	positive	n.s.	n.s.
Capelli/Neumark (2001)				
- cross-section	positive	positive	n.s.	n.s.
- longitudinal	positive	positive	n.c.	n.s.

Bresnahan et al. (2002)				
- cross-section	positive	positive	positive	ORG/ICT; HC/ICT
Brynjolfsson et al. (2002)				
- longitudinal	positive	n.s.	n.c.	ORG/ICT
Australia:				
Gretton et al. (2002)				
- longitudinal	positive	positive	positive	ORG/ICT; HC/ICT
Germany:				
Bertschek/Kaiser (2001)				
- cross-section	positive	positive	n.c.	n.s.
Wolf/Zwick (2002)				
- longitudinal	positive	positive	positive	n.c.
Hempell (2003)				
- longitudinal	positive	n.c.	n.s.	ICT/HC
Bauer (2003)				
- cross-section	n.a.	n.s.	n.a.	n.c.
- longitudinal	n.a.	positive	n.a.	n.c.
France:				
Caroli/Van Reenen (2001)				
- longitudinal	n.s.	positive	n.s.	ORG/HC
Switzerland:				
Arvanitis (2005)				
- cross-section	positive	positive	positive	ICT/HC
UK:				
Crespi et al. (2006)				
- longitudinal	positive	n.s.	n.c.	ICT/ORG

Table 8.1: Summary of the empirical literature
Notes: the dependent variable is average labour productivity; ICT: information and communication technologies; ORG: workplace organization; HC: human capital; „positive": statistically significant (at the test level of 10%) positive coefficient of the variables(s) for ICT, ORG and HC respectively; n.s.: statistically not significant (at the test level of 10%); n.c.: not considered; n.a.: not available (for such cases in which the corresponding variables are included in the models, but the results are not explicitly presented).

In the European studies there is a tendency for complementarities between ICT and human capital and between organizational and human capital. The results are indicative but not completely comparable because some of the observed differences can be traced back to differences with respect to the sectors and industries covered in the studies, the specification of the independent variables and the nature of the investigations (cross-sectional versus longitudinal).

8.3 Data

The present study was initialized by two surveys, both conducted in autumn, 2005. The reference period for the qualitative data is the period 2003-2005 unless otherwise mentioned. The reference year for the quantitative variable is 2004. The variables (survey instrument) used in this study as well as their meaning is presented in table 8.2.

8.3.1 Swiss data

The data used in the Swiss part of this study were collected in the course of a survey among Swiss enterprises using a questionnaire which included questions on the incidence

and within-firm diffusion of several ICT technologies (e-mail, Internet, intranet, extranet) and new organizational practices (team-work, job rotation, employees‘ involvement), employees‘ vocational education and job-related training, and also on basic economic data for 2004 (sales, value of intermediate inputs, investment expenditure, number of employees, etc.).[1]

Variable	*Definition and measurement*
Basic model	
logCL	Logarithm of gross investment expenditure per employee 2004
logASSETN	Logarithm of assets value per employee at the and of 2004
logQUAL	Logarithm of the share of employees with tertiary level education 2004
LogTRAIN	Logarithm of employees participating to internal and/or external training courses initialized or supported by the firm 2004
logRDL	Logarithm of R&D expenditure per employee (average of the period 2003-2005);
INTERNET	Six-level ordinate variable for the intensity of internet use: share of employees using internet in daily work: 0: 0%; 1: 1-20%; 2: 21-40%; 3: 41-60%; 4: 61-80%; 5: 81-100%
INTRANET	Six-level ordinate variable for the intensity of intranet use: share of employees using internet in daily work: 0: 0%; 1: 1-20%; 2: 21-40%; 3: 41-60%; 4: 61-80%; 5: 81-100%
TWORK	Ordinate variable measuring how widespread is team-work inside a firm on a five-point Likert scale (1: 'very weakly widespread'; 5: 'very strongly widespread'); team work: project groups, quality circles, semi-autonomous teams, etc.
JROT	Ordinate variable measuring how widespread is job rotation inside a firm on a five-point Likert scale (1: 'very weakly widespread'; 5: 'very strongly widespread'); team work: project groups, quality circles, semi-autonomous teams, etc.
LEVEL	Three-level ordinate variable for the change of the number of managerial levels in the period 2000-2005: 1: increase; 2: no change; 3: decrease
COMP_OVERALL	Three-level ordinate variable measuring the change of the distribution of decision competences between managers and employees inside a firm in the period 2000-2005: 1: shift towards managers; 2. no shift; 3: shift towards employees
COMP_WORKPACE	Ordinate variable measuring the distribution of decision competences to determine work pace (1: 'primarily managers'; 5: 'primarily employees')
COMP_WORKSEQ	Ordinate variable measuring the distribution of decision competences to determine the sequence of the tasks to be performed (1: 'primarily managers'; 5: 'primarily employees')
COMP_WORKASSIGN	Ordinate variable measuring the distribution of decision competences to assign tasks to the employees (1: 'primarily managers'; 5: 'primarily employees')
COMP_WORKWAY	Ordinate variable measuring the distribution of decision competences to determine the way of performing tasks (1: 'primarily managers'; 5: 'primarily employees')
COMP_PRODUCTION	Ordinate variable measuring the distribution of decision competences to solve emerging production problems (1: 'primarily managers'; 5: 'primarily employees')
COMP_CUSTOMER-CONTACT	Ordinate variable measuring the distribution of decision competences to contact customers (1: 'primarily managers'; 5: 'primarily employees')

[1] The questionnaire was based to a considerable extent on similar questionnaires used in earlier surveys (see EPOC, 1997; Francois et al.; 1999, Vickery and Wurzburg, 1998; and Canada Statistics, 1999). Versions of the questionnaire in German, French and Italian are available in www.kof.ethz.ch.

COMP_CUSTOMER	Ordinate variable measuring the distribution of decision competences to solve emerging problems with customers (1: 'primarily managers'; 5: 'primarily employees')

Table 8.2: Definition of model variables.

The survey was based on a disproportionately stratified (with respect to firm size) random sample of firms with at least 20 employees covering all relevant industries of the business sector as well as firm size classes (on the whole 29 industries, and within each industry three industry-specific firm size classes with full coverage of the upper class of large firms)[2]. Answers were received from 1895 firms, i.e. 38.7% of the firms in the underlying sample. The response rates do not vary much across industries and size classes with a few exceptions (over-representation of paper and energy industry, under-representation of hotels, catering and retail trade). The non-response analysis (based on a follow-up survey of a sample of the non-respondents) did not indicate any serious selectivity bias with respect to the use of ICT and new organizational practices (team-work, job rotation). A careful examination of the data of these 1895 firms led to the exclusion of 185 cases with contradictory or non-plausible answers, so the remaining 1710 valid answers were finally used for the analyses presented in the following sections.

8.3.2 Greek data

The data we used in the Greek part of this study were collected similarly through a survey among Greek enterprises based on the same questionnaire that has been used in the Swiss part of the study. This questionnaire was translated into Greek and pre-tested by three experts highly experienced in such surveys and questionnaires, from ICAP, one of the largest business information and consulting companies of Greece, and also by two postgraduate students from the University of Aegean with experience in information systems research. Based on their remarks the final version of the questionnaire was developed. This survey instrument is the same that has been used in chapters 4-7 of this disseration and is described in detail in chapter 3. A non-response analysis was performed (survey of a sample of the non-respondents), which did not indicate any serious selectivity bias with respect to the use of ICT, new organizational practices, vocational education and job-related training. For the 271 Greek firms we also retrieved from the database of ICAP some economic data for 2004 that were not collected through the questionnaire. So we finally obtained for all these Greek firms all the economic data that were collected for the firms of the above Swiss data set through the Swiss questionnaire, with only one difference: the Swiss questionnaire collected the 'gross investment expenditure in 2004', as a measure of 'traditional capital', while from the ICAP database we could retrieve only the 'assets value at the end of 2004' for this purpose. However, we believe that this is not a problem, since both these variables are good measures of the 'traditional capital' a firm uses.

[2] Table 1 contains only 26 industries; the Swiss sample has „watches", "telecommunication" and "computer services" as separate industries that were put together with "electronics/instruments", "transport" and "other business services" respectively to make the industry classification comparable to that of the Greek data.

8.4 Method and results

8.4.1 Patterns of use of ICT, new organizational practices and human capital in Greece and Switzerland

For both Greek and Swiss data, as mentioned in the previous section, we initially calculated their descriptive statistics; the most important of them are shown in Tables 8.3 and 8.4 and enable us to draw some conclusions on the patterns of use of ICT, new organizational practices and human capital in Greece and Switzerland and also make comparisons between them. Concerning ICT capital there are remarkable differences between the patters of Internet usage (which is 'outwards-looking' aiming at linking the firm to the outside world) and intranet usage (which is 'inwards-looking' aiming at linking employees and organizational units within the firm). As we can see from Table 8.4, the percentage of firms not using Internet (3.0% in Greece and 3.6% in Switzerland) is very small. In both countries the class with the highest relative frequency is that of the firms with 1-20% of their employees using the Internet (52.1% in Greece and 37.8% in Switzerland), while much smaller is the percentage of the firms characterised by extensive diffusion of the Internet with more than 60% of their employees using the Internet (16.3% in Greece and 26.4% in Switzerland).

	Greece		Switzerland	
Variable	Mean	Standard deviation	Mean	Standard deviation
Log (value added per employee)	10.833	1.088	11.834	0.515
LogASSETN (logCL)	10.084	1.660	8.699	1.856
logQUAL	2.869	1.040	2.534	1.099
LogTRAIN	2.386	1.454	2.725	1.212
logRDL	1.798	2.961	3.936	3.702
INTERNET	2.948	1.340	3.380	1.491
INTRANET	3.015	1.793	2.668	1.877
TWORK	1.915	1.775	2.218	1.677
JROT	0.945	1.493	0.505	1.145
LEVEL	1.881	0.423	2.053	0.350
COMP_OVERALL	2.166	0.536	2.304	0.529
COMP_WORKPACE	2.196	1.045	2.743	0.703
COMP_WORKSEQ	1.834	0.864	2.540	0.870
COMP_WORKASSIGN	1.483	0.654	2.038	0.686
COMP_WORKWAY	2.081	0.921	2.509	0.910
COMP_PRODUCTION	1.985	0.950	2.103	0.698
COMP_CUSTOMER-CONTACT	2.426	1.201	2.650	1.414
COMP_CUSTOMER	1.970	0.977	2.155	0.975

Table 8.3: Descriptive statistics.

Variable	Greece	Switzerland
Average value-added per employee in Euro	74,506	106,821
Percentage of firms in which ... % of employees are using *internet:*		
0	3.0	3.6

1-20	52.1	37.8
21-40	15.6	18.5
41-60	13.0	13.7
61-80	8.9	9.3
81-100	7.4	17.1
Percentage of firms in which ... % of employees are using *intranet*:		
0	24.4	43.5
1-20	27.4	15.1
21-40	12.5	10.3
41-60	11.4	8.7
61-80	7.0	7.3
81-100	17.3	15.1
Percentage of employees with tertiary-level education	26.2	20.8
Percentage of employees with job-related training	23.3	26.8
Teamwork (1)	25.9	24.3
Job rotation (1)	7.7	3.6
Change of the number of management levels since 2000:		
- increase	15.6	3.7
- no change	80.7	87.3
- decrease	3.7	9.0
Overall distribution of decision competencies since 2000:		
- shift towards managers	7.4	3.4
- no shift	68.6	63.0
- shift towards employees	24.0	33.6
Distribution of decision competencies with respect to (2):		
work pace	9.9	12.3
sequence of tasks	2.2	13.8
assignment of tasks	0.4	4.8
way of performing tasks	4.8	15.2
solving of production problems	5.9	4.4
contact to customers	18.1	25.1
solving problems with customers	4.8	8.6

Table 8.4: Patterns of use of ICT and new Organizational Forms in Greece and Switzerland
(1): percentage of firms reporting the values 4 or 5 of an ordinate variable measuring how widespread is *team-work* and job rotation resp. inside a firm on a five-point Likert scale; (2): percentage of firms reporting the values 4 or 5 of an ordinate variable measuring the distribution of decision competences to determine work *pace, the sequence of tasks etc. inside a firm* an on a five-point Likert scale

A comparison between the two countries leads to the conclusion that while the share of firms using the Internet is almost the same in both countries (97.0% in Greece and 96.4% in Switzerland), the intensity of use of Internet in those Swiss firms that have introduced this technology is higher than in the Greek firms (also from Table 8.3 we can see that the mean of this variable is 3.380 for Switzerland and 2.948 for Greece).

On the contrary, there is considerable percentage of firms that do not have an intranet in both countries (24.4% in Greece and 43.5% in Switzerland). The class with the highest relative frequency in both countries is again that of the firms with 1-20% of their employees using intranet, but it has a lower relative frequency than the corresponding class (1-20%) of Internet usage in both countries (27.4% in Greece and 15.1% in Switzerland); the

percentage of the firms with extensive intra-firm diffusion of intranet technology having more than 60% of their employees using firm intranet is slightly lower in Greece 24.3% but higher 22.4% in Switzerland. The comparison between the two countries leads to the conclusion that the share of firms not having an intranet is higher in Switzerland than in Greece (43.5% and 24.4% respectively) and the intensity of use of intranet in the Greek firms is higher than in the Swiss firms (also from Table 8.3 we can see the mean of this variable is 2.668 for Switzerland and 3.015 for Greece). We also remark that in the Greek firms the use of Internet and Intranet on average are at similar level (from Table 8.3 we can see that the averages of the corresponding variables are 2.948 and 3.015 respectively), while in the Swiss firms a more 'outward-looking' use of ICT can be observed: the use of Internet is higher than the use of intranet (the averages of the corresponding variables being 3.380 and 2.668 respectively).

Concerning human capital, in table 8.4 we can see that the mean percentage of employees with vocational education at the tertiary level is 26.2% in the Greek firms and 20.8% in the Swiss firms; the share of employees receiving job-related training is 26.8% in the Swiss firms and 23.3% in the Greek firms. So the comparison between the two countries results again in a 'mixed' conclusion: from the two forms of human capital we examined, Swiss firms offer to their employees more job-related training than the Greek firms, while the later employ more tertiary level personnel than the former.

From the new organizational practices associated with new forms of 'work design' the above tables show that the most frequently adopted of them is team-work (with 25.9% of the Greek firms and 24.3% of the Swiss firms having extensive diffusion of 'team-work' at the levels of 4 (strongly widespread) or 5 (very strongly widespread)). Much lower is the adoption of 'decrease of management levels' (by 9.0% of the Swiss firms and 3.7% of the Greek firms) and of the 'job rotation' (by 7.7% of the Greek firms and 3.6% of the Swiss firms). A comparison between the two countries again gives a 'mixed' conclusion: the percentage of the firms that decreased management levels is much larger in the Swiss firms than in the Greek firms, while the adoption of job rotation is higher in the later than in the former; concerning the level of adoption of team-work by taking into account the results of both tables we conclude it is higher in the Swiss firms than in the Greek firms (from Table 8.3 we can see that the mean of this variable is 2.218 for Switzerland and 1.915 for Greece).

However, for the 'employee voice'-related new organizational practices the comparison between the two countries gives a clear conclusion that Swiss firms adopt them to a much higher extent than the Greek ones. In a considerable percentage of the firms there has been a shift of the overall distribution of competences towards employees since 2000 (in 33.6% of the Swiss firms and 24.0% of the Greek firms). The highest decentralization has been made in the competences of contacting customers (with 25.1% of the Swiss firms and 18.1% of the Greek firms reporting one of the two higher values (4 or 5) of the ordinate variable measuring how widespread this type of decentralization is inside a firm on a five-point Likert scale), followed by decentralization in deciding the way of performing various tasks (15.2% and 4.8% respectively), the sequence of tasks (13.8% and 2.2% respectively) and the work pace (12.3% and 9.9% respectively).

Finally it is worth commenting that concerning knowledge capital, as we can see in Table 8.3, the investment per employee in research and development in the Swiss firms is much

higher than in the Greek firms. A last discussion point is related to the time lag between the introduction of new technology and/or new organizational practices and the effects on productivity in the two countries. We have some information on the (approximate) adoption time of internet and intranet as well as team-work and job rotation for the Swiss case: 89.4% of all firms having Internet and 75.4% of all firms having Intranet in the year 2005 have introduced the new technology before 2003.[3] The respective figures for firms having introduced team-work and job rotation before 2000 are 65.5% and 58.3% respectively.[4] Thus, the time lags both for technology and organization seem to be large enough to allow some effect on productivity. However, we cannot be sure that a thorough exploitation of possible technology and organization effects has taken place in the observed period.

8.4.2 Model specification and variable construction

Throughout this study we use the logarithm of annual value added (sales revenue minus value of intermediate inputs) per employee as dependent variable. As independent variables we used measures of "ICT capital", "organizational capital", "human capital" "physical capital" and "knowledge capital". In particular, as measures for technology input, particularly ICT input ("ICT capital") we used the intensity of use of two important ICT, internet (linking to the outside world) and intranet (linking within the firm), quantified by the share of employees using Internet and intranet respectively in their daily work. The firms were asked to report this share not by a precise figure but within a range of twenty percentage points in a six-level scale: 0%, 1% to 20%, 21% to 40%, 41% to 60%, 61% to 80% and 81% to 100%. Based on these data we constructed two ordinal variables, i.e. one for internet and one for intranet, taking the values 0 to 5, thus covering the whole range from 0% to 100% (see Table 8.4). The idea behind this variable is that a measure of the diffusion of a certain technology within a firm would be a more precise proxy for 'ICT capital' than the mere incidence of this technology or some kind of simple hardware measure (e.g. number of installed personal computers). We expect in general a positive correlation of these technology variables with labour productivity.

The measurement of organizational inputs, here restricted to inputs related to workplace organization, is an issue still open to discussion, since there is not yet a definite agreement among applied economists to the exact definition of "organizational capital" (see Black and Lynch, 2002 and Lev, 2003 for a discussion on this matter; see also Appelbaum et al, 2000, chapter 7 for definitions of high-performance work system variables). In order to choose the variables related to changes as well as introduction and use of new organizational practices at the workplace level we draw on the definition offered by Black and Lynch (2002), who distinguish three components of organizational capital: "work design", "employee voice" and "workforce training". The first component, "work design", includes practices that involve changing the occupational structure of the workplace, the number of levels of management within the firm, the existence and diffusion of job rotation, the job share arrangements and the level of cross-functional co-operation. The second component "employee voice" is associated with practices that give employees, especially non-managerial ones, greater autonomy and discretion in the structure of

[3] In addition, we know from an earlier study that 78.0% of the firms in the sample have introduced Internet before 2000 (see Arvanitis et al., 2002). Unfortunately, we do not dispose of such data for the Greek case.

[4] 46.3% of all Greek firms having team-work have already adopted this organizational form before 1999; 67.2% before 2001. With respect to job rotation: 52.4% have adopted it already before 1999; 71.0% before 2001.

their work, such as individual job enrichment schemes, decentralization of decision competencies that give to employees more decision competences, etc. Based on the above definitions in this study we regard "organizational capital" as consisting of the first two of these components, "work design" and "employee voice", while we view the third component "workforce training" as part of the human capital of the firm, as explained in the following paragraph. In this direction we constructed the following three- or five-level ordinate variables covering most of the above-discussed aspects of organisational capital (Table 8.4):

i) for measuring "work design" practices: intensity of use of team-work (project groups, quality circles, semi-autonomous teams), intensity of use of job rotation, increase/stability/decrease of the number of management levels;
ii) for measuring "employee voice": overall shift of decision competencies from managers to employees inside a firm and distribution of decision competencies between manages and employees inside a firm with respect to: (a) work pace, (b) sequence of the tasks to be performed, (c) the assignment of tasks, (d) the way of performing tasks, (e) solving emerging production problem, (f) contacts to customers and (g) solving emerging problems with customers. We expect an overall positive correlation of organizational variables with average labour productivity, but we do not have sign expectations for every single variable.

For measuring human capital we use two variables: the share of employees with vocational education at the tertiary level (universities, business and technical colleges, etc.) and the share of employees receiving job-related training (internal and/or external training courses initialized or supported by the firm) (table 8.4). According to standard analysis (see e.g. Barro and Lee 1994) we expect a positive correlation of these variables with labour productivity. Furthermore, we control for physical capital (measured through the logarithm of annual gross investment expenditure per employee in the Swiss part of the study, and the logarithm of assets value per employee in the Greek part of it), knowledge capital (measured through the logarithm of annual R&D expenditure per employee), firm size and sector affiliation. Firm size controls could also serve as an approximation for firm age controls (young firms are mostly small), thus taking into consideration the possibility that firm age could play a role in the relationship between decentralization and technology as postulated in Acemoglu et al. (2006). Finally, controls for sector affiliation could be seen also as controls for the heterogeneity of a firm's environment, a further factor influencing technology-decentralization relationship according to Acemoglu et al. (2006).

8.4.3 'Compact' model

As mentioned in the previous section two variables for the use of internet and intranet serve as proxies for "ICT capital", eleven organizational variables are used to approximate "organizational capital" and two variables are proxies for "human capital". In order to be able to assess the relative significance of each of these three variable blocks for labour productivity, it is necessary to construct comparable overall measures of these three 'types of capital'. To this end, we constructed four composite indices: one based on the two technology variables (variable ICT), one based on the two human capital variables (HUMAN), one for the three organizational variables measuring "work design" (ORG1)

and one for the eight organizational variables measuring "employee voice" (ORG2). These composite indices were calculated as the sum of the standardized values (average 0; standard deviation 1) of the underlying variables (see table 8.4). Then based on them, we estimated "compact" models having the logarithm of annual value added per employee as dependent variable, and the above composite indices ICT, HUMAN, ORG1 and ORG2 as independent variables, besides the variables for the physical capital, the R&D intensity and the control variables.

A second reason for specifying this "compact" model was to enable an investigation of the issue of the complementarity between technology, human capital and the two forms of organizational capital; the composite indices are considered as metric variables and interaction terms of these variables can be inserted in the model for investigating the corresponding complementarities (see coming section).

8.4.4 Greek results

In table 8.5 we can see the estimates of the "compact" model based on the Greek data. We remark that the composite indices for information technology (ICT), human capital (HUMAN) and the organizational variables representing "employee voice" (ORG2), as well as the variable of the 'traditional' physical capital have significant positive coefficients; on the contrary the composite indicator comprising the three variables representing new forms of "work design" (ORG1) and the variable of the knowledge capital (logarithm of R&D expenditure per employee) do not have statistically significant coefficients.

The relative importance of these production factors with respect to labour productivity, as measured by the magnitude of the corresponding standardized regression coefficients (table 8.5), leads to the following ranking of them: traditional capital in the first position, followed by ICT, then human capital and at the end the 'employee-voice' oriented new organizational practices.

Next we constructed two more models by adding in the above "compact" model interaction terms between the composite variables for technology, organizational and human capital, which are considered as metric variables, in order to examine whether there is complementarity between them. In particular, we added the ICT*ORG1 and ICT*ORG2 terms (table 8.5). In the second model we added the term ICT*HUMAN. We found that only the interaction term of the technology variable with the new forms of "work design" variable (ICT*ORG1) has a weakly negative coefficient (with 8% significance). These results (taking also into account the corresponding results of the Swiss part of this study presented next) show that the Greek firms have not yet learnt how to combine effectively these three important factors: ICT, human capital and new organizational practices, e.g. how to use ICT for supporting and improving new organizational practices, how to use the highly educated personnel and also the training for supporting and improving new organizational practices, or for exploiting better the capabilities offered by their ICT systems, etc.

Explanatory variables	ICT*ORG1& ICT*ORG2		ICT*HUMAN	
	Original coefficient	Standardized coefficient	Original co-efficient	Standardized coefficient
logASSETN	0.112***	0.171	0.118***	0.181
	(0.040)		(0.040)	
logRDL	0.003	0.007	0.004	0.011
	(0.024)		(0.024)	
HUMAN	0.095*	0.145	0.091*	0.141
	(0.049)		(0.049)	
ICT	0.101**	0.166	0.101**	0.165
	(0.044)		(0.045)	
ORG1	0.013	0.022	0.009	0.016
	(0.036)		(0.036)	
ORG2	0.032**	0.137	0.030*	0.130
	(0.016)		(0.016)	
ICT*ORG1	-0.034*	-0.105	//	
	(0.019)			
ICT*ORG2	0.007	0.047	//	
	(0.009)			
ICT*HUMAN	//		-0.005	-0.015
			(0.022)	
Middle-sized firms	0.008	0.003	0.016	0.007
	(0.159)		(0.160)	
Large firms	-0.087	-0.036	-0.085	-0.035
	(0.173)		(0.176)	
Services firms	0.058	0.026	0.099	0.045
	(0.139)		(0.138)	
Constant	9.668***		9.599***	
	(0.446)		(0.452)	
N	251		251	
DF	11		10	
SER	1.011		1.017	
F	4.564***		4.581***	
R^2adj	0.135		0.125	

Table 8.5: Compact model: average labour productivity (log (value added per employee) 2004[(1)] (OLS estimates); Greece

(1): calculated in full-time equivalents; reference group for sector dummies: manufacturing; reference group for firm size dummies: firms with less than 20 employees; standard errors in brackets; ***, **, * denote statistical significance at the 1%, 5% and 10% level respectively; heteroscedasticity-robust standard errors (White procedure).

8.4.5 Swiss results

The estimates of the "compact" model for the Swiss data are presented in Appendix D. We can see that the composite indices for technology (ICT), human capital (HUMAN) and the organizational variables, representing "employee voice" (ORG2) have significant

positive coefficients, while the same happens with the variables representing the 'traditional' capital and knowledge capital. Their relative importance in respect to labor productivity, is measured by the magnitude of the standardized regression coefficients of these variables, leads to the following ranking: human capital is at the first position, follwed by technology, then 'employee voice', followed by the 'traditional' capital and knowledge capital.

We have also inserted in the "compact" model the two interaction terms of the composite variables for technology, organization and human capital which are considered as metric variables: ICT*ORG1, ICT*ORG2, and ICT*HUMAN (table 8.6). We found that, in constrast with the Greek results, the coefficients of the interaction term of the technology variable with the human capital variable are positive and statistically significant. These results imply the existence of a complementarity of ICT and human capital, which means that in Switzerland the combined use of ICT and human capital in a firm wuld enhance its performance, additionally to the effects of those factors taken alone.

Explanatory variables	**ICT*ORG1& ICT*ORG2**		**ICT*HUMAN**	
	Original co-effi-cient	Standardized coeffi-cient	Original co-effi-cient	Standardized coeffi-cient
logCL	0.033***	0.124	0.034***	0.128
	(0.009)		(0.009)	
logRDL	0.014***	0.100	0.013***	0.097
	(0.004)		(0.004)	
HUMAN	0.037***	0.119	0.040***	0.131
	(0.010)		(0.009)	
ICT	0.054***	0.191	0.027*	0.096
	(0.009)		(0.016)	
ORG1	-0.001	-0.004	-0.002	-0.007
	(0.006)		(0.006)	
ORG2	0.005**	0.047	0.006**	0.052
	(0.002)		(0.003)	
ICT*ORG1	-0.001	-0.008	//	
	(0.003)			
ICT*ORG2	-0.002	-0.029	//	
	(0.002)			
ICT*HUMAN	//		0.008*	0.099
			(0.004)	
Middle-sized firms	0.013	0.027	0.016	0.031
	(0.013)		(0.013)	
Large firms	0.028**	0.068	0.029**	0.071
	(0.012)		(0.012)	
High-tech manufacturing	0.042	0.037	0.047	0.041
	(0.043)		(0.042)	
Low-tech manufacturing	0.081**	0.073	0.084**	0.075
	(0.039)		(0.039)	

Modern services	0.198***	0.135	0.188***	0.128
	(0.058)		(0.059)	
Traditional services	0.026	0.022	0.030	0.025
	(0.041)		(0.041)	
Constant	11.32***		11.29***	
	(0.079)		(0.079)	
N	1710		1710	
DF	14		13	
SER	0.450		0.450	
F	28.3***		30.6***	
R^2adj	0.186		0.187	

Table 8.6: Compact model with interaction terms: average labour productivity (log (value added per employee) 2004 (1) (OLS estimates); Switzerland

(1): calculated in full-time equivalents; reference group for sector dummies: construction; reference group for firm size dummies: firms with less than 20 employees; standard errors in brackets; ***, **, * denote statistical significance at the 1%, 5% and 10% level respectively; heteroscedasticity-robust standard errors (White procedure).

8.5 Summary and conclusions

This chapter has presented a comparative empirical study of the effect of ICT capital, human capital, new organizational practices and their combined use, also controlling for the physical and the knowledge capital, on labour productivity in Greece and Switzerland, based on firm-level data from both countries. Its analytical framework is that of a firm-level production function. Both the Greek and the Swiss part of this study are based on the same questionnaire and samples of similar composition (concerning firm sizes and sectors), and also use the same variables and models specification, being therefore comparable. Our results are based on firm samples structurally similar as to firm size and industry, so that differences related to the quite different industry structures of the two countries (e.g., Switzerland having a high share of banks and pharmaceutical industries, Greece having a high share of textiles and clothing industry) are cancelled out. In the following sections we summarize the empirical results and discuss similarities and differences between the two countries.

8.5.1 Similarities

For both samples we found statistically significant positive effects for physical capital, ICT, human capital (HUMAN) and "employee voice" oriented organizational practices (ORG2); no effect (Greek case) or even a negative effect (Swiss case) has been found for "work design" oriented organizational changes (ORG1). Also for both countries the intranet effect was stronger than the Internet effect, meaning that the use of ICT for the improvement of intra-firm information, communication and coordination processes has a higher payoff, measured in labour productivity gains, than the use of ICT for the improvement of the corresponding inter-firm processes.

8.5.2 Differences

There are also considerable differences between the firms in the two countries. First, the relative importance of these effects, as measured by the standardized coefficients of the compact model, is not the same in both samples. For the Greek firms we found the following ranking: physical capital > ICT > human capital > "employee voice" practices (ORG2). For the Swiss firms the respective ranking is: human capital > ICT > "employee voice" practices (ORG2) > physical capital ≈ R&D. We remark that in the Swiss firms the impact of human capital, ICT capital and organizational capital, associated with "employee voice" practices, is higher than the impact of the "traditional" physical capital, while, on the contrary, in Greek firms these three "new" production factors have a lower impact on labour productivity than the physical capital. For Greek firms physical capital ("tangibles") is (still) very important, more important than ICT, which has both a tangible component (hardware) and an intangible component (software); also the "intangibles" (human capital, R&D) are less important for achieving a better economic performance in Greek firms, while the R&D variable shows no effect on productivity. Even though more persons with tertiary level education are employed in Greek firms than in Swiss firms, human capital is evidently more efficiently utilized in Swiss firms. On the whole, "intangibles" have a high impact on economic performance of Swiss firms (strong effects of human capital, ICT capital and organizational capital associated with "employee voice" practices; clearly positive effect of R&D), but a much lower impact on the economic performance of the Greek firms. Therefore, it can be concluded that Swiss firms are more efficient and mature in creating and using these "new" production factors than the Greek ones.

Second, the "employee voice" effect on labour productivity, which is, as already mentioned, significantly positive for firms in both countries, is based on different types of employee competences. In Greek firms this effect is related to the decentralization of competences referring to the working conditions (work pace, work way, work sequence), while in Switzerland to the decentralization of competences having to do with the work content (contact to customers, solving of problems related to customers). These differences can be interpreted as reflecting different management philosophies and different levels of employee autonomy. Co-operation between management and employees with respect to working conditions is required mostly for strongly routine activities and production processes, which is rather a characteristic of Greek firms. Employee competences on work content is relevant for less routine activities requiring more individual initiative from employees, as is often the case in Swiss firms.

Third, there are differences between firms of the two countries with respect to the complementarity effects between ICT capital, human capital and organizational capital. We could not find any interaction effects for the Greek firms, while there was evidence for two interaction effects (between human capital and ICT, and also between human capital and "employee voice" oriented organizational practices) for the Swiss firms. Therefore, in Greek firms the use of ICT does lead to positive productivity effects, but the potential of this technology is not fully utilized because human capital is not efficiently combined with it; similarly, the decentralization of some competences has positive productivity effects as well, but its potential is also not fully exploited due to inefficient combination of it with human capital. On the contrary, Swiss firms seem to be able to take a maximum out of the potential of technology and decentralization through the combination of them

with appropriate human skills, which enable a higher exploitation of ICT and a more successful decentralization of competences.

The results of this study could provide interesting policy implications at the government level, given that a country needs to have and the government of a country wants to exercise some kind of industrial policy, which is rather the case for Greece than for Switzerland. Government organizations should not provide to the firms only subsidies, loans, tax reductions and other incentives for making new investments in ICT, human capital skills, new organizational practices and R&D; it is necessary at the same time to provide to the firms (and especially to the SMEs) knowledge (e.g., guides, best practices both from the same country and from other more advanced countries, etc.) concerning the efficient creation, use and exploitation of these "new" production factors, as well as the appropriate combination of them. Consulting companies, ICT companies and educational organizations (e.g. universities) should also follow the same direction as well.

CHAPTER 9

Investigation and Evaluation of ICT Productivity and Determinants at System-Level

9.1 Introduction

The focus of the research described in the previous chapters had been placed on ICT value at the firm level, trying to investigate the effect various factors affecting its impact on various business performance measures. However, this impact is generated through the development of a number of individual IS (see Figure 9.1) which satisfy the needs of their users, produce value to them, and fulfill their intended objectives. Those users may be internal (employees) or external (customers, suppliers, other partners, etc) to the organization and their satisfaction implies the success of the individual IS.

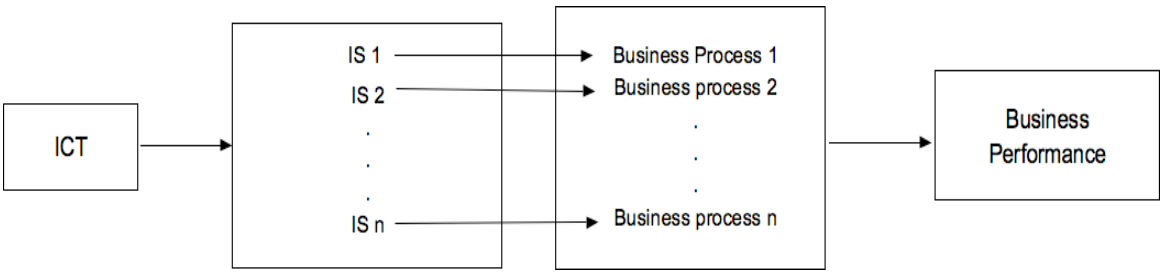


Figure 9.1: The impact of individual IS on performance

Considering the ICT business value generation process model, proposed by Melville et al (2004, see figure 2.3, chapter 2), it encounters that the success of an IS providing support to a business process increases its performance and creates value to the organization, contributing thus positively to organizational performance (figure 9.2).

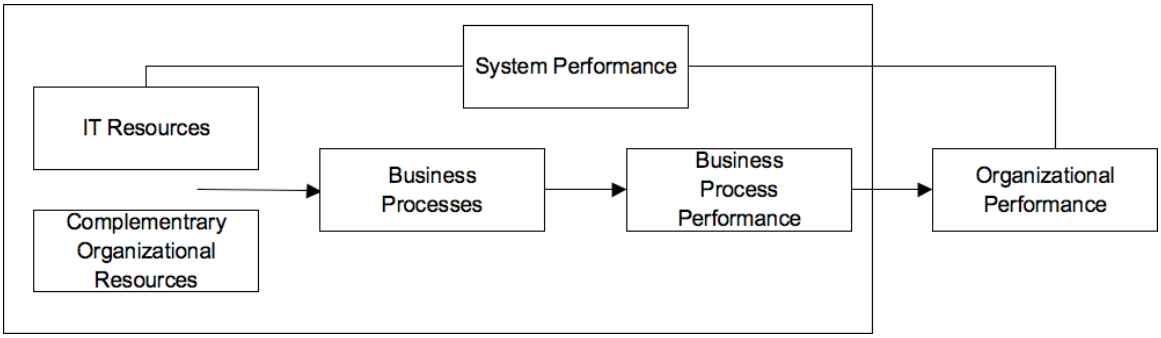


Figure 9.2: The contribution of ICT system value to organizational performance

For this reason we extend the firm-level research described in the previous chapters for the level of an individual IS, developing and testing empirically a novel approach for investigating and evaluating the productivity of particular IS and its main determinants by estimating 'Value Flow Models'. By conducting system-level IS evaluation managers will be able to assess whether the IS that supports the processes of their organization fulfills the objectives it is meant to, and produces value to its users. In this way they will be able to know the contribution of the firm's ICT investments to business performance anddecide the necessary interventions (improvements) in order to enhance this performance.
As mentioned in the introduction, Information Systems (IS) evaluation, defined as a process that takes place at different points in time during the IS lifecycle in order to identify and make explicit, quantitatively or qualitatively, the impacts (both the positive and the negative ones) of an IS (Farbey et al, 1999), has been one of the most extensively re-

searched and at the same time most complicated subjects in the area of IS for more than two decades (e.g. Hirschheim and Smithson 1988, Farbey et al 1995, Smithson and Hirscheim 1998, Farbey et al 1999, Irani 2002, Gunasekaran et al 2006). The relevant literature emphasizes that IS evaluation is highly complex, because the benefits and in general the value created by most categories of IS are multidimensional, both tangible and intangible, financial and non-financial, making it difficult to decide "what to measure" for the evaluation and "how". Moreover, different categories of IS have different objectives and produce different types of benefits and value, so they require different kinds of evaluation methods. Farbey et al (1995) classify IS into eight IS categories according to Farbey et al (1995) classify IS into eight IS categories according to the method required for evaluating them (mandatory IS, automation IS, direct value added IS, management information and decision support systems (MIS - DSS), infrastructure IS, inter-organizational IS, strategic IS and business transformation IS) and proposes different evaluation approaches and methodologies for each of them. The development therefore of a generic "best IS evaluation method" suitable for all situations is not possible, thus it is necessary to develop specialized IS evaluation methods and frameworks, which are suitable for specific types of IS. Smithson and Hirschheim (1998) classify the existing IS evaluation methods into three basic categories and discuss their basic characteristics. The first category are the efficiency-oriented methods, which evaluate the performance or quality of an IS with respect to some predefined technical and functional specifications, being focused on whether the IS is functioning properly, and aiming to answer the question "is it doing things right?". The second category consists of effectiveness-oriented methods, which have been influenced mainly by management science approaches; they evaluate how much an IS supports the execution of business-level tasks or the achievement of business-level objectives, being focused on its impact on achieving business-level objectives, and aiming to answer the question "is it doing the right things?". The third category consists of understanding-oriented approaches, which aims at a deeper understanding of the mechanisms of value generation by IS and their association with the organizational context.

In chapter 9, we deal with a highly important category of IS, that has recently attracted much interest both from the research & development and the practical implementation viewpoint. This category includes Information Systems supporting learning in various ways, usually referred as e-learning systems. In order to maximize the benefits from the huge investments made in e-learning, it is necessary to develop and use appropriate methods for its systematic evaluation. The purpose of this evaluation is to assess the educational value generated by e-learning, and its main determinants, to identify good and bad practices, to detect problems and finally to improve the effectiveness of e-learning. However, due to the above radical differences between the e-learning and the "traditional" education, the evaluation of e-learning cannot be performed using the methods that have been developed for the evaluation of the traditional education (Hoyt and Cashin 1977, Marsch 1982, Cashin and Downey 1992): e-learning has brought up big innovations in the way courses are taught, the role of the teacher, the interaction between teachers and learners and the interaction between the learner and the content, so it requires different and appropriate evaluation methods. A lot of research has been conducted in this area; however there is an "absence of a widely established and practiced methodology by which to rigorously evaluate e-learning, and through which to develop the secure body of knowledge on which to build learning technology as a discipline" (Dempster, 2004). Therefore further research is required in this area in order to develop practically applica-

ble e-learning evaluation methods that generate rich and useful information concerning the different types of value that e-learning creates, the mechanisms of their creation and also possible interventions for increasing them.

Based on the above, Chapter 9 deals with the evaluation of IS in system-level. In particular, it includes an empirical investigation of an e-learning system, by proposing a method of multi-layer e-learning evaluation, consisting of value measures structured in the following three layers: a) "efficiency evaluation" measures (evaluating the basic resources and capabilities offered by an e-learning system, such as the educational content, the technical quality of the system, the usability of the system, the capabilities it offers for customizing the learning process to e-learners particular needs and preferences, the instructor support and the degree of electronic community development), b) "effectiveness evaluation" measures (evaluating the extent of usage of the e-learning system and its educational effectiveness), c) "intended future behavior" measures (evaluating the intention to use the e-learning system in the future and to recommend it to colleagues). Furthermore this method provides estimations of the relations between the value measures of the above three layers. Those multiple layers of value measures as well as the relations among them constitute a "value flow model", which includes: i) the value created by the basic resources and capabilities offered by an e-learning system (at the first layer), ii) how this (first level) value results in higher level value (concerning the accomplishment of various higher-level objectives), and finally iii) how the above levels of value result in value related to future intended behavior (i.e. intention to use in the future or recommend it to colleagues). This approach constitutes an extension to the "classical" technology acceptance models approach with additional measures of IS value and is theoretically founded on the process theories of IS value creation (e.g. Soh and Markus 1995) and on the multi-dimensional and multi-layer approaches of IS success literature (e.g. DeLone and McLean 1992, 2003, Seddon 1997).

In section 9.2 a review of the relevant literature is presented. In section 9.3 follows a description of the value model estimation approach proposed for the evaluation of an e-learning service, which has been developed in the e-RMIONE project of the eTEN Programme of the European Union (www.ermione-edu.org). In section 9.4 the results of a first application of this approach are presented. Section 5 presents the SEM empirical investigation of the value flow model using the same data. Finally the last two sections, 5 and 6, analyze the results, the conslusions, the limitations of the approach as well as further research directions.

9.2 Literature review

Extensive research has been conducted concerning the evaluation of the traditional education and especially concerning students" evaluation of "traditional" teaching effectiveness (SETE) (Marsch, 1982, Marsh 1987, Hoyt & Cashin, 1977, Cashin and Downey, 1992). Wang (2003) mentions the following six SETE instruments as the most important ones: the Instructional Development and Effectiveness Assessment (IDEA), the Students' Evaluations of Educational Quality (SEEQ), the Endeavor Instrument, the Student Instructional Rating System (SIRS), the Instructor and Course Evaluation System (ICES) and the Student Description of Teaching (SDT) Questionnaire. The first two of them are the most widely used ones. The IDEA instrument (Hoyt & Cashin 1977, Cashin &

Downey 1992) consists of 38 evaluation criteria, which are grouped in the following four evaluation dimensions: instructor methods, students' ratings on course objectives, course content and students' self-ratings. The SEEQ instrument (Marsh 1982, Marsh 1987) is longer and has the following nine evaluation dimensions: learning/value, enthusiasm, organization, group interaction, individual rapport, breadth of coverage, exams/grades, assignments and workload. As we have already mentioned in the Introduction, those SETE instruments cannot be used for the evaluation of e-learning, since e-learning is characterized by significant differences from the traditional teaching.

Considerable amount of research has also been conducted in the e-learning evaluation area, which has resulted in the development of some high-level e-learning evaluation frameworks. The most well-known and widely used framework for measuring the effectiveness of training programs, which has been used both for traditional training and e-learning, has been developed by D. Kirkpatrick in the late 1950s, and has been adapted and modified subsequently, through its basic structure has not changed significantly (Kirkpatrick, 1983). It consists of the following four levels of evaluation: Learners Reaction, Learning, Workplace Behavior and Organizational Results. Jackson"s framework (1998) is based on the evaluation of e-learning objectives (intentions), implementation and outcomes, and suggests that it is necessary to take into account also the context (previous knowledge, attitudes and conceptions of the e-learners); furthermore, it provides a systematic way for evaluation of outcomes based on the "Structure of the Observed Learning Outcome" (SOLO) taxonomy developed by Biggs & Collins (1982). A more detailed framework is the "Evaluating Learning Technology" (ELT) (Oliver and Conole 1998), which provides systematic guidance for the six e-learning evaluation stages it proposes: identification of stakeholders, formulation of questions to each group of stakeholders, selection of a research approach (quantitative or qualitative), selection of data capture techniques, selection of data analysis techniques and choice of presentation format. Garrison & Anderson (2003) propose that e-learning evaluation should include seven stages: determination of strategic intent of the e-learning program, examination of the courses' content, examination of the design of the interfaces, identification of amount of interactivity supported, evaluation of student assessment methods, measurement of the degree of student support and evaluation of outcomes. However, the existing e-learning evaluation frameworks are at a higher-level and much more abstract than the SETE instruments, since they propose only evaluation stages and directions, so they need further development, improvement, elaboration and also empirical investigation in "real life" settings.

The research work that has been performed in the area of e-learning quality is also interesting from the e-learning evaluation viewpoint. Lorenzo and Moore (2002) proposed the following basic determinants of on-line education quality, which they call the "Five Pillars of Quality Online Education": Learning Effectiveness, Student Satisfaction, Faculty Satisfaction, Cost Effectiveness and Access. Ehlers (2004, 2005) argues that quality in e-learning should be viewed as a co-production by the learner and the learning environment, identifying seven basic fields of e-learning quality from the e-learners' viewpoint: tutor support, cooperation and communication in the e-course, technology, costs-expectations-value relation, information transparency concerning the e-course and its provider, e-course structure and didactics. Additionally, Euler (2006) follows a similar holistic approach to e-learning quality by suggesting six quality dimensions known as "CEL Quality Dimensions": program strategy, pedagogy, economics, organization, tech-

nology and culture. Wang (2003), developed a global instrument for measuring the total e-learner satisfaction with asynchronous e-learning systems (a global satisfaction index), consisting of 17 relevant variables, in order to support mainly summative evaluation of e-learning. He concluded that e-learner satisfaction is determined by four major constructs: content, learner interface, learning community, and personalization. Quite useful information could also provide the ISO/IEC 19796-1 reference framework for the description of quality approaches in learning, education and training.

Another research stream in the area of e-learning evaluation is based on the Technology Acceptance Model (TAM) and its extensions (Davis 1989, Venkatesh et al 2003), and deal with the identification of the factors affecting either the extent of use of an e-learning system by the learners, or their intention to use it in the future or recommend it to colleagues (as measures of user acceptance), which are regarded as the basic surrogate measures of the value that e-learning generates. In this direction Selim (2003) used the TAM in order to investigate empirically the acceptance of course web-sites by students and identify its main determinants. For this purpose he developed the "Course Website Acceptance Model" (CWAM) consisting of the three constructs of the TAM (perceived usefulness, perceived ease of use, and use), which were elaborated for the case of a course web-site; using structural equation modelling (SEM) he validated his model and revealed the most important factors of the course web-site acceptance. Saade and Bahli (2005) conducted an empirical study aiming at explaining the acceptance (measure as intention to use in the future) of Internet-based learning systems, based on an extension of the TAM, which included the concept of cognitive absorption as antecedent of perceived usefulness and perceived ease of use; the results of this study, which used data collected from students, provided support for this model as explaining the acceptance of the Internet-based learning system and for cognitive absorption as an important variable affecting the above TAM variables. Another extension of the TAM has been developed by Ngai et al (2005), including Technical Support as an additional construct, for the empirical examination of the adoption of Web Course Tools (WebCT), measured through current system use and intention to use in the future. This e-learning acceptance research based on the TAM and its extensions provides useful elements that should be taken into account for the development of e-learning evaluation methods, however its main dependent variables, such as "use" or "intention to use", do not necessarily reflect the magnitude of the value created by e-learning, since there are occasions where the use of a particular e-learning system is simply better than the other existing options, or even mandatory (i.e. there are no other options), so we can have e-learning systems with equal use but offering very different levels of value.

The conclusions of the research regarding e-learning critical success factors (CSFs) should be taken into account as well for the development of e-learning evaluation methods. Volery and Lord (2000) identified three main e-learning CSFs: technology (ease of access and navigation, interface design, level of interaction), instructor (attitudes towards students, technical competence, and classroom interaction) and previous use of technology by the students. Soong et al (2001) concluded that the main CSFs of e-learning are: human factors concerning the instructors (motivational skills, time and effort investment), technical competency of instructors and students, constructivist mindset of instructors and students, high level of collaboration, user-friendly and sufficiently supported technical infrastructure. In a more recent study Selim (2005) investigated what do university students perceive as CFSs for e-learning acceptance, identifying eight major CSF categories:

attitude towards and control of technology, teaching style, computer competency, interactive collaboration, e-learning course content/design, ease of access, infrastructure and support.

Summarizing, from this literature review it is concluded that for the evaluation of e-learning only a number of abstract-level frameworks have been developed, which are quite general and include only evaluation stages and directions. Therefore further research is required for the development of practically applicable and useful e-learning evaluation methods, which generate rich and useful information concerning the different types of value that e-learning creates, the mechanisms of their creation and also possible interventions for increasing them, and also for investigating and validating such methods in "real-life" conditions and situations. For this purpose it is necessary to combine elements from previous research on the evaluation of the traditional education, on the evaluation of e-learning (e.g. from the existing e-learning evaluation frameworks), on the e-learning acceptance on the e-learning CSFs, etc., and also take into account the multi-dimensional and multi-layer approaches of IS success literature (e.g. DeLone and McLean 1992, 2003, Seddon 1997).

9.3 A value flow model estimation approach

Taking into account the above conclusions of the literature review we developed a method for e-learning multi-layer evaluation and value flow model estimation, in order to use it for the evaluation of an e-learning service in the area of European cultural heritage, created for the e-RMIONE (E-Learning Resource Management Service for InterOperability Networks in the European Cultural Heritage Domain) project of the eTEN Programme of the European Union (www.ermione-edu.org). The proposed method incorporates elements from: i) the IS evaluation and success research, ii) the traditional education evaluation research, iii) the TAM-based e-learning research and iv) the e-learning CSFs research. Its basic evaluation measures and the hypothesized relations among them are shown in *figure 9.3.*

The measures are structured in three layers. The first layer includes evaluation measures of the e-learning resources and capabilities offered to the user: educational content, electronic support by the instructor, development of a community feeling, technical quality and reliability, capability to customize the learning process to ones" learning style and needs, and ease of use; the evaluations of these e-learning resources and capabilities by the users constitute a measure of the first level efficiency-oriented value created by the e-learning service. The second layer includes deeper-level evaluation measures of e-learning effectiveness: extent of usage of the e-learning system and degree of educational effectiveness (i.e. how effective the e-learning system was for learning new concepts, facts, methods, technologies, theories, etc.); the evaluations of system use and educational effectiveness constitute a measure of the higher effectiveness-oriented value created by this e-learning service. The third layer includes evaluation measures of user's intended future behaviour concerning this e-learning service: the degree of intention to use it in the future and to recommend it to other colleagues, which constitute a measure of future behaviour – oriented value. Additionally another context-oriented layer has been added with measures of personal characteristics of each learner, such as his/her degree of interest in the course subject and his/her degree of experience with computers, in order to examine

to what extent they affect e-learning effectiveness, and compare their impact with the impact of the e-learning resources and capabilities (of the first layer).

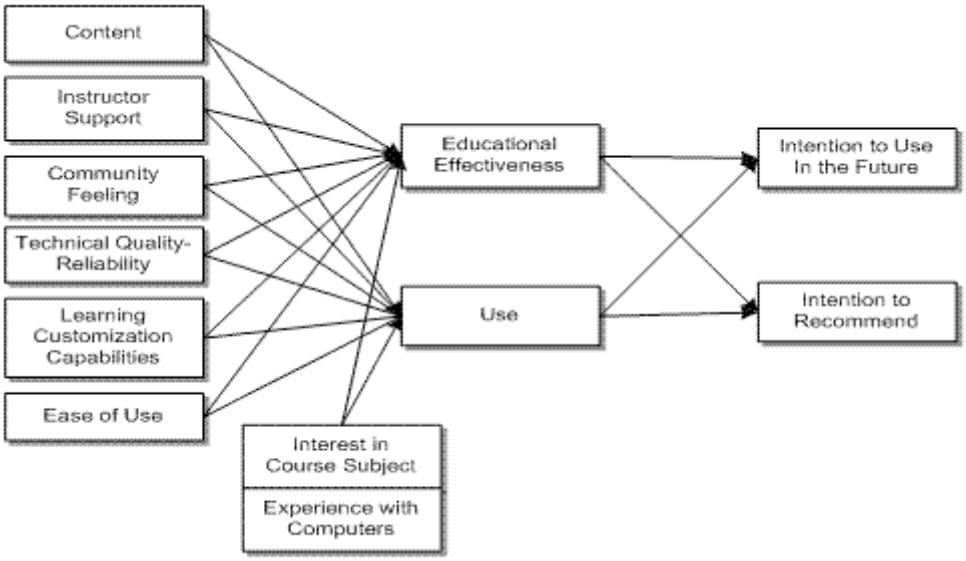


Figure 9.3: Structure of the e-learning multi-layer evaluation and value flow model estimation method.

The users of the particular e-learning service we have examined, were asked to evaluate all the above aspects of these four layers through a structured questionnaire, which includes 20 questions in total and can be seen in Appendix C.A. At this point we should mention that we decided to conduct an initial empirical investigation of the value flow model by using only one measure for each variable (measure). In a more sophisticated analysis however (in section 9.5) we have developed a SEM model consisting of constructs, which include more than one measures.

Starting from the initial analysis, rom the ratings given by the users the average rating for each measure was calculated. Then for each layer (over all the measures of it) and finally the global average rating (over all three layers). In this way we produced estimates of the value created by the e-learning service at each layer (i.e. of the efficiency-oriented value, the effectiveness-oriented value and the future behavior-oriented value) and also in total, while we also identified the measures and layers that constitute strengths and weaknesses of the service.

As a second step the relations between each measure and all the measures of the previous layer have been calculated, so that we can determine which of the measures of the previous layer have higher impact on it. For a basic estimate of these relations we have calculated the correlations among these measures, while for a more accurate estimation of them we can use structural equation modeling (SEM) techniques (Diamantopoulos 1994, Gefen et al 2000). In this way a "value flow model" has been constructed, which enables the location and understanding of the value generation sources (first layer), the higher level value creation process (second layer) based on these value generation sources, and, finally, the way in which first and second stage value is transformed into future behavior-oriented value (third layer). The basic contribution of this approach is that it enables not

only the identification of the strengths and weaknesses of an e-learning service, but also the identification of their origins in previous layers and their consequences for the next layers. Moreover, it offers the capability to define priorities for improvements of the resources and capabilities (of the first layer), based on their average ratings by the users and also on their impact on the creation of higher layers' value (e.g. value concerning educational effectiveness or intended future behavior).

The above e-learning evaluation method is theoretically founded on the process theory of Soh and Markus (1995). According to this theory the process of value creation from IS starts from "IT Expenditures", which through a conversion sub-process result in "IT-Assets"; then these IT-Assets through a usage process produce "IT-Impacts", which finally affect the organizational performance. For the case of e-learning an appropriate mix of "IT-Assets" should be provided to the learner, so this basic concept has to be analyzed into the six e-learning resources-capabilities of the first layer of *figure 9.3*. Also, according to the technology acceptance models (Davis 1989, Venkatesh et al 2003) the usefulness and the ease of use that users perceive are the main determinants of their intended future behavior (e.g. their intention to use it in the future, to recommend it to other colleagues, etc.)

9.4 Data, method and results

For an initial validation of the above e-learning multi-layer evaluation and value flow model estimation method we collected ratings of all these measures from 65 students from the University of Leuven (Belgium) and the University of the Aegean (Greece), who have participated in an e-learning course through the e-learning system e-RMIONE. Those students used the e-RMIONE service for a period of two months attending the e-course during the spring semester of 2006. For this purpose a questionnaire was distributed to them in paper form and was completed in "physical" meetings, organized immediately after the end of the corresponding e-courses. It included 20 questions in total. In this case the value flow model has been tested by using one question for its measure of it (12 in total) in order to get a first impression regarding its applicability. The measures (questions) used for this initial testing are shown in table 9.1. and are scaled from 1-4 or from 1-6 (these 4 or 6 point scales have been preferred, since they do not include an "intermediate" point of "neutral" or "medium" type - as it happens in the usual 5 or 7-point scales - so that we avoid "neutral" ratings by the students). In Appendix C the reader can see which of the 20 questions have been also used for the initial analysis. A first version of this questionnaire had been previous pre-tested by all the partners of the e-RMIONE project and also by three final year students of the Department of Information and Communication Systems Engineering of the University of the Aegean, and their remarks were taken into account for producing the final version of the questionnaire. Due to the fact that the questionnaires were completed during face-to-face sessions after the end of the e-course, the response rate was very high at the level of (96%) receiving a total of 65 valid responses.

Based on the ratings given by the students we calculated the average rating for each measure, then for each layer and finally the global average over all three layers (table 9.1).

MEASURE	SCALE	AVERAGE RATING
Content	1 to 6	4.36
Electronic support by instructor	1 to 6	4.53
Development of a community feeling	0 to 1	0.58
Technical quality and reliability	1 to 6	4.36
Capability to customize the learning process to ones" learning style and needs	1 to 6	3.92
Ease of use	1 to 6	3.58
Efficiency measures average		4.04
Usage of the e-learning system	1 to 6	4.05
Degree of educational effectiveness	1 to 6	4.47
Effectiveness measures average		4.26
Intention to use it in the future	1 to 6	3.52
Intention to recommend it to colleagues	1 to 6	3.70
Future behaviour measures average		3.61
Total average		3.97
Interest in the course subject	1 to 4	2.93
Degree of experience with computers	1 to 4	3.95

Table 9.1: Average ratings for all value measures

We can see that the average rating over the six efficiency-oriented value measures of the first layer is 4.04, therefore the users perceive a moderately high value of the service concerning its efficiency (i.e. the e-learning resources and capabilities it offers). By comparing the average ratings of the measures of this first layer we remark that the highest average ratings have been given for the electronic support by instructor (4.53), the content (4.36) and the technical quality and reliability (4.36), which constitute the strengths of the service, while the lowest average ratings have been given for the ease of use (3.58), the development of a community feeling (1+0.58*5=3.90) and the capability to customize the learning process to ones' learning style and needs (3.92), which constitute the weaknesses of the service. Concerning the second layer we can see that the average rating over the two effectiveness–oriented value measures is 4.26, therefore the users perceive a moderately high to high value of the service concerning its effectiveness; by comparing the average ratings of the two measures of this layer we remark that the highest average rating has been given for the degree of educational effectiveness (4.47), which constitutes another strength of the service. Finally the average rating over the two future behavior-oriented value measures of the third layer is 3.61; the rating given for the intention to recommend the service to colleagues (3.70) is higher than the one for the intention to use it in the future (3.52), however both constitute weaknesses of the service. As far as the measures of personal characteristics of the users is concerned, the average degree of their experience with computers is very high (3.95 in the 1 to 4 scale), while moderately high to high is their interest in the subject of the course they attended (2.93 in the 1 to 4 scale).

In order to estimate the impact of the first layer on the other two layers, we calculated the correlation coefficients initially between each of the six value measures of the first layer (efficiency-oriented measures) and each of the two value measures of the second layer (effectiveness-oriented measures), which are shown in the second and the third column of

Table 9.2; in this Table are shown the statistically significant correlation coefficients at the 5% level (i.e. with significance lower than 5%), and also with an asterisk (*) the ones that are statistically significant at the 10% level but not at the 5% level, while with "NS" are denoted correlation coefficients that are not statistically significant. Also in the same columns of this Table (in the last two rows) we can see the correlation coefficients between each of the two measures of personal characteristics of the users and each of the two value measures of the second layer. We remark that the development of a community feeling (COMM) and the capability to customize the learning process to ones' learning style and needs (CUST) are characterized by the higher correlation coefficients with the two effectiveness measures, followed by the content (CONT) and the electronic support by instructor (INSUP); all these four efficiency measures have a medium level (around 0,5) of statistically significant correlation coefficients with both effectiveness measures of the second layer. Also the degree of experience with computers (COMPEXP) has statistically significant correlation coefficients of lower level with both effectiveness measures.

	USE	**ACEO**	**INTUSE**	**FUTREC**
EDCONT	0.465	0.412	0.600	0.637
INSUP	0.440	0.473	0.365	0.372
COMDEV	0.551	0.486	0.270	0.289
ERREL	NS	0.197*	NS	NS
PROCUS	0.482	0.521	0.362	0.483
PEOU	NS	NS	0.469	0.476
INTSUB	NS	NS	0.374	NS
COMPEXP	0.348	0.323	NS	NS

Table 9.2: Correlation coefficients between efficiency-oriented value measures-personal characteristics measures and effectiveness-oriented value measures-future behavior value measures (EDCONT=educational content, INSUP=support from the instructor, COMDEV=development of a community feeling, ERREL=reliability of the system regarding errors, PROCUS=learning process customization capabilities, PEOU=perceived ease of use, INTSUB=interest in the course subject, COMPEXP=computer experience, USE=degree of system usage, INTUSE=intention to use in the future, FUTRECOM=intention to recommend the system to other colleagues).

For each of the effectiveness measures (USE and EDEFF) we constructed a regression model, which had this effectiveness measure as dependent variable and the six efficiency measures and the two personal characteristics measures as independent variables. The R^2 values of these models were 0.51 for the model of the system usage (USE) and 0.49 for the model of the degree of educational effectiveness (EDEFF). Therefore we conclude that the six efficiency-oriented value measures of the first layer and the two personal characteristics can explain about 50% of the variation of the effectiveness-oriented value measures.

Next we calculated the correlation coefficients between each of the two effectiveness-oriented value measures of the second layer and each of the two future behavior-oriented value measures of the third layer, as basic estimates of the impact of the former on the latter. We remark that both effectiveness measures and future behavior measures have statistically significant correlation coefficients of medium level (0.507 and 0.534 for USE with FUTUSE and FUTREC respectively, as well as 0.407 and 0.5 for EDEFF with FUTUSE and FUTREC). As a conclusion, system usage has higher levels of correlation with

both future behavior measures than the degree of educational effectiveness.

Furthermore, for each of the two future behavior measures (FUTUSE and FUTREC) we constructed a regression model, which had this future behavior measure as dependent variable and the two effectiveness measures as independent variables. The R^2 values of both these models were very low: 0.29 for the model of the intention to use the service in the future and 0.35 for the model of the intention to recommend it to colleagues. So we proceeded with adding to each of these two modes the six efficiency measures of the first layer as additional independent variables. The R^2 values of both these two new models (each of them having eight independent variables in total) were much higher than the first two models: 0.59 for the model of the intention to use the service in the future and 0.64 for the model of the intention to recommend it to colleagues; by adding to the independent variables the two personal characteristics (therefore estimating models with ten independent variables in total) the R^2 values of both these two new models increase by another 5%. Therefore we conclude that the two effectiveness-oriented value measures of the second layer can explain about 30% of the variation of the future behavior-oriented value measures; however, together the six effectiveness-oriented value measures of the first layer and the two effectiveness-oriented value measures of the second layer can explain a much higher percentage of about 60% of the variation of the future behavior-oriented value measures, while by adding the two personal characteristics the percentage of their variation we can explain rises to about 65%. For this reason we also calculated the correlation coefficients between each of the six efficiency-oriented value measures of the first layer and each of the two future behavior-oriented value measures of the third layer; also we calculated the correlation coefficients between each of the personal characteristics and each of the future behavior-oriented value measures; they are all shown in the fourth and the fifth column of Table 9.2. We remark that educational content has the highest correlation coefficients with the two future behavior measures (of medium to high level: 0.600 and 0.637 respectively), followed by ease of use (0.469 and 0.476 respectively) and the capability to customize the learning process to ones' learning style and needs (0.362 and 0.483 respectively).

According to the above results, the educational content, instructor's support and technical quality of this e-learning service seem to be its strengths. On the other hand, we have identified two critical resources and capabilities that have to be improved, since they are both characterized by low average ratings by the users (Table 1) and by high impact on the creation of second and third layers' value (Table 2): 1) Community feeling (i.e. we should further develop tools and functions enabling communication and interaction between the e-learners (forums, chats, e-mail, etc)), and 2) Customization capabilities, (i.e. we should further develop the capabilities offered to the users for personalizing (customizing) the e-learning platform according to their particular needs, preferences and learning style).

9.5 A SEM approach for value flow model estimation

The hypothesized value flow model has been also tested through the SEM approach. From this model the context measures (interest in the course subject and experience in using computers) were excluded since their role has been clearly identified in the previous section. The same set of data has been used and the same survey method has been applied. It should be mentioned that the choice of the number of questions/items included for each e-learning value measure was based mainly on how clear and directly understandable it was, taking also into account existing questionnaire length limitations. Therefore, for the more complex and ambiguous value measures several questions/items have been included (as items reflecting the corresponding construct). However, the questionnaire had to be kept at a reasonable size, so that the above students can quickly and easily read and fill it. Thus, for the clear and directly understandable value measures only one question/item has been included in the questionnaire; The single-item value measures are Content, Instructor's Support, Customization Capabilities, System Use and Accomplishment of Course Educational Objectives; on the contrary several items were included for the value measures concerning Learning Community, Technical Quality, Perceived Ease of Use and Intention to Use. In Appendix C are shown the nine value measures as well as their related items and questions (20 in total).

The hypothesized value flow model in depicted in *figure 9.4*. The basic difference from the model of *figure 9.3* is the inclusion of constructs (measured through more than one items) and the deletion of the context variables (interest in the course subject and experience in using computers), since their role has already been identified in section 9.4. For estimating the parameters of the value flow model (including 9 constructs and 20 items), we used Structural Equation Modeling (SEM), and in particular the Partial Least Squares (PLS) approach (Chapter 3).

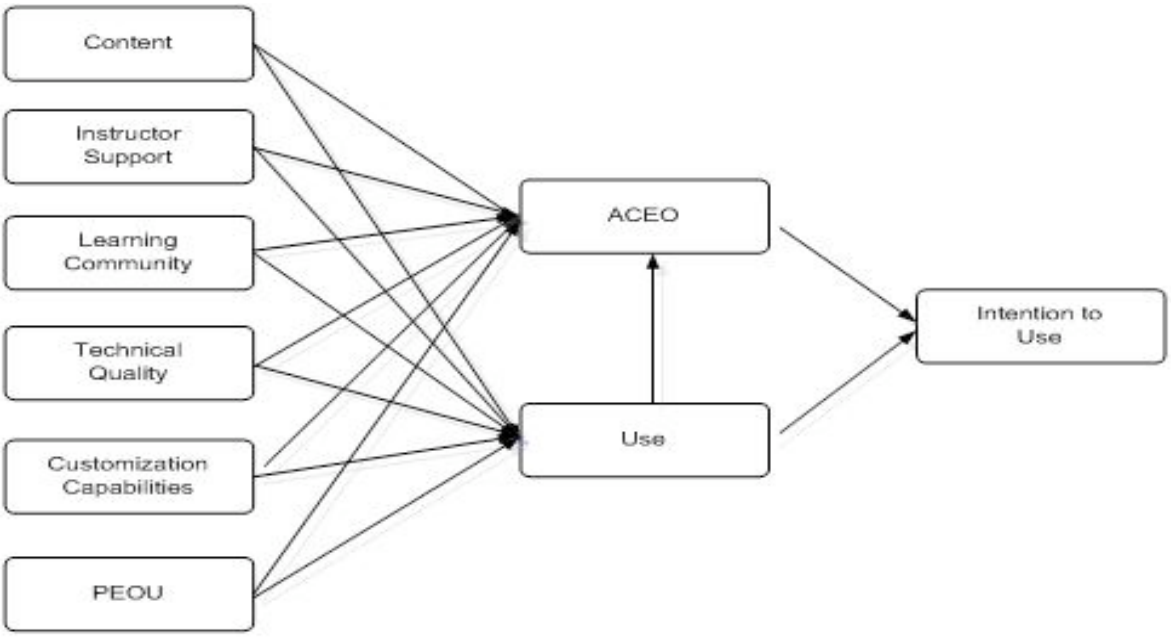


Figure 9.4: The hypothesized SEM value flow model

9.6 Results

As a first step, for each of the 20 items - value measures of the above model the average rating given for it by the e-learners has been calculated, and is shown in Table 9.4 together with the corresponding scale. We note that for the 12 items that have been used for the initial analysis, the average ratings have already been calculated and are shown in table 9.1. However, in order to have a clear and complete picture, they are also included in table 9.4, together with the rest of the items used in the SEM approach.

Even though these items are all ordinal variables their averages are meaningful as comparative indicators of the value perceived the e-learners in each of these 20 value dimensions. We remark that from the e-learning resources and capabilities offered to the e-learners (first layer of the model) the main weaknesses (having the lowest average ratings) according to the e-learners concern the graphical user interface (GUISat), the customization capabilities (ProCus) and the development of e-learning community (ComDev). On the contrary the e-learners perceive a moderately high level of "Accomplishment of Course Educational Objectives" (KnowIm), which has been achieved through a moderately high level of usage of the e-learning system; also, they have a medium intention to attend another e-course on a similar subject provided by the same e-learning platform or recommend it to colleagues.

As a second step the value flow model shown in *figure 9.4* has been estimated through the PLS approach using the PLS-Graph software (Chin 2001); it has 9 constructs (LVs) and 20 items (MVs) (reflective indicators of the constructs), which are shown in table 9.2. Initially the measurement model and the factorial validity were assessed according to the guidelines proposed by the relevant literature (e.g. Gefen et al 2000, Gefen and Starub 2005). The examination of the standardized items loadings showed that some of them were below the recommended cutoff level of 0.6 (Chin, 1998); those items with loadings below this cutoff level (ComDev, RespTime, SysError, ErRel, GUISat, GuideUse and GuideSat) were removed and the new model was estimated having now 13 items. All the item loadings of the 'outer model' were this time far above 0.6, as shown in table 9.5. Additionally convergent validity was tested by examining the t-values of these item loadings; all of them were above the recommended 1.96 value.

Value Measure	Item	Average	Scale
Perceived Ease of Use (PEOU)	OperSeq	4.49	1 - 6
	LearnDif	2.92	1 – 4
	GUISat	3.05	1 - 6
	GuideUse	0.38	0 - 1
	GuideSat	4.30	1 - 6
Technical Quality	Resptime	4.05	1 - 6
	Syserrors	0.57	0 - 1
	ErRel	4.12	1 - 6
	CrashExp	0.26	0 - 1
	CrashRes	3.09	1 - 4

Instructor Support	InSup	4.48	1 - 6
Customization Capabilities	ProCus	3.84	1 - 6
Learning Community	ComDev	0.56	0 - 1
	ComBel	2.75	1 - 4
	ComImro	4.31	1 - 6
Educational Content	EdCont	4.30	1 - 6
Accomplishment of Educational Objectives (ACEO)	KnowIm	4.44	1 - 6
Use	SysUse	4.03	1 - 6
Intention to Use	FutAtt	3.52	1 - 6
	Recom	3.70	1 - 6

Table 9.4: Averages and standard deviations of the items-value measures

Construct	Item	Loading
Perceived Ease of Use (PEOU)	OperSeq	0.787
	LearnDif	0.972
Technical Quality	CrashExp	-0.817
	CrashRes	0.999
Instructor Support	InSup	1.000
Customization Capabilities	ProCus	1.000
Learning Community	ComBel	0.976
	ComImro	0.975
Educational Content	EdCont	1.000
Accomplishment of Educational Objectives (ACEO)	KnowIm	1.000
Use	SysUse	1.000
Intention to Use	FutAtt	0.999
	Recom	0.999

Table 9.5: PLS outer model loadings

Then, in order to examine the reliability of the above constructs for each of them was calculated the Composite Reliability (CR), which constitutes a better internal consistency index than Cronbach's Alpha as mentioned in the relevant literature (e.g. Chin and Gopal, 1995). These CR values are shown in the last column of Table 9.6; we can see that all of them are above the recommended minimum acceptable level of 0.7 (Fornell & Larcker, 1981), so it is concluded that each construct of the model and their reflective indicators

are reliable. Finally, the discriminant validity was examined by comparing the square root of the Average Variance Extracted (AVE) of each construct with its correlations with the other constructs according to the relevant literature (e.g. Gefen and Straub, 2005). In Table 9.6 we can see that the square root of the AVE of each construct was larger than any correlation between this construct and any other construct, which proves the discriminant validity of the constructs of the model. Note that for the single-item constructs the AVE receives its highest possible value (1.00).

	PEOU	LC	TQ	IU	U	ACEO	EC	IS	CC	SQAVE	CR
PEOU	1.000									0.885	0.712
LC	-0.174	1.000								0.976	0.976
TQ	-0.173	-0.193	1.000							0.913	0.862
IU	-0.203	0.175	0.149	1.000						0.999	1.000
U	-0.207	0.162	0.135	0.997	1.000					1	1.000
ACEO	-0.212	0.177	0.141	0.997	0.998	1.000				1	1.000
EC	-0.215	0.186	0.139	0.998	0.998	0.998	1.000			1	1.000
IS	-0.290	0.142	0.164	0.814	0.813	0.807	0.808	1.000		1	1.000
CC	-0.211	0.172	0.133	0.997	0.998	0.998	0.998	0.814	1.000	1	1.000

Table 9.6:Correlations, squared root of AVE and composite reliabilities

EC: Educational content, IS: Instructor support, LC: Learning community, CC: Customization capabilities, TQ: Technical quality, PEOU: Perceived ease of use, U: Use, ACEO: Accomplishment of course educational objectives, IU: Intention to use

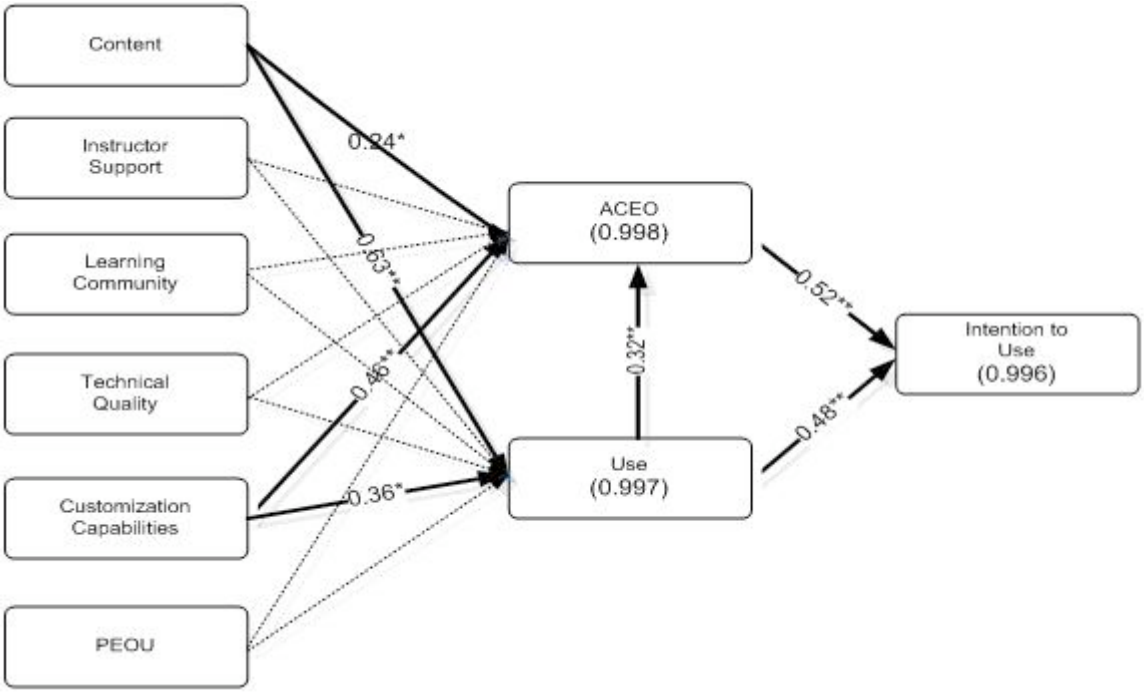
Next, in order to test the estimated structural model we employed the bootstrap resampling procedure (Chin 2001, Tenenhaus et al 2005), which enables testing the statistical significance of the PLS path coefficients. In *figure 9.5* are shown the standardized coefficients of the statistically significant paths, as well as the explained variance of the endogenous LVs (constructs) of the second and third layer of the value flow model. We remark that between the constructs of the first and the second layer of the value flow model the only statistically significant paths were those from the Educational Content to ACEO (0.24) and to Use (0.63), and also from Customization Capabilities to ACEO (0.46) and to Use (0.36). Between the constructs of the second and the third level of the value flow model all the paths are statistically significant: from Use to ACEO (0.32) and to Intention to Use (0.48), and from ACEO to Intention to Use (0.52). Furthermore we remark that the R^2 values of the second layer constructs are very high at the level of 0.998 and 0.997 for ACEO and Use respectively, which means that most of the variance in ACEO and Use is explained by the value flow model. Similarly the R^2 of the third layer construct Intention to Use is very high at the level of 0.996, which means that most of the variance in users' intentions to use is explained by this model.

From the above results it is concluded that from the e-learning resources and capabilities offered to the e-learners (first layer) only two have a statistically significant effect on the value creation of the second layer (i.e. value associated with the extent of usage of the e-learning system and its educational effectiveness – accomplishment of educational objectives):

- the completeness and structure of the educational content uploaded onto the plat-

form has a strong effect both on the Use (direct effect 0.63) and on the ACEO (direct effect 0.24 and total effect 0.24 + 0.63 x 0.32 = 0.44)

- the capability offered to e-learners to customize the e-learning environment according to their needs and preferences has a medium effect on the Use (direct effect 0.36) and a strong effect on the ACEO (direct effect 0.46 and total effect 0.46 + 0.36 x 0.32 = 0.58)
- both the second layer constructs (USE and ACEO) have a statistically significant effect on the creation of third layer value associated with intention for future usage: USE has a strong effect on Intention to Use (direct effect 0.48 and indirect effect 0.48 + 0.32 x 0.52 = 0.65)
- ACEO has a strong effect on Intention to Use (direct effect 0.52)



* Significant at the 0.05 level
** Significant at the 0.01 level

Figure 9.5: Structural model - significant paths and explained variance of the latent variables (LV).

Finally based on the above results we can prioritize the necessary improvements in the e-learning resources and capabilities based on the two criteria mentioned in section 3: the average rating by the e-learners and the effect on the creation of higher levels value. Taking into account the results of table 9.4 (looking at the average ratings by the e-learners for all item – value measures of the first layer) and figure 9.2 (effects of the constructs of the first layer on the ones of the second layer) it is concluded that the designers of this cultural heritage e-learning course should focus:

- on reconsidering and improving the functionalities of the e-learning systems associated with the customization/personalization capabilities offered to users, and also
- on the quality and structure of the educational content.

9.7 Conclusions, limitations and further research directions

Chapter 9 has presented a multidimensional value flow model – based approach for the evaluation of e-learning IS, which is theoretically founded on conclusions and elements from various research areas, such as IS evaluation, traditional learning evaluation, e-learning evaluation, e-learning quality, e-learning critical success factors, technology acceptance models (TAM) and IS success and quality. The proposed evaluation approach can capture the various levels, dimensions and mechanisms of value creation in e-learning. The e-learning resources and capabilities are regarded as the basis of value creation, resulting in the use of the system and the accomplishment of the course's educational objectives, and then to a positive future behavior concerning usage and recommendation to colleagues. The importance of these factors in general depends on the nature and the characteristics of each particular e-course. The value flow concept can be applied-after necessary modifications-for the evaluation of any kind of IS providing useful implications for decision making in organizations regarding improvements. In this way it provides implications for the success degree of an IS, which can be then utilized in the firm-level evaluation since a successful IS is positively related to business performance.

The proposed value flow model – based approach for the evaluation of e-learning enables the prioritization of the necessary improvements in the e-learning resources and capabilities based on those two criteria: the average rating by the e-learners and the effect on the creation of higher levels value. This means that the focus should be placed on the limited resources of the organizations (e.g. human resources, financial resources, etc.), on the improvement of the e-learning resources and capabilities that have lower levels of evaluation by the e-learners and at the same time strong effect on higher level value measures.

For the investigated cultural heritage e-learning course developed as part of the ERMI-ONE Project, it has been found that from the e-learning resources and capabilities offered to the e-learners the main weaknesses concern the graphical user interface, the customization capabilities and the development of learning community. From its estimated value flow model it has been concluded that the quality of the course educational content and the customization capabilities are the main resources and capabilities that have strong statistically significant effect on usage and accomplishment of educational objectives, while the latter have strong statistically significant effect on the future usage intention. On the contrary instructor support, technical quality, learning community and perceived ease of use of the e-learning platform were not found to play a crucial role in the value flow model, which is in contrast with previous research findings (e.g. Soong et. al 2000, Selim 2005); this difference is probably due to particular characteristics of the investigated cultural heritage e-learning course. Therefore, taking into account the above improvements prioritization criteria, the designers of the investigated cultural heritage e-learning course should reconsider and improve the functionalities of the e-learning systems associated with the customization/personalization capabilities offered to users; also they should place emphasis on the quality and structure of the educational content.

The findings of this research offer a first validation of the "value flow model approach" in IS evaluation, which can be used as a "guide" for an effective and applicable evaluation of not only e-learning IS, but also of any other type of IS by appropriate adaptation and definition of the basic value measures of each layer and their operationalizations based on

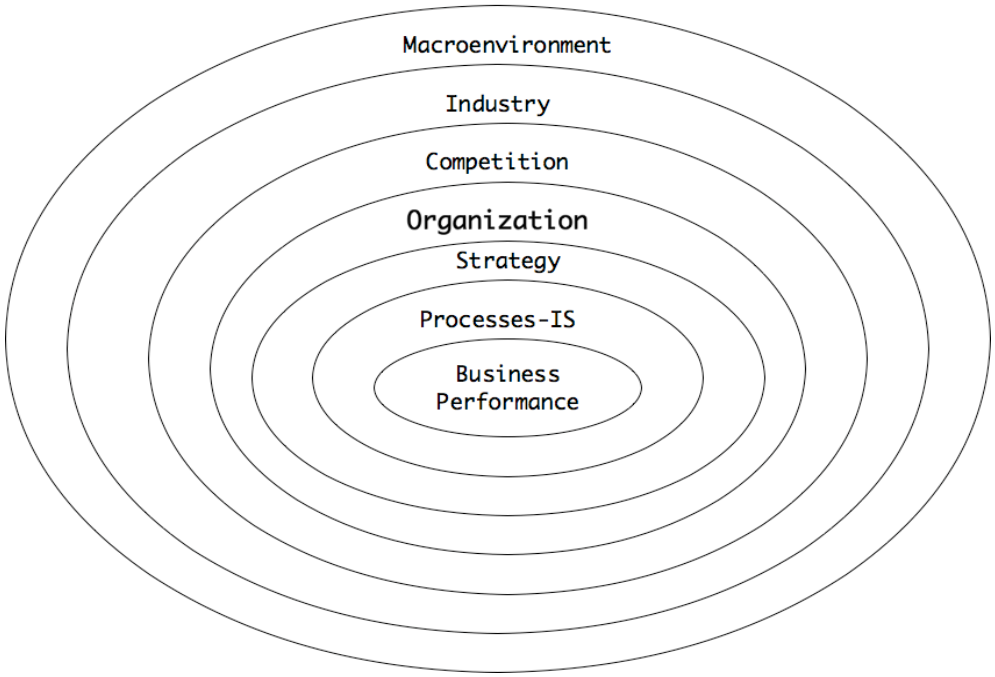
previous research and theory. Its basic advantage is that it enables a multidimensional evaluation and identification of the value creation and transformation-flow mechanisms; by knowing the roots of value creation we can focus our attention on the most important system functionalities/capabilities/resources that play the most crucial role for the users, and rationally set priorities for system improvements.

The most important limitation of the first application/validation of the "value flow model approach" presented in this paper was small sample size. Also, there was a conscious effort from the authors to keep the questionnaire as small as possible, in order to construct a relatively simple value flow model in this first validation of this concept, as well as to achieve a high response rate among the participating students in this e-course. Future research directions include the examination of the value flow model concept and its usefulness for IS evaluation in different types of IS, with bigger samples, more extended questionnaire including several items for each construct, as well as use of covariance-based SEM approaches.

CHAPTER 10

Conclusions

The main focus of the present PhD Thesis has been the investigation of the factors affecting the productive impact of ICT on business perofrmance. In particular, at firm level, the impact of ICT investment has been examined, as well as the role of the main complementary factor, process change, expressed and measured through the extent of implementing BPR and TQM initiatives. Moreover, the effect of business strategy and external business environment on the above variables has been investigated. An international comparison to the main of the above issues between Greek and Swiss firms, has taken place, as well. The research has been also been extended at a system-level, aiming at identifying those factors that influence the success of particular IS, which support the various business processes.



This PhD Thesis contributes to the exising literature by fulfilling the gaps that have been identified and mentioned in the previous section. In particular:

- It empirically investigates the mediating role of business process change, examining and comparing its two basic paradigms, BPR and TQM, in the relationship between ICT investment and business performance.
- It empirically investigates the moderating role of both BPR and TQM, in the business value created by ICT investments. It draws useful conclusions regarding the BPR and TQM activities having the highest ICT moderating effect.

- Extending this research 'upstream', it offers an empirical study concerning the effect of business strategy on both ICT and business process change (distinguishing again between BPR and TQM), and through them (and also 'directly') on business performance
- It also investigates empirically the same questions for the five M. Porter's forces, which constitute fundamental characteristics of the external environment of an organization.
- It conducts (for first time in Greece) a comparative empirical study of the impact of the various forms of capital used by organizations in modern economy ('traditional' capital, computer capital, human capital, organizational capital (new organizational practices)) on labor productivity, in Swiss and Greek firms.
- All the above empirical studies are based on a sound foundation from economic science, the Cobb-Douglas Production Function.
- Finally, it extends the above research for the level of an individual IS, developing and testing empirically an extension for investigating and evaluating of the productivity of particular IS and its main determinants by estimating 'Value Flow Models'.

The main findings and conclusions are:

- ICT investment has a positive effect on the extent of BPR but not on TQM; on the contrary, non-ICT investment has a positive effect on the extent of TQM but not on BPR.
- BPR and TQM initiatives have both a positive impact on business performance.
- BPR is a partial mediator in the relationship between ICT investment and business perofrmance, whereas TQM is not; on the contrary, TQM is a partial mediator in the relationship between non-ICT investment and business performance, wheras BPR is not.
- BPR and TQM have a significant moderating impact of similar magnitude in the relationship between ICT investment and performance. Process simplification, process improvement and horizontal process creation, are the BPR activities with the largest moderating effects; the TQM activities with the largest moderating effects are systematic measurement of employee satisfaction, simplification of work and close cooperation with suppliers.
- Cost leadership, differentiation or focus strategy does not affect ICT or non-ICT investment
- Cost leadership strategy has a small effect on TQM, but no effect on BPR; differentiation stategy has small effects on both BPR and TQM. However, focus strategy has medium effects on both BPR and TQM.
- BPR mediates completely the impact of differentiation strategy on business performance, and partially the impact of focus strategy on business performance; the other business process change paradigm, TQM, mediates completely the impacts of cost leadership strategy and differentiation strategy on business performance, and partially the impact of focus strategy on business performance.
- Concerning the external environment, from the 'five forces' of M.Porter's industry analysis model, the non-price competition has a small positive impact on ICT investment, while suppliers' power have a small negative effect; none of these forces affects non-ICT investment.

- Customer power and threat from substitutes have small to medium effects on both BPR and TQM; also, suppliers' power has a small to medium effect, and threat of new entrants has a small effect only on TQM.

The abovementioned findings concern the national context of Greece, a small developing country, with particular characteristics, such as small market size and small average firm size. The international comparison with the Swiss firms led to the following findings: starting from the similarities, capital (traditional, computer, human), as well as new organizational practices associated by decentralisation of decision making from management to employees, affect labor productivity in a positive way. On the other hand new organizational practices associated with new forms of work design, such as teamwork, job rotation and decrease of hierarchical levels, does not affect labor productivity. However, significant differences have been identified. The knowledge capital is much higher in Switzerland, and has an impact on labour productivity, while in Greece it has not. In the Swiss firms the impact of human capital, ICT capital and organizational capital associated with decentralisation is higher than the impact of ''traditional" physical capital, while in Greek firms these three ''new" production factors have on the contrary a lower impact on labour productivity than the physical capital. Therefore Greek firms are weak, in comparison to the Swiss ones, with respect to the 'knowledge capital', and to the exploitation of the 'new' types of capital (human, ICT and organizational) for improving business performance.

Finally, regarding investigation and evaluation of ICT productivity at system level, the contribution of the present Dissertation is the development of a novel approach based on'value flow modelling', according to which the quality of the resources and capabilities of an IS results in user satisfaction, in high usage rates and, finally, in future usage intention (which can be translated into acceptance and success of the system). The empirical application of this approach and estimation of a value flow model in an e-learning system provided a good validation of the proposed approach, resulting in the identification of the strenghts and weaknesses of the system, as well as particular improvement priorities.

APPENDICES

APPENDIX A: SURVEY INSTRUMENT

1. Yearly total sales revenue (without VAT): _____ Euro
2. Yearly total expenses for buying materials and services (without VAT): _____ Euro
3. Number of employees: _____
4. Value of assets at the end of the year (without VAT): _____Euro
5. Value of ICT equipment (hardware, software and networks) at the end of the year (without VAT) : _____ Euro

Answer the following two groups of questions in a scale 1 – 5, where 1 = Not at all, 2 = To a small extent, 3 = To a moderate extent, 4 = To a large extent, 5 = To a very large extent, by clicking the appropriate box in the right of each question:

6. To what extent have you performed the following business process reengineering (BPR) activities in the last 5 years?

BPR ACTIVITIES	1	2	3	4	5
BPR_1: Creation of new horizontal (inter-departmental) processes (that cross more than one departments)					
BPR_2: Creation of new inter-departmental units/workgroups (e.g. customer or product-focused)					
BPR_3: Creation of new horizontal coordination roles (process coordinators) for monitoring and coordinating the efficient and faster execution of process crossing more than one department.					
BPR_4: Simplification of processes					
BPR_5: Improvement of processes					
BPR_6: Abolition of processes					
BPR_7: Redesign of processes so that they become customer-focused					
BPR_8: Job enrichment - increase of decision making competences authorization for employees involved in some processes					
BPR_9: Decrease of supervision and number of supervisors in some processes					

7. To what extent does your company perform the following quality management activities?

QUALITY MANAGEMENT ACTIVITIES	1	2	3	4	5
TQM_1: Use of statistical quality control methods					
TQM_2: Permanent quality improvement teams					
TQM_3: Systematic measurement-monitoring of customer satisfaction					
TQM_4: Cooperation with suppliers for quality improvement					
TQM_5: Work simplification for quality improvement					
TQM_6: Systematic measurement-monitoring of employees satisfaction					
TQM_7: Continuous quality improvement					

8. To what extend does the strategy of your company emphasizes on the following:

Low prices	1 2 3 4 5
High product/service quality	1 2 3 4 5

Wide variety of specialized products/services	1 2 3 4 5

9. To what extent does the business environment, in which your firm operates, have the following characteristics?

High bargaining supplier power	1 2 3 4 5
High bargaining customer power	1 2 3 4 5
High price competition from firms offering similar products or services	1 2 3 4 5
High non-price competition from firms offering similar products or services	1 2 3 4 5
High threat from new entrants in the market	1 2 3 4 5
High threat from substitute products/services (which will gain market share)	1 2 3 4 5

APPENDIX B: CONCEPTUALIZATION RESOURCES OF THE BPR AND TQM INSTRUMENTS

BPR		**TQM**	
BPR_1	Hammer and Champy, 1993; Gunasekaran and Nath, 1997	TQM_1	Dewhurst et al., 2003; Powell, 1995
BPR_2	Gunasekaran and Nath, 1997; Autor et al., 1998	TQM_2	Lawler et al., 1992
BPR_3	Al Mashari and Zairi, 2000	TQM_3	Anderson et al., 1994; Flyn et al., 1994
BPR_4	Hammer and Champy, 1993	TQM_4	Flynn et al 1994; Powell, 1995
BPR_5	Hammer and Champy, 1993	TQM_5	Lawler et al; 1992
BPR_6	Hammer and Champy, 1993	TQM_6	Anderson et al; 1994
BPR_7	Champy, 2002	TQM_7	Dean and Bowen, 1994, Deloitte, 1994
BPR_8	Brynjolfsson and Mendelson, 1993; Lawler et al., 2001		
BPR_9	Gurbaxani and Whang, 1991; Gunasekaran and Nath, 1997		

APPENDIX C: THE SURVEY INSTRUMENT FOR SYSTEM-LEVEL IS EVALUATION

VALUE MEASURES	ITEMS	QUESTIONS
Content	EdCont*	The educational content of the e-course you participate in was very good.
Instructor's Support	InSup*	The overall electronic support provided by the instructor (e.g. electronic answers to questions, the use of the forum tool among students and the instructor to share common interest, etc.) was very good.
Learning Community	ComDev*	In your opinion, was the development of a community feeling possible thanks to the "Forum functionality" and the exchange of information between students and instructors?
	ComBel	If you answered positively to the previous question, to which extent did you feel you belonged to a remote community of on-line learners sharing the common goal of learning a specific topic?
	ComImpro	If you answered positively to the same question, was the community feeling helpful to improve the learning process of eRMIONE functionalities?
Technical Quality	RespTime	To which degree are you satisfied with the eRMIONE response time to the users' input?
	SysErrors	Did you experience system errors while using eRMIONE?
	ErRel*	To which degree are you satisfied with the reliability of the eRMIONE service as far as errors are concerned?
	CrashExp	Did you experience unexpected crashes of the eRMIONE system?
	CrashRes	In case of a crash, was the restart easy?
Customization Capabilities	ProCus*	eRMIONE offers the opportunity to customize the learning process according to your wishes and learning needs.
Perceived Ease of Use (PEOU)	LearnDif*	Was it difficult to learn how to use the basic functionalities of eRMIONE?
	GUISat	Are you satisfied with the user interface (screens, menus, toolbars, buttons, etc.)?
	GuideUse	Did you often use the "Help service"?
	GuideSat	Are you satisfied with the supporting level of the provided system guides to use the software?
	OperSeq	To which degree the sequences of operations to perform the basic tasks of eRMIONE are easy to remember and repeat?

USE	Use*	I have profusely used the eRMIONE e-learning system and services while participating in the e-course.
Educational Effectiveness	ACEO*	The eRMIONE service offered me the opportunity to improve knowledge on a specific topic through the e-course I took part in (e.g. the acknowledgement of new concepts, terms, methods, technologies, etc.).
Intention to Use	FutAtt*	I would attend another e-course on a similar subject provided by eRMIONE.
	Recom*	I would recommend eRMIONE to other students.

Note: With an (*) are denoted the items (questions) that have been also used in the initial analysis.

APPENDIX D: COMPACT MODEL: AVERAGE LABOR PRODUCTIVITY-SWITZERLAND

Explanatory variables	(1)		(2)		(3)		(4)	
	Original coeffi-cient	Standardized coeffi-cient	Original coeffi-cient	Standardized coeffi-cient	Original coeffi-cient	Standardized coeffi-cient	Original coeffi-cient	Standardized coeffi-cient
logCL	0.032***	0.119	0.033***	0.123	0.033***	0.125	0.033***	0.123
	(0.009)		(0.009)		(0.009)		(0.009)	
logRDL	0.014***	0.103	0.014***	0.101	0.015***	0.108	0.013***	0.096
	(0.004)		(0.004)		(0.004)		(0.004)	
HUMAN	0.362***	1.179	0.037***	0.122	0.038***	0.123	0.037***	0.120
	(0.083)		(0.008)		(0.008)		(0.008)	
RES1	-0.327***	0.982	//		//		//	
	(0.083)							
ICT	0.050***	0.179	0.215***	0.762	0.050***	0.177	0.049***	0.174
	(0.009)		(0.045)		(0.008)		(0.009)	
RES2	//		-0.167***	-0.504	//		//	
			0.046					
ORG1	-0.003	-0.001	-0.000	-0.000	-0.214***	-0.802	-0.001	-0.002
	(0.006)		(0.006)		(0.081)		(0.006)	
RES3	//		//		0.214***	0.778	//	
					(0.080)			
ORG2	0.004*	0.039	0.004*	0.039	0.005**	0.047	0.070***	0.655
	(0.002)		(0.002)		(0.002)		(0.018)	
RES4	//		//		//		-0.066***	-0.594
							(0.018)	
Middle-sized firms	-0.039**	-0.077	-0.024	-0.049	0.057***	0.115	0.003	0.006
	(0.019)		(0.017)		(0.021)		(0.013)	
Large firms	-0.036*	0.088	0.030	-0.073	0.087***	0.212	-0.003	-0.006
	(0.020)		(0.020)		(0.025)		(0.015)	
High-tech manufacturing	-0.154**	-0.135	-0.139**	-0.122	0.249***	0.218	-0.084	-0.073
	(0.063)		(0.067)		(0.091)		(0.056)	
Low-tech manufacturing	0.150***	0.135	0.032	0.029	0.236***	0.211	0.030	0.027
	(0.046)		(0.040)		(0.073)		(0.041)	
Modern services	-0.166*	-0.112	-0.238*	-0.162	0.378***	0.256	0.034	0.023

	(0.100)		(0.131)		(0.090)		(0.070)	
Traditional services	0.038	0.033	-0.087*	-0.074	0.112**	0.095	-0.122**	-0.102
	(0.042)		(0.051)		(0.054)		(0.058)	
Constant	10.63***		11.52***		11.09***		11.45***	
	(0.187)		(0.099)		(0.111)		(0.089)	
N	1710		1710		1710		1710	
DF	13		13		13		13	
SER	0.447		0.448		0.449		0.448	
F	28.5***		28.8***		29.6***		28.2***	
R^2adj	0.202		0.199		0.195		0.199	

PUBLICATIONS

Journal papers

- **Pazalos, K**., Loukis, E., Georgiou, S. (2009). Evaluating e-courses based on value flow models estimation, *International Journal of Applied Systemic Studies*, xx(xxxx).
- Loukis, E., **Pazalos, K**. (2009). An Empirical Investigation of the Moderating Effects of BPR and TQM on ICT Business Value, *Journal of Enterprise information management*, 22(5).

Conference Papers

- **Konstantinos Pazalos**, Euripidis Loukis, "An extended Methodology for e-Learning Evaluation Based on the Accomplishment of Educational Objectives", EDEN 2006 Conference, Vienna
- Euripidis Loukis, **Konstantinos Pazalos**, Fotini Michailidou, " Electronic Collaboration Networks in the cultural heritage domain: the e-RMIONE project", EGOV 2006 Conference, Krakov.
- **Konstantinos Pazalos**, Vassilis Nikolopoulos, Euripidis Loukis, Athena Thanou, Martin Ulmann, "e-RMIONE-An e-Learning Resource Management Service for Constructing Interoperable Networks in the European Cultural Heritage Domain", EDEN 2006 Conference, Vienna
- Euripidis Loukis, **Konstantinos Pazalos**, " A Methodology for the Evaluation of an e-Learning Service in the Cultural Heritage Domain", ETPE 2006 Conference, Thessaloniki.
- Euripidis Loukis, Stelios Georgiou, **Konstantinos Pazalos,** "A Value Flow Model for the Evaluation of an e-Learning Service, ECIS 2007 Conference, 7-9 June, St. Gallen, Switzerland.
- Alexandra Zgouva, **Konstantinos Pazalos**, "Integrating e-Learning in Enterprise Information Systems: A Strategy for Effective Development and Evaluation", EDEN 2007 Conference, Naples, Italy.
- **Κωνσταντίνος Παζάλος**, Ευριπίδης Λουκής, Στέλιος Γεωργίου, "Ενα μοντέλο ροής αξίας για την αξιολόγηση ηλεκτρονικών υπηρεσιών", 3ο συνέδριο Ελληνικής Εταιρίας Συστημικών Μελετών, Πειραιάς, Μάϊος 2007.
- Loukis, E., Pazalos, K., and Georgiou, S. (2008) "The Moderating Role of BPR and TQM on ICT Business Value", European Mediterranean Conference of Information Systems, May 2008, Dubai, UAE.
- Loukis, E., **Pazalos, K**. (2008). The Intervening Role of BPR in the ICT - Business Performance Relationship. In Proceedings of the 12th Pan-Hellenic Conference of Informatics, Samos, Greece.

References

Acemoglu, D., Aghion, P., Lelarge, C., Van Reenen, J. and Zilibotti F., (2006). Technology, Information and the Decentralization of the Firm. NBER Working Papers No. 12206, Cambridge, Mass.

Addison, J.T., (2005). The Determinants of Firm Performance: Unions, Works Councils, and Employee Involvement/High-Performance Practices. *Scottish Journal of Political Economy,* 52(3), pp. 406-450.

Aghion, P., Caroli, E. and Garcia-Penalosa, C., (1999). Inequality and Economic Growth: The Perspectives of the New Growth Theories. *Journal of Economic Literature*, 37(4), pp. 1615-1660.

Agrawal, V. K., Haleem, A. (2003). Culture, Environmental Pressures, and the Factors for Successful Implementation of Business Process Engineering and Computer-Based Information Systems. *Global Journal of Flexible Systems Management*, 4 (1&2), pp. 27-46

Ahire, S. L., Golhar, D. Y. and Waller, M. A. (1996). Development and Validation of TQM Implementation Constructs. *Decision Sciences*, 27(1), pp. 23-56.

Aiken, L. S. and West, S. G. 1996. Multiple Regression: Testing and Interpreting Interactions. Newbury Park, CA: Sage.

Aiken, M., Hasan, B. and Vanjani, M. (1996). Total Quality Management: A GDSS Approach. *Information Systems Management*, 13(1), pp. 73-75.

Al Mashari, M. and Zairi, M. (2000). Revisiting BPR: A Holistic Review of Practice and Development. *Business Process Management Journal*, 6(1), pp. 10-42.

Al Mashari, M., Irani, Z. and Zairi, M. (2001). Business Process Reengineering: A Survey of International Experience. *Business Process Management Journal*, 7 (5), pp. 437-453.

Al-Mashari, M. and Zairi, M. 2000. Revisiting BPR: A Holistic Review of Practice and Development. *Business Process Management Journal*, 6(1), pp. 10-42.

Al-Mashari, M., Irani, Z. and Zairi, M. 2001. Process Reengineering: A Survey of International Experience. *Business Process Management Journal*, 7(5), pp. 437-453.

Albadvi, A., Keramati, A., Razmi, J. (2007). Assesing the Impact of Information Technology on Firm Performance Considering the Role of Intervening Variables: Organizational Infrastructures and Business Process Reengineering. *International Journal of Production Research*, 12(15), pp. 2697-2734.

Aldrich, H.E., and Auster, E.R. (1986). Even Dwarfs Started Small: Liabilities of Age and Size and Their Strategic Implications. In B.M. Staw and L.L. Cummings (eds.). *Research in Organizational Behavior* Greenwich, CT: JAI Press, pp. 165-198.

Altinkemer, K., Chaturvedi, A., and Kondarredy, S. (1998). Business Process Reengineering and Organizational Performance: An Exploration of Issues. *International Journal of Information Management*, 18 (6), pp. 381-392.

Altinkemer, K., Ozcelik, Y., and Ozdemir, Z. (2007). Productivity and Performance Effects of IT-enabled Reengineering: A Firm-Level Analysis. *In: Proceedings of the European Conference of Information Systems*, St. Gallen, Switzerland.

Anderson, J. C., Rungtusanatham, M., and Schroeder, R. J. (1994). A Theory of Quality Management Underlying the Deeming Management Method. *Academy of Management Review*, 19(3), pp. 472-509.

Appelbaum, E., Bailey, T., Berg, P. and Kalleberg, A.L., (2000). Manufacturing Advantage. Why High-Performance Work Systems Pay Off. Cornell University Press, Ithaca (Ch. 7, Measuring the Components of a High-Performance Work System).

Armstrong, J. S. and Overton, T. (1977). Estimating Non-Response Bias in Mail Surveys. *Journal of Marketing Research*, 14(3), pp. 396-402.

Arvanitis, S. (2005). Computerization, Workplace Organization, Skilled Labor and Firm Productivity: Evidence for the Swiss Business Sector. *Economics of Innovation and New Technology*, 14(4), pp. 225-249.

Arvanitis, S., Marmet, D. and Staib, D., (2002). Einsatz von Informations- und Kommunikationstechnologien in den schweizerischen Unternehmungen – KOF/ETH-Panelumfrage 2000. Bundesamt für Statistik (BFS), Neuchâtel.

Attaran, M. (2003). Information Technology and Business Process Redesign. *Business Process Management Journal*, 9 (4), pp. 440-458

Attaran, M. (2004). Exploring the Relationship Between Information Technology and Business Process Reengineering. *Information and Management*, 41, pp. 585-596.

Attaran, M. 2003. Information Technology and Business Process Redesign. *Business Process Management Journal*, 9(4), pp. 440-458.

Atzeni, G., Carboni, O. (2006). ICT Productivity and Firm Propensity to Innovative Invetment: Evidence from Italian Microdata. *Information Economics and Policy*, 18, pp. 139-156

Badri, M. A., Davis, D., Davis, D. (2000). Operations Strategy, Environmental uncertainty and Performance: A Path Analytic Model of Industries in Developing Countries, *The International Journal of Management Science*, 28, pp. 155-173

Barro, R.J. and Lee, J.-W., (1994). Sources of Economic Growth. Carnegie-Rochester Conference Series on Public Policy, 40, pp. 1-46.

Barro, R.J., (1999). Human Capital and Growth in Cross-Country Regressions. *Swedish Economic Policy Review*, 6, pp. 237-277.

Bauer, T.K., (2003). Flexible Workplace Practices. IZA Discussion Paper No. 700, Bonn.

Bertschek, I. and Kaiser, U. (2004). Productivity Effects of Organizational Change: Microeconomic Evidence. *Management Science*, 50 (3), p. 394.

Bhaumic, S. K., Gangopadhyay, S., Krishnan, S. (2007). Entry, Reforms, Complementarity and Perofrmance: A Tale of two Indian Manufacturing Sectors. *Economic Systems*, 31, p. 375-390

Biazzo, S. (1998). A Critical Examination of the Business Process Re-engineering Phenomenon. *International Journal of Operations Production Management*, 18 (9/10), pp. 1000–1016.

Biggs J. B., Collins K. F. (1982). Evaluating the Quality of Learning: the SOLO Taxonomy. Academic Press, New York.

Black, S. E. and Lynch, L. M. (2004). What's driving the New Economy? The Benefits of Workplace Innovation. *The Economic Journal*, 114, pp. 97-116.

Black, S.E. and L.M. Lynch (2002): Measuring Organizational Capital in the New Economy. CES Working Paper 02-04, Washington D.C.

Black, S.E. and Lynch, L.M., (2000). What's Driving the New Economy: The Benefits of Workplace Innovation, NBER Working Paper No. 7479, Cambridge, Mass.

Bloom B. S. (1956). Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain. New York: David McKay Co Inc. "

Borghans, L. and ter Weel, B., (2006). The Division of Labour, Worker Organization, and Technological Change. *Economic Journal,* 116, pp. F45-F72.

Boudreau, M., Gefen, D., and Straub, D. (2001). Validation in IS research: A State-of-the-Art Assessment. *MIS Quarterly*, 25, pp. 1-16.

Bouwens. J., Abernethy, M. A. (2000). The Consequences of Customization on Management Accounting System Design. *Accounting, Organizations and Society*, 25, pp. 221-241.

Bower, M., Jarvenpaa, S. and Stoddart, D. (1994), CIGNA Corporation, Inc.: Managing and Institutionalizing Business Reengineering, Harvard Business School, Boston, MA.

Bresnahan, T. and Trajtenberg, M. (1995). General Purpose Technologies – 'Engines of Growth'?, *Journal of Econometrics*, 65, pp. 83-108.

Bresnahan, T., Brynjolfsson, E., Hitt, L. M. (2002). Information Technology, Workplace Organization and the Demand for Skilled Labor: Firm-level Evidence. *The Quarterly Journal of Economics*, 117, pp. 339-376.

Bresnahan, T.F. and Greenstein, S., (1997). Technical Progress and Co-invention in Computing and in the Uses of Computers, *Brookings Papers on Economic Activity*, Micro, pp. 1-83.

Browne, M. W. and Cudeck, R. (1993). Alternative Ways of Assessing Model Fit. In Testing Structural Equation Models, eds. K. A. Bollen and S. Long, Newbury Park, CA, Sage Publications, Inc.

Brynjolfsson, E. (1993). The Productivity Paradox of Information Technology: Review and Assessment. *Communications of the ACM*, 36(12), pp. 67-77.

Brynjolfsson, E. and Hitt, L.M., (2000). Beyond Computation: Information Technology, Organizational Transformation and Business Performance. *Journal of Economic Perspectives,* 14(4), pp. 23-48.

Brynjolfsson, E., and Mendelson, H. (1993). Information Systems and the Organization of Modern Enterprise. *Journal of Organizational Computing*, 3, pp. 245-55.

Brynjolfsson, E., Hitt, L. M. (1996). Paradox lost? Firm Level Evidence on the Returns to Information Systems Spending. *Management Science*, 42 (4), pp. 541–558.

Brynjolfsson, E., Hitt, L. M. (1998). Beyond the productivity paradox – Computers are the catalyst for bigger changes. *Communications of the ACM*, 41 (8), pp. 49–55.

Brynjolfsson, E., Hitt, L. M. (1996). Firm Level Evidence on the Returns to Information Systems Spending. *Management Science*, 42(4), pp. 541-558.

Brynjolfsson, E., Hitt, L.M. and Yang, S., (2002). Intangible Assets: Computers and Organizational Capital. Brookings Papers on Economic Activity, 1, pp. 37-199.

Byrne, B. M. (2001). Structural equation modeling With AMOS: Basic Concepts, Applications and Programming. Lawrence Erlbaum Associates, New Jersey.

Canada Statistics, (1999). Information and Communications Technologies and Electronic Commerce, Survey. Canada Statistics, Ottawa.

Capelli, P. and Neumark, D., (2001). Do "High Performance" Work Practices Improve Establishment-Level Outcomes? *Industrial and Labor Relations Review*, 54(4), pp. 737-775.

Caroli, E. and Van Reenen, J. (2001). Skill Biased Organizational Change? Evidence from a Panel of British and French Establishments. *Quarterly Journal of Economics*, 116(4), pp. 1449-1492.

Cashin, W. E. Downey R. G. (1992). Using Global Student Rating Items for Summative Evaluation. *Journal of Educational Psychology*, 84(4), pp. 563-572.

Champy, J. (2002a). Seven Steps to X-engineering. *Executive Excellence*, 19(6).

Champy, J. (2002b). X-Engineering the Corporation: Reinventing your Business in the Digital Age. Warner Books, New York, NY.

Chan, Y., Huff, S., Barclay, D., Copeland, D. (1997). Business Strategic Orientation, information systems strategic orientation, and strategic alignment. *Information Systems Research*, 8, pp. 125-150.

Chapman, R. G. (1992). Assessing Non-Response Bias the Right Way: A Customer Satisfaction Case Study. *Proceedings of American Marketing Association Summer Educators*, pp. 322-329.

Chenhall, R. H., Lnagefield-Smith, K. (1998). The Relationship Between Strategic Priorities, Management Techniques, and Management Accounting: An Empirical Investigation Using a System Approach. *Accounting, Organizations and Society*, 23 (3), pp. 243-264

Chin, W. W. (1998). Issues and Opinion on Structural Equation Modeling. *Management Information Systems Quarterly*, 22(1), pp. 7-16.

Collis, D. J., Montgomery, C. A. (2008). Competing on Resources. *Harvard Business Review*, July-August 2008.

Counsell, J. (1997). Using Technology to Involve the Workforce. *Total Quality Management*, 8(2 and 3), pp. 5126-5129.

Collins, R. (1996). *Total Quality Management, Effective Management.* New Zealand: C.C.H. International.

Crespi, G., Criscuolo, C. and Haskel, J., (2006). Information Technology, Organizational Change and Productivity Growth: Evidence from UK Firms. Queen Mary College, University of London Working Paper No. 558, London.

Davenport, T. (1993). Process Innovation: Re-engineering Work Through Information Technology. Harvard Business School Press, Boston, USA.

Davenport, T. and Nohria, N. (1994). Case Management and the Integration of Labor. *Sloan Management Review*, 31, pp. 11-27.

Davenport, T. and Short, J. (1990). The New Industrial Engineering: Information Technology and Business Process Redesign. *Sloan Management Review*, 31(4), pp. 11-27.

Davern, M. J., Kauffman, R. J. (2000). Discovering Potential and Realizing Value from Information Technology Investment. *Journal of Management Information Systems*, 16 (4), pp. 121-143.

Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), pp. 319-339.

Day, G. (1994). The Capabilities of Market-Driven Firms. *Journal of Marketing*, 58, pp. 37-52

Dean, J., and Bowen, D. (1994). Management Theory and Total Quality: Improving Research and Practice through Theory Development. *Academy of Management Review*, 19 (3), pp. 392-418.

Dedrick, J., Gurbaxani, V., Kraemer, K. (2003). Information Technology and Economic Performance: A Critical Review of Empirical Evidence. *ACM Computing Surveys*, 35(1), pp. 1-28.

DeLone, D. H., McLean, E. R. (1992). Information Systems Success: The Quest for the Dependent Variable. *Information Systems Research*, 3(1), pp. 60-95.

Demirbag, M., Tatoglu, E, Tekinhus, M., Zaim, S. (2006). An Analysis of the Relationship between TQM Implementation and Organizational Performance: Evidence from

Turkish SME's. *Journal of Manufacturing Technology Management*, 17 (6), pp. 829-847.

Dempster J. (2004). Evaluating E-learning, Center for Academic Practice. University of Warwick, accessed from http://www.warwick.ac.uk/go/cap/resources/eguides/

Desarbo, W. S., Benedetto, A. D., Song, M., Sinha, I. (2005). Revisiting the Miles and Snow Strategic Framework: Uncovering Interrelationships between Strategic Types, Capabilities, Enviromental Uncertainty, and Firm Performance. *Strategic Management Journal*, 26, pp. 47-74.

Dess, G. G., & Davis, P. S. 1984. Porter's (1980) Generic Strategies as Determinants of Strategic Group Membership and Organizational Performance. *Academy of Management Journal*, 27, pp. 467–488.

Devaraj, S., and Kohli, R. (2000). Information Technology Payoff in the Health-Care Industry: A longitudinal study. *Journal of Management Information Systems*, 16 (4), pp. 41-65.

Dewan, S. and Min, C. (1997). The Substitution of Information Technology for other Factors of Production: A Firm-Level Analysis. *Management Science*, 43(12), pp. 1660-1675.

Dewhurst, F. W., Martinez-Lorente, A. R. and Sanchez-Rodriguez, C. (2003). An Initial Assessment of the Influence of IT on TQM: A Multiple Case Study. *International Journal of Operations & Production Management*, 23(4), pp. 348-374.

Diamantopoulos, A. (1994). Modeling with LISREL: A Guide for the Uninitiated. *Journal of Marketing Management*, 10, pp. 105-136.

Doll, W. J. and Torkzadeh, G. (1997). Developing a Multidimensional Measure of System-Use in an Organizational Context, Information and Management, 33, pp. 171-185.

Donaldson, L. (2001). The Contingency Theory of Organizations. Sage Publications Inc., USA.

Easton, G. S. and Jarrell, S. L. (1994). The Effects of Total Quality Management on Corporate Performance: An Empirical Investigation. Working Paper, School of Business, Indiana University, Bloomington.

EFQM. 1998. Self Assessment 1998 – Guidelines for Companies. European Foundation for Quality Management, Brussels, Belgium.

Ehlers, U. (2004). Quality in E-learning from a Learner's Perspective. Third EDEN Research Workshop 2004, Oldenburg, Germany.

Ehlers, U. (2005). Why do you Need Quality in E-learning? European Quality Observatory retrieved in 23/08/08 from: http://www.elearningeuropa.info/index.php?page=doc&doc_id=6068&doclng=3&menuzone=0&focus=1www.weiterbildungsblog.de

EPOC, (1997). New Forms of Work Organization. Can Europe Realize its Potential? Results of a Survey of Direct Employee Participation in Europe. European Foundation for the Improvement of Living and Working Conditions, Dublin.

Euler, D., Seufert, S. (2006). The Quality Management Approach "EFMD CEL-certified accreditation of e-learning". EDEN Conference 2006, Vienna.

Farbey, B., Land, D., Targett, D. (1999). IS Evaluation: A Process of Bringing Together Benefits, Costs and Risks. In: W. Currie, R. Galliers (Eds.), Rethinking Management Information Systems, Oxford University Press, New York, pp. 204-228.

Farbey, B., Land, F., Targett, C. (1995). A Taxonomy of Information Systems Applications: The Benefits' Evaluation Ladder. *European Journal of Information Systems*, 4, pp. 41-50.

Fazel, F. (2003). TQM vs. BPR. *Quality Progress*, 36 (10), pp. 59-62.

Fitzgerald, B., Ciaran, M. (1996). Business Process Reengineering: Putting Theory into Practice. INFOR. Feb 1996, retrieved in 23/8/08 from: http://findarticles.com/p/articles/mi_qa3661/is_199602/ai_n8751004

Flynn, B. B., Shroeder, R. G. and Sakakibara, S. (1994). A Framework for Quality Management Research and an Associated Measurement Instrument. *Journal of Operations Management*, 11(4), pp. 339-366.

Forza, C. (1995a). Quality Information Systems and Quality Management: A Reference Model and Associated Measures for Empirical Research. *Industrial Management and Data Systems*, 95(2), pp. 6-14.

Forza, C. (1995b). The Impact of Information Systems on Quality Performance – An Empirical Study. *International Journal of Operations and Production Management*, 55(6), pp 69-83.

Francis, A., MacIntosh, R. (1997). The Market, Technological, and Industry Context of Business Process Reengineering in the UK. *International Journal of Operations and Production Management*, 17(4), pp. 344-364

Francois, J.-P., Favre, F. and Greenan, N., (1999). Organizational Changes in Industrial Firms and Computerization of Industrial Enterprises. OECD, Paris.

Fuentes-Fuentes, M. M., Albacete-Saez, C. A. and Llotems-Montes, F. J. (2004). The Impact of Environmental Characteristics on TQM Principles and Organizational Performance. *The International Journal of Management Science*, 32, pp. 425-442.

Fynes, B., Voss, C. (2002). The Moderating Effect of Buyer-Supplier Relationships on Quality Practices and Performance. *International Journal of Operations & Production Management*, 22(6), pp. 589-613.

Galbreath, J., Galvin, P. (2008). Firm Factors, Industry Structure and Performance Variation: New Empirical Evidence to a Classic Debate. *Journal of Business Research*, 61, pp. 109-117.

Gao, G., Zhou, K. Z., and Yim, C. K. (2007). On What Should Firms Focus in Transitional Economies? A Study of the Contingent Value of Strategic Orientations in China. *International Journal of Research in Marketing*, 24, pp. 3-15.

Garrison D. R., Anderson, T. (2003). E-Learning in the 12st Century: A Framework for Research and Practice. Routledge, London.

Gebauer, H. (2008). Identifying Service Strategies in Product Manufacturing Companies by Exploring Environment-Strategy Configurations. *Industrial Marketing Management*, 37, pp. 278-291

Gefen, D., Straub, D. and Boudreau, M. (2000). Structural Equation Modelling and Regression: Guidelines for Research Practice. *Communications of the Association for Information Systems*, 4(7), pp. 1-78.

Giffi, C., Roth, A. V. and Seal, G. M. (1990). Competing in World Class Manufacturing. Business One Irwin, Homewood, Illinois, IL.

Gimzauskiene, E., Kloviene, L. (2008). The Role of Institutional Factors on Changes of Performance Measurement System. *Economics and Management*, 13, pp. 22-29

Govindarajan, V., Gupta, A. K. (1985). Linking Control Systems to Business Unit Strategy: Impact on performance. *Accounting, Organizations and Society*, 10, pp. 125-135.

Greenan, N. and Guellec,D., (1994). Coordination Within the Firm and Endogenous Growth. *Industrial and Corporate Change,* 3(1), pp. 173-195.

Greene, W. H. (2003). Econometric Analysis- 5th edition. Prentice Hall Inc.

Gregor, S., Martin, M., Fernandez, W., Stern, S., and Vitale, M. (2006). The transformational Dimension in the Realization of Business Value from Information Technology. *Strategic Information Systems*, 15, pp. 249-270

Gretton, P., Gali, J. and Parham, D., (2002), Uptake and Impacts of ICT in the Australian Economy: Evidence from Aggregate, Sectoral and Firm levels. Paper Presented in The OECD Workshop on ICT and Business Performance, Paris, December 9.

Grover, V., Teng, J. and Fiedler, K. (1993). Information Technology Enabled Business Process Redesign: An Integrated Planning Framework. *The International Journal of Management Science*, 21(4), pp. 433-447.

Grover, V., Teng, J., Segars, A. H. and Fiedler, K. (1998). The Influence of Information Technology Diffusion and Business Process Change on Perceived Productivity: the IS Executive's Perspective. *Information and Management*, 34, pp. 141-159.

Guimaraes, T. and Bond, W. (1996). Empirically Assessing the Impact of BPR on Manufacturing Firms. *International Journal of Operation & Production Management,* 16(8), pp. 5-28.

Gujarati, D. N. (2003). Basic Econometrics - 4e edition, Mc-Graw Hill Higher Education.

Gunasekaran, A and Nath, B. (1997). The Role of Information Technology in Business Process Reengineering. *International Journal of Production Economics*, 50, pp. 91-104.

Gunasekaran, A., Ngai, E. W. T., McGaughey (2006). Information Technology and Systems Justification: A Review for Research and Applications. *European Journal of Operational Research*, 173, pp. 957-983.

Gupta, A. K., Govindarajan, V. (1984). Business Unit Strategy, Managerial Characteristics and Business Unit Effectiveness at Strategy Implementation. *Academy of Management Journal*, 27(1), pp. 25-41

Hammer, M. (1990). Re-engineering work: Don't Automate, Obliterate. *Harvard Business Review*, 68(4), pp. 104-112.

Hammer, M. and Champy, J. (1993). Re-engineering the Corporation: A Manifesto for Business Revolution. Harper Press, New York, USA.

Hempell, T. (2003). Do Computers Call for Training? Firm-level Evidence on Complementarities between ICT and Human Capital Investments. ZEW Discussion Paper No. 03-20, Mannheim.

Hendricks, K. B., and Singhal, V. R. (1997). Does Implementing an Effective TQM Program Actually Improve Operating Performance? Empirical Evidence from Firms that Have Won Quality Awards. *Management Science*, 43 (9), pp. 1258-1272.

Hipkin, I. (2004). Determining Technology Strategy in Developing Countries. *The International Journal of Management Science*, 32(3), pp. 245-260.

Hirschheim, R., Smithson S. (1988). A Critical Analysis of Information Systems Evaluation, in: N. Bjorn-Andersen, G. Davis (Eds), Information Systems Assessment: Issues and Challenges, North Holland, Amsterdam, 1988, pp. 17-37.

Hofstede, G. and Hofstede, G. J. (2005).Cultures and Organizations: Software of the Mind. Mc-Graw-Hill, USA.

Holland, D., Kumar, S. (1995). Getting Past the Obstacles to Successful Reengineering. *Business Horizons* 38 (3), pp. 79–85.

Hoyt, D. P., Cashin, W. E. (1977). IDEA technical report No 1: Development of the IDEA system, Kansas State University, Center for Faculty Evaluation and Development.

Hughes, M., Morgan, R. (2007). Deconstructing the Relationship Between Entrepreneurial Orientation and Business Performance at the Embryonic Stage of Firm Growth. *Industrial Marketing Management*, 36 (5), pp. 651-661.

Hung, H. M. (2007). Influence of the Environment on Innovation Performance of TQM. *Total Quality Management & Business Excellence*, 18 (7), pp. 715-730

Hunter, L. W., Bernhardt, A., Hughes, K L. and Skuratowitz, E. (2000). It' not Just the ATMs: Firm Strategies, Work Restructuring and Workers' Earnings in Retail Banking. Wharton School, USA.

Hyvonen, J. (2007). Strategy, Performance Measurement Techniques and Information Technology of the Firm and their Links to Organizational Performance. *Management Accounting Research*, 18(3), pp. 343-366.

Ichniowski, C., Kochan, T.A., Levine, D.I., Olson, C. and Strauss, G., (2000). What Works at Work: Overview and Assessment. In: Ichniowski, C., Levine, D.I, Olson, C. and Strauss, G. (Eds.), The American Workplace. Skills, Compensation and Employee Involvement. Cambridge University Press, Cambridge, pp. 1-37.

Irani, Z. (2002). Information Systems Evaluation: Navigating Through the Problem Domain. *Information and Management*, 40 (1), pp. 11-24.

Irani, Z. (2008) Information Systems Evaluation: What Does it Mean? *Construction Innovation*, 8 (2), pp. 88-91.

Irani, Z., Love, P.E.D. (2002). Developing a Frame of Reference for ex-ante IT/IS Investment Evaluation. *European Journal of Information Systems*, 11(1), pp. 74-82.

ISO/IEC 9126 (2001). Software Engineering – Product Quality, International Standardization Organization (ISO).

Jackson B. (1998). Evaluation of Learning Technology Implementation. Learning Technology Dissemination Initiative (LTDI) Report, accessed from http://www.icbl.hw.ac.uk/ltdi/evalstudies.

Johnson, H. T., and Kaplan, R. (1987). Relevance Lost. The Rise and Fall of Management Accounting. Harvard Business School Press, Boston, Mass.

Kalakota, R. and Robinson, M. (1999), E-business: Roadmap for Success, Addison-Wesley, Reading, MA.

Kallio, J., Saarinen, T., Salo, S., Tinnila, M., Vepsalainen, A. (1999). Drivers and Tracers of Business Process Change. *Journal of Strategic Information Systems,* 8, pp. 125–142

Karagiannopoulos, G. D., Georgpoulos N., Nikolopoulos, N. Fathoming Porter's Five Forces Model in the Internet Era. *Info*, 7(6), pp. 66-76

Kaynak, H. (2003). The Relationship Between Total Quality Management Practices and their Effects on Firm Performance. *Journal of Operations Management*, 21(4), pp. 405-435.

Keeble, P. (1995). A New Methodology for Business Process Re-engineering. INFOR. Nov 1995, retrieved in 23/8/08 from: http://findarticles.com/p/articles/mi_qa3661/is_199511/ai_n8710202

Kim, E., Nam, D., Stimpert, J.L. The Applicability of Porter's Generic Strategies in the Digital Age: Assumptions, Conjectures and Suggestions. *Journal of Management*, 30(5), pp. 569-589

Kirkpatrick, D. (1983). Four Steps to Measuring Training Effectiveness. *Personnel Administrator*, 28(11), pp. 19-25

Kline, R. B. (2005). Principles and Practice of Structural Equation Modeling. Guilford Press, New York, NY.

Kock, N. F. J. and McQueen, R. J. (1997). Using Groupware in Quality Management Programs. *Information Systems Management*, 14(2), pp. 56-62.

Kuwaiti, M. E. and Kay, J. M. (2000). The Role of Performance Measurement in Business Process Reengineering. *International Journal of Operations and Production Management*, 20 (12), pp. 1411-1426.

Langfield-Smith, K. (1997). Management Control Systems and Strategy: A Critical Review. *Accounting, Organizations and Society*, 22, pp. 207-232.

Laszlo, G. P. (1997). The Role of Quality Cost in TQM. *The TQM Magazine* 9(6), pp. 410–413. URL: http://dandini.emerald library.com/vl=83866744/cl=14/fm=html/nw=1/rpsv/cw/mcb/0954478x/v9n6/s5*/p410*

Lau, H. G. & Idris, M. A. (2001). *The Soft Foundation of the Critical Success Factors on TQM Implementation* in Malaysia. *The TQM Magazine* 13(1): 51–60 URL:http://www.emerald-library.com/ft

Lawler, E.E., Mohrman, S.A., Ledford, G.E. (1992). Employee Involvement and Total Quality Management. Jossey-Bass, San Francisco, CA, .

Lawrence, P. R., Lorsch, J. W. Organization and Environment. Homewood, IL:Irwin, 1967

Lebas, M. (1995). Performance Measurement and Performance Management. *International Journal of Production Economics* 41(1–3), pp. 23–25.

Lederer, A. K. and Mendelow A. L. (1989). Coordination of Information Systems Plans With Business Plans. *Journal of Management Information Systems*, 6(2), pp. 5-12.

Lev, B., (2003). The Measurement of Firm-specific Organizational Capital. NBER Working Paper No. 9581, Cambridge, Mass.

Li, M., Ye, L. (1999). Information Technology and Firm Performance: Linking With Environmental, Strategic and Managerial Contexts. *Information Management*, 35(1), pp. 43-51.

Lim, J., Richardson, V. J., Roberts, T. L. (2004). Information Technology Investment and Firm Performance: A Meta-Analysis. In Proceedings: 37th Hawaii International Conference on System Sciences, (HICSS'04), Hawaii.

Lindbeck, A. and Snower, D.J., (2000). Multi-Task Learning and the Reorganization of Work: From Tayloristic to Holistic Organization. *Journal of Labor Economics*, 18, pp. 353-376.

Lockamy, A., and Smith, W. (1997). A Strategic Alignment Approach for Effective Business Process Reengineering: Linking Strategy, Processes and Customers for Competitive Advantage. *International Journal of Production Economics*, 50, pp. 141-153.

Lorenzo, G., Moore J.C., (2002). Report to the Nation: Five pillars of Quality Online Education, The Sloan Consortium, Needham, MA, retrieved in 25/6/2005 from http://www.sloan-c.org/

Lorsch, J. W. (2002). Smelling Smoke: Why Boards of Directors Need the Balanced Scorecard. *Balanced Scorecard Report*, September-October, p.9.

Loukis, E., Sapounas, I., Milionis, A. The Effect of Hard and Soft Information and Communication Technologies Investment on Manufacturing Business Performance in Greece-A Preliminary Econometric Study. *Telematics and Informatics*, 26, pp. 193-210.

Love, P. E. and Irani, Z. (2004). An Exploratory Study of Information Technology Evaluation and Benefits Management Practices of SME's in the Construction Industry. *Information and Management*, 42, pp. 227-242

Loveman, G. (1994). Information Technology and the Corporation in the 1990s. MIT Press, Cambridge, MA, USA.

Lu, H. P., and Yeh, D. C. (1998). Enterprises' Perceptions on Business Process Reengineering: A Path Analytic Model. *International Journal of Management Science*, 26 (1), pp. 17-27.

Lucas, Jr., Berndt, D. J., Truman, G. A. (1996). Reengineering Framework for Evaluation of a Financial Imaging System. *Communications of ACM*, 39, pp. 86-96.

Luftman, J., Kempaiah, R. and Nash, E. (2006). Key Issues for IT Executives 2005'. *MIS Quarterly Executive*, 5(2), pp. 81-100.

Mahmood, M., Mann, G. (1993). Measuring the Organizational Impact of Information Technology Investment: An Exploratory Study. *Journal of Management Information Systems*, 10, pp. 97-122.

Marsh, H. W. (1982) SEEQ: A Reliable, Valid and Useful Instrument for Collecting Students' Evaluations of University Teaching, British Journal of Educational Psychology, 52, pp. 77-95.

Marsh, H. W. (1987). Students' evaluations of university teaching: Research findings, methodological issues, and directions for further research. *International Journal of Educational Research*, 11, pp. 253-388.

Martinez-Lorente, A. R., Sanchez-Rodriguez, C. and Dewhurst, F. W. (2004). The effect of information technologies on TQM: An initial analysis. *International Journal of Production Economics*, 89(1), pp. 77-93.

Martinsons, M. G. (1995). The Theory, the Practice and the Future of Reengineering. *International Journal of Information Management*, 15(4), pp. 253-269.

Martinsons, M. G. and Revenaugh, D. L. (1997). Re-engineering is Dead; Long Live Reengineering. *International Journal of Information Management*, 17(2), pp. 79-82.

McAfee, A., Brynjolfsson, E. (2008). Investing in IT: That Makes a Competitive Difference. *Harvard Business Review*, July-August 2008.

McKenney, J. L. and Clark, T. H. (1995). Proctor and Gamble: Improving Consumer Value Through Process Redesign. Harvard Business School Case Study 9-195-126.

McKeown, I and Philip, G (2003). Business Transformation, Information Technology and Competitive Strategies: Learning to Fly. *International Journal of Information Management*, 23(1), pp. 3-24

Melville, N., Gurbaxani, V. and Kraemer, K. (2007). The Productivity Impact of Information Technology Across Competitive Regimes: The Role of Industry Concentration and Dynamism. *Decision Support Systems*, 43(1), pp. 229-242.

Melville, N., Kraemer, K. and Gurbaxani, V. (2004). Information Technology and Organizational Performance: An Integrative Model of IT Business Value. *MIS Quarterly*, 28(2), pp. 283-322.

Middendorf, T., (2006). Human Capital and Economic Growth in OECD Countries. Jahrbücher für Nationalökonomie und Statistik 226(6), pp. 670-686.

Milgrom, P. and Roberts, J., (1990). The Economics of Modern Manufacturing. *American Economic Review,* 80 (3), pp. 511-528.

Miller, D. (1988). Relating Porter's Business Strategies to Environment and Strcture: Analysis and Performance Implications. *Academy of management Journal*, 31 (2), pp. 280-308.

Miller, D., Friesen, P. H. (1982). Innovation in Conservative and Enterpreneual Firms: Two Models of Strategic Momentum. *Strategic Management Journal*, 3, pp. 1-25.

Miller, H. (1996). The Multiple Dimensions of Information Quality. *Information Systems Management*, 13(2), pp. 79-82.

Montes, F. G., Jover, A V. Fernandez, L. M. (2003). Factors Affecting the Relationship Between Total Quality Management and Organizational Performance. *International Journal of Quality and Reliability Management*, 20(2), pp. 189 – 209.

Mookherjee, D., (2006). Decentralization, Hierarchies, and Incentives: A Mechanism Design Perspective. *Journal of Economic Literature,* 44(2), pp. 367-390.

Morton, N. A. and Hu, Q. (2008). Implications of the Fit Between Organizational Structure and ERP: A Structural Contingency Theory Perspective. *International Journal of Information Management*, 28(5), pp. 391-402.

Murphy, M., (2002). Organizational Change and Firm Performance. STI Working Paper 2002/14, OECD, Paris.

Ngai, E. W. T., Poon, J. K. L., Chan Y. H. C. (2005). Empirical Examination of the Adoption of WebCT using TAM. *Computers & Education*, 44(3), pp. 220-231

Nicholson, W. (1998). Microeconomic Theory: Basic Principles and Extensions. 7th edition. The Dryden Press, Orlando, Florida.

NIST (1995) Award criteria – Malcolm Baldrige National Quality Award, US National Institute of Standards and Technology, Gaitherburg, MD.

O'Brien, J. P. (2003). The Financial Leverage Implications of Pursuing a Strategy of Innovation. *Strategic management journal*, 24, pp. 415-431.

O'Neill, P., and Sohal, A. S. (1999). Business Process Reengineering: A Review of Recent Literature. *Technovation*, 19, pp. 571-581.

OECD, (2004). The Economic Impact of ICT – Measurement, Evidence and Implications. OECD, Paris.

Oliver M., Conole G. (1998). Evaluating learning technology: a toolkit for practitioners. *Active Learning*, 8, pp. 3-8

Organisation for Economic Co-operation and Development (OECD) (2004). The Economic Impact of ICT – Measurement, Evidence and Implications. Paris, France.

Pantazi, M. A. and Georgopoulos, N. (2006). Investigating the Impact of Business-Process-Competent Information Systems on Business Performance. *Managing Service Quality*, 16(4), pp. 421-434.

Parnell, J. A., Wright, P., Tu, H. S. (1996). Beyond the Strategy-Performance Linkage: The Impact of the Strategy-Organization-Environment Fit on Business Performance. *American Business Review*, pp. 41-50

Prajogo, D. I. and Sohal, A. S. (2006). The Relationship Between Organizational Strategy, Total Quality Management (TQM) and Organization Performance – The Mediating Role of TQM. *European Journal of Operational Research*, 168, pp. 35-50.

Preslac, A. R. (2003). A Firm Level Study of Information Technology Productivity by Industry Using Financial and Market Based Measures. *Journal of Information Technology Impact*, 3(2), pp. 77-90.

Ranft, A., Marsh, S. J. (2008). Assessing Knowledge Through Acquisitions and Alliances: An Empirical Examination of New Market Entry. *Journal of Management Issues*, 1, pp. 51-67.

Rangan, V. and Dell, M. (1998). Dell Online. Harvard Business School Case Study 9-598-116.

Ravichandrasn, T., and Lertwongsatien, C. (2005). Effect of Information Systems Resources and Capabilities on Firm Performance: A Resource-Based Perspective. *Journal of Management Information Systems*, 21(4), pp. 237-276.

Reed, R., Lemak, D. J. and Montgomery, J. C. (1996). Beyond Process: TQM Content and Firm Terformance. *Academy of Management Review*, 21(1), pp. 173-202.

Reich, B.H. and Benbasat, I. (1998). Factors That Influence the Social Dimension of Alignment Between Business and Information Technology Objectives, working paper.

Rivers, D. and Vuong, Q.H., (1988). Limited Information Estimators and Exogeneity Tests for Simultaneous Probit Models. *Journal of Econometrics*, 39, pp. 347-366.

Roach, S. (1987). America's Technology Dilemma: A Profile of the Information Economy. Morgan Stanley Special Economic Study, New York, USA.

Robinson, K.C., Mc Dougall, P.P. (2001). Entry Barriers and New Venture Performance: A Comparison of Universal and Contingency Approaches. *Strategic Management Journal*, 22(6-7), pp. 659-685.

Rodriguez, C. S., Dewhurst, F. W., Martinez-Lorente, A. R. (2006). IT Use in Supporting TQM Initiatives: An Empirical Investigation. *International Journal of Operations and Production Management*, 26 (5), pp. 486-504.

Saade, R., Bahli B. (2005). The Impact of Cognitive Absorption on Perceived Usefulness and Perceived Ease of Use in on-line Learning: an Extension of the Technology Acceptance Model. *Information and Management*, 42(2), pp. 317-327.

Saraph, J. V., Benson, P. G. and Schroeder, R. G. (1989). An Instrument for Measuring the Critical Factors of Quality Management. Decision Sciences, 20(4), pp. 810-829.

Sarkera, S. and Lee, S. A. (1999). IT-Enabled Organizational Transformation: A Case Study of Organizational Failure at TELECO. *Journal of Strategic Information Systems*, 8(1), pp. 83-103.

Sawy, O. A., Hars, A. (1999). Competence and Impact Tools for BPR. Information and Management, 36, 301-311.

Seddon P. B. (1997). A Respecification and Extension of the DeLone and McLean Model of IS success. *Information Systems Research*, 8(3), pp.240-253.

Seetharaman, A., Sreenivasan, J. (2006). Critical Success Factors of Total Quality Management, *Quality & Quantity*, 40, pp. 675–695

Selim H. M. (2003). An Empirical Investigation of Student Acceptance of Course Websites. *Computers and Education*, 40(4), pp. 343-360.

Selim, H. M. (2005). Critical Success Factors for E-learning Acceptance: Confirmatory Factor Models. *Computers and Education*, 45(1), pp. 35-55.

Sharma, B. (2006). Quality Management Dimensions, Contextual Factors and Performance: An Empirical Investigation. Total Quality management, 17 (9), pp. 1231-1244.

Sila, I. (2007). Examining the Effects of Contextual Factors on TQM and Performance Through the Lens of Organizational Theories: An empirical study. *Journal of Operation Management*, 25, pp. 83-109.

Sircar, S., Turnbow, J. L., and Bordoloi, B. A Framework for Assesing the Relationship Between Information Technology Investment and Firm Performance. *Journal of Management Information Systems*, 16 (4), pp. 69-97.

Smithson, S. and Hirscheim, R. (1998). Analysing Information Systems Evaluation: Another Look at an Old Problem. *European Journal of Information Systems*, 7, pp. 158-174

Sobkowiak, R. T. and LeBleu, R. E. (1996). Repositioning HR Information Systems: Empowering Employees Through Information. *Information Systems Management*, 13, 62-64.

Soh, C. and Markus M. L. (1995). How IT Creates Business Value: A Process Theory Synthesis, Proceedings of the Sixteenth International Conference on Information Systems, Amsterdam, the Netherlands, December 1995, pp. 29-41.

Soltani, E., Lai, P. C., Javadeen, S. R. and Gholipour, T. H. (2008). A Review of the Theory and Practice of Managing TQM: An Integrative Framework. *Total Quality Management & Business Excellence*, 19(5), pp. 461-479.

Soong, B. M. H., Chan, H. C., Chua, B. C., Loh, K. F. (2001). Critical Success Factors for On-line Course Resources. *Computers & Education*, 36(2), pp. 101-120.

Spencer, B. (1994). Models of Organization and Total Quality Management: A Comparison and Critical Evaluation. *Academy of Management Review*, 19(3), pp. 446-471.

Stephenson, J. and Weil, S. (1992). Quality in Learning, Kogan Page, London.

Stoelhorst, J. W., Raaij, E. M. (2002). On Explaining Performance Differentials. Marketing and the Managerial Theory of the Firm. *Journal of Business research*, 5721, pp. 1-16.

Stolarick, K. (1999). IT spending and firm productivity: Additional Evidence from the Manufacturing Sector. Center for Economic Studies, U.S. Census Bureau, Working Paper 99-10.

Stoner, J. A. F. & Freeman R. E. (1992). *Operations Management, Management.* New Jersey: Prentice-Hall International.

Strassman, P. (1990). The Business Value of Computers: An Executive's Guide. The Information Economic Press, New Canaan, Connecticut, USA.

Stratopoulos, T., Dehning, B. (2000). Does Successful Investment in Information Technology Solve the Productivity Paradox? *Information and Management*, 38 (2), pp. 103-117.

Straub, D., Boudreau, M. and Gefen, D. (2004). Validation Guidelines for IS Positivist research. *Communications of the Association for Information Systems*, 13, pp. 380-427.

Tai, D. W., and Huang, C. E. (2007). The Relationship Between Business Process Reengineering and Organizational Performance in Taiwan. *Journal of American Academy of Business*, Cambridge, 10 (2), 296-301.

Talwar, R. (1993). Business Re-engineering-a Strategy-Driven Approach. *Long Range Planning*, 26 (6), pp. 22-40.

Tapscott, D. and Caston A. (1993). Paradigm Shift: The New Promise of Information Technology, McGraw-Hill, New York, NY.

Teo, T. S. H., King, W. R. (1996). Assessing the Impact of Integrating Business Planning and IS Planning. *Information & Management* , 30 , pp. 309-321.

Terziovskia, M., Fitzpatrickb, P., O'Neill, P. (2003). Successful Predictors of Business Process Reengineering (BPR) in Financial Services. *International Journal in Production Economics*, 84 (2003), pp. 35–50

Theodorou, P., and Florou, G. (2008). Manufacturing Strategies and Financial Performance—The Effect of Advanced Information Technology: CAD/CAM systems. *The International Journal of Management Science*, 24(2), pp. 107-121.

Venkatesh, V., Morris, M. G., Davis, G. B., Davis F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), pp. 425-478.

Venkatraman, N. (1989). The Concept of Fit in Strategy Research: Towards Verbal and Statistical Correspondence. *Academy of Management Review*, 14(3), pp. 423-444.

Vickery, G. and Wurzburg, G., (1998). The Challenge of Measuring and Evaluating Organizational Change in Enterprises. OECD, Paris.

Volery, T., Lord, D. (2000). Critical Success Factors in Online Education. *The International Journal of Education Management*, 14(5), pp. 216-223.

Wan, Z, Fang, Y. and Wade, M. (2007). A Ten-Year Odyssey of the 'IS Productivity Paradox' - A Citation Analysis (1996-2006). The Americas Conference on Information Systems (AMCIS) 2007, Keystone, Colorado, USA.

Wang Y. S. (2003) Assessment of Learner Satisfaction with Asynchronous Electronic Learning Systems. *Information and Management*, 41(1), pp. 75-86.

Weston, F. C. J. (1993). Weighing 'Soft' and 'Hard' Benefits of Information Technology. *Manufacturing Systems*, 11(7), 120-121.

Wirtz, B. W., Mathieu, A., Schilke, O. (2007). Strategy in High-Velocity Environments. *Long range Planning*, 40(3), pp. 295-313.

Wolf, E. and Zwick, T., (2002). Reassessing the Impact of High Performance Workplaces. ZEW Discussion Paper No. 02-07, Revised Version, Mannheim

Yeo, K. T. (1996). Guest Editorial - Management of Change-from TQM to BPR and Beyond. *International Journal of Project Management*, 14(6), 321-432.