UNIVERSITY OF THE AEGEAN

DEPARTMENT OF INFORMATION AND COMMUNICATION SYSTEMS ENGINEERING

THE NETWORK OF RELATIONSHIPS AMONG IS, INNOVATION AND BUSINESS PERFORMANCE
-   **AN EMPIRICAL INVESTIGATION BASED ON DATA FROM EUROPEAN FIRMS**

Doctoral Dissertation
by
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by Fotini Michailidou

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Abstract

Introduction

Organizations have been making for more than two decades big investments in information and communication technologies (ICT) aiming at the development of various types of information systems (IS) that support important business functions and processes of them. So a critical issue that is posed to both researchers and practitioners is to understand and assess the business value generated by these ICT investments and to find ways of increasing it. For this reason the business value generated by ICT has been for long time a major research topic. This ICT business value research can be divided into four periods. In the first period (from the mid 1980s until the mid 1990s) there has been very little empirical evidence of a positive association between ICT investment and business performance (Roach 1987, Brynjolfsson 1993, Strassman 1997); these counter-intuitive results lead to extensive debates about this 'ICT Productivity Paradox' (Brynjolfsson 1993) and the basic reasons behind it. In the second period (from the mid 1990s until the mid 2000s) there have been mixed results: many studies provided empirical evidence of positive contribution of ICT investment to some business performance measures (Brynjolfsson and Hitt 1996, Stolarick 1999, OECD 2004, Arvanitis 2005a), even though there are still some other studies resulting in mixed or inconclusive results. In the third period (from 2000 until today) research focuses on the identification and deeper understanding of 'internal' factors (related to the internal functions of the organization), which can increase the business value generated by ICT, such as business process redesign, new human skills, innovations, 'soft ICT investment', etc. (Devaraj & Kohli 2000, Arvanitis 2005a, Hempell 2005, Loukis et al 2008a). In this direction emphasis is put on the identification and analysis of various moderators and mediators of the relationship between ICT and business performance. Finally in the fourth period (from 2005 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, sectoral context, national context and culture, etc. on ICT business value (Melville et al 2007, Loukis et al 2008b).

Recently there is a growing research interest in the business value generated by particular types of IS, such as e-business systems (Zhu 2004, Zhu & Kraemer 2005, Soto-

Acosta & Merono-Cerdan 2008), Enterprise Resource Planning (ERP) systems (Poston and Grabski 2001, Hunton et al 2003, Nicolaou 2004, Hendricks et al. 2006),e-procurement systems (Croom and Johnston 2003, Hawking et al. 2004, Mukhopadhyay and Kekre 2002, Radovilsky and Hegde 2004) etc., and also in identifying and analyzing the moderators and mediators of the relationships of them with business performance.

In this direction this PhD Dissertation presents an empirical study of the relations between the extent of adoption of three quite different and widely adopted types of IS, the internal, the e-business and the e-procurement ones (at a first level), the extent of innovation (which is one of the most widely discussed in the literature mechanisms - mediators of ICT impact on business performance (e.g. Antonelli et al 2000, Bresnahan 2003, Hempell 2005)) and the resulting ICT business benefits (at a second level), and finally business performance (at a third level). It aims to investigate and compare these three IS types, as to their impact on innovation and on the benefits provided to the firm from its ICT infrastructure and finally on business performance. Also, it aims to investigate and compare to what extent the impacts of these three IS types on business performance are mediated by innovation. Finally, it also aims to examine the effects of some sectoral and national contexts on the above network of relations.

Literature review and research gaps

Previous empirical literature has investigated only some parts of the above highly important network of relations dealt with in the present study, while some other parts have been explored to a limited extent or even remain unexplored. Therefore are missing 'holistic' empirical investigations (based on a common dataset) of the whole network of relations between the extent of adoption of various IS types, innovation and resulting business benefits, which will enable a better understanding of these critical interrelations.

Several empirical studies have been conducted concerning the impact of internal ERP systems on firm performance (Hitt et al 2002, Hunton et al 2003, Nicolaou and Reck 2004, Nicolaou and Bhattacharya 2006, Wieder et al 2006, Hendricks et al 2006) with mixed results: some of these studies provide evidence of positive impact of ERP systems on some measures of business performance; however, some other studies did not find a statistically significant effect of ERP systems on the same or other measures of

organizational performance. This indicates that there are additional variables affecting this relation.

Also there have been some studies concerning the impact of e-business adoption on various non-financial (Devaraj et al 2007, Sanders 2007, Soto-Acosta and Meroño-Cerdan 2008) and financial measures of business performance (Zhu and Kraemer 2002, Barua et al 2004, Johnson et al 2007, Quan 2008). These studies have produced considerable evidence that e-business has a positive impact on various financial and non-financial measures of business performance, though there are still a few studies finding non statistically significant impacts. Also, they have identified a number of mediating factors in this relationship, such as the development of internal and external e-business capabilities, the digitization of business activities with customers and suppliers, etc.; however, the mediating role of innovation in the relationship between e-business and performance has not been examined.

Another research stream has developed a rich theoretical argumentation concerning the potential of ICT as catalysts and enablers of important innovations (e.g. Porter & Millar 1985, Hammer 1990, Hammer & Champy 1993, Davenport 1993, Bresnahan & Trajtenberg 1995, Antonelli et al 2000, Brynjolfsson and Hitt 2000, Bresnahan et al 2002, Bresnahan 2003). This research identifies a unique characteristic of ICT in comparison to the other technologies firms are using: ICT are 'general purpose technologies', characterized by high flexibility and adaptability, so they can be used in the whole economy in numerous different ways and for many purposes, in order to enable important innovations. For this reason ICT can change the way that human work is performed, measured, controlled and reported; also they enable significant restructuring of the work, in order to allocate routine, well-defined tasks associated with symbols processing to computers and separate and redesign of the tasks that require human skills; furthermore, ICT enable an individual worker to have all the required information for completing a bigger part of a process, so the existing fragmentation of many processes can be dramatically reduced resulting in large efficiency gains.

However, these theoretical arguments and expectations concerning the innovative potential of ICT have been empirically investigated only to a limited extent (Bartel et al 2007, Hempell and Zwick 2008, Engelstätter and Sarbu 2010, Ollo-Lopez and Muneta 2012). Also, this limited empirical literature has examined the relation between ICT in general and innovations, so the relation between particular types of IS, such as e-business,

e-procurement and intra-organizational - internal systems (having quite different objectives, users and functionalities), has not been examined and compared.

Contribution of the present research

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

- It presents an empirical investigation of the relations between three different widely adopted types of IS, the internal, the e-business and the e-procurement IS (at a first level), the level of innovation and the business benefits obtained from ICT (at a second level), and finally business performance (at a third level). It examines and compares these three fundamental IS types as to their impact on innovation, on the benefits provided to the firm by its ICT infrastructure, and finally on business performance.

- It examines empirically to what extent the effect of these three types of IS on business performance is through the innovation they drive, and to what extent the enthusiastic expectations of the relevant theoretical literature are empirically confirmed. It examines in general the mediating effect of innovation in the relation between IS and business performance.

- It investigates empirically the above issues for the tourism sector, which is particularly important for the economy of our country and the European South in general.

- It examines and compares the above mentioned relations for the tourism sector in the Mediterranean, Central European and Scandinavian region, taking into account the existing current debate for the economic performance differences between the European South, Mediterranean region on the one hand and the Central Europe and Scandinavian on the other.

Findings and conclusions

The main findings and conclusions of this PhD Dissertation can be summarized as follows (they are described in detail in the following chapters):

- Internal IS, e-procurement IS and e-business IS are all drivers of innovation.

- The internal systems have the strongest effect on innovation, the e-business systems have a much smaller effect and finally the e-procurement systems have the smallest effect. Therefore the enthusiastic expectations of the relevant theoretical literature that e-business and e-procurement will have a much stronger and dramatic impact on innovation than the 'traditional' internal IS are not confirmed.

- The internal systems have a much higher impact on ICT benefits and business performance, followed by the e-business ones, while the e-procurement ones have the smallest impact.

- The effects of internal and e-business IS on ICT benefits and through it on business performance are partially mediated by innovation. With respect to the internal IS a smaller part of their effect on business performance (39%) is through the innovation they drive, while the largest part (61%) is through the automation of already existing business processes for existing products/services. On the contrary, the largest part of the much smaller effect of e-business IS on business performance is through the innovation they drive (63%), and a much smaller part of it (37%) is through automation of existing business processes for existing products/services. Finally, the effect of e-procurement IS on business performance is completely mediated by innovation.

- Concerning innovation it has been concluded that it has a positive impact on business performance, which is partially mediated by the increase of ICT benefits that it causes.

Particularly for the Tourism Sector the findings were:

- In general, the estimated models for tourism sector lead to similar conclusions to the ones drawn from the general model. They provided evidence of positive impact of internal, e-business and e-procurement IS on innovation, with the internal IS being a stronger driver of innovation, followed by the e-business and the e-procurement ones.

- The impact of the internal, e-business and e-procurement IS on the business benefits that the tourism firms achieve from their ICT infrastructures, is mediated by innovation (partially for the first two, and completely for the third).

- The only difference compared to the general model is that in the estimated tourism model the mediation effect of innovation on the impacts of internal IS and e-business IS on business performance is weaker (17% and 27% respectively instead of 39% and 63% for the general model).

- The comparisons amongst the Mediterranean, the Central European and the Scandinavian regions' tourism sector have shown that the former is characterized by higher levels of innovation, greater business benefits from ICT and higher level of use of some important internal applications (ERP, accounting and document sharing/collaborative work applications) in comparison with Central European and Scandinavian tourism firms.

- The effect of innovations on business performance is higher in the Mediterranean tourism sector in relation to both the Central European and the Scandinavian tourism sectors. On the contrary, the effect of using internal IS on the benefits obtained from ICT is lower in the Mediterranean tourism firms in comparison with both the Central European and the Scandinavian ones, which means that the latter make more effective use of internal IS than the former.

Ευρεία Περίληψη στα Ελληνικά

Εισαγωγή

Οι επιχειρήσεις για περισσότερο από δύο δεκαετίες πραγματοποιούν μεγάλες επενδύσεις σε τεχνολογίες πληροφορικής και επικοινωνιών (ΤΠΕ) στοχεύοντας στην ανάπτυξη διαφόρων τύπων πληροφοριακών συστημάτων που θα υποστηρίζουν σημαντικές επιχειρησιακές λειτουργίες και διαδικασίες τους. Άρα ένα κρίσιμο θέμα που τίθεται τόσο για τους ερευνητές όσο και για τα στελέχη διοίκησης επιχειρήσεων είναι η κατανόηση και ο υπολογισμός της επιχειρησιακής αξίας που δημιουργείται από αυτές τις επενδύσεις σε ΤΠΕ και η εύρεση τρόπων για την αύξησή της. Για αυτό το λόγο η επιχειρησιακή αξία που δημιουργείται από τις ΤΠΕ έχει αποτελέσει για πολύ καιρό ένα μεγάλο ερευνητικό θέμα. Η μελέτη της επιχειρησιακής αξίας που προκύπτει από ΤΠΕ μπορεί να χωριστεί σε τέσσερις περιόδους. Κατά την πρώτη περίοδο (από τα μέσα της δεκαετίας του '80 μέχρι τα μέσα της δεκαετίας του '90) υπάρχουν πολύ λίγες εμπειρικές ενδείξεις θετικής συσχέτισης ανάμεσα στις επενδύσεις σε ΤΠΕ και στην απόδοση των επιχειρήσεων (Roach 1987, Brynjolfsson 1993, Strassman 1997). Αυτά τα αποτελέσματα οδήγησαν σε εκτεταμένες συζητήσεις για αυτό το «παράδοξο της παραγωγικότητας των ΤΠΕ» (Brynjolfsson 1993) και για τους βασικούς λόγους πίσω από αυτό. Κατά τη δεύτερη περίοδο (από τα μέσα της δεκαετίας του '90 μέχρι τα μέσα της δεκαετίας του 2000) υπήρχαν ανάμεικτα αποτελέσματα: πολλές μελέτες παρείχαν εμπειρικές αποδείξεις θετικής συμβολής της επένδυσης σε ΤΠΕ σε κάποια μέτρα-διαστάσεις της επιχειρησιακής απόδοσης (Brynjolfsson & Hitt 1996, Stolarick 1999, OECD 2004, Arvanitis 2005a), ενώ υπήρχαν και κάποιες άλλες μελέτες με ανάμεικτα ή αντίθετα αποτελέσματα. Κατά την τρίτη περίοδο (από το 2000 μέχρι σήμερα) η έρευνα επικεντρώθηκε στον προσδιορισμό και την βαθύτερη κατανόηση εσωτερικών παραγόντων (που σχετίζονταν με εσωτερικές λειτουργίες τις επιχείρησης), οι οποίοι μπορούν να αυξήσουν την επιχειρησιακή αξία που δημιουργείται από τις ΤΠΕ όπως επανασχεδιασμός των επιχειρησιακών διαδικασιών (BPR), νέες ανθρώπινες δεξιότητες, καινοτομίες, «εύκαμπτες» (soft) επενδύσεις σε ΤΠΕ, κ.τ.λ. (Devaraj & Kohli 2000, Arvanitis 2005a, Hempell 2005, Loukis et al 2008a). Σε αυτή την κατεύθυνση δίνεται έμφαση στον προσδιορισμό και στην ανάλυση διαφόρων παραγόντων που μετριάζουν ή διαμεσολαβούν στη σχέση μεταξύ ΤΠΕ και απόδοσης των επιχειρήσεων. Τέλος κατά την

τέταρτη περίοδο (από το 2007 μέχρι σήμερα) η έρευνα αρχίζει να ασχολείται με την επίδραση εξωτερικών παραγόντων, που σχετίζονται με το εξωτερικό περιβάλλον της επιχείρησης, όπως ο ανταγωνισμός, η δυναμική της βιομηχανίας, ο κλαδικός παράγοντας, ο εθνικός παράγοντας και η εθνική κουλτούρα κ.α. στην επιχειρησιακή αξία από τη χρήση ΤΠΕ (Melville et al 2007, Loukis et al 2008b).

Τελευταία υπάρχει ολοένα αυξανόμενο ενδιαφέρον για την επιχειρησιακή αξία που προκύπτει από συγκεκριμένους τύπους πληροφοριακών συστημάτων (ΠΣ), όπως συστήματα ηλεκτρονικού επιχειρείν (Zhu 2004, Zhu & Kraemer 2005, Soto-Acosta & Merono-Cerdan 2008), Λογισμικό διαχείρισης επιχειρηματικών πόρων (ERP) (Poston & Grabski 2001, Hunton et al 2003, Nicolaou 2004, Hendricks et al. 2006), αυτοματοποιημένο σύστημα προμηθειών (Croom & Johnston 2003, Hawking et al. 2004, Mukhopadhyay & Kekre 2002, Radovilsky & Hegde 2004) κ.α. και επίσης στον προσδιορισμό και στην ανάλυση των παραγόντων που ενισχύουν και διαμεσολαβούν στη σχέση ανάμεσα σε αυτά τα συστήματα και στην απόδοση των επιχειρήσεων.

Σε αυτή την κατεύθυνση αυτή η διδακτορική διατριβή παρουσιάζει μια εμπειρική μελέτη των σχέσεων ανάμεσα στην υιοθέτηση τριών διαφορετικών και ευρέως υιοθετημένων πληροφοριακών συστημάτων, των εσωτερικών πληροφοριακών συστημάτων, των συστημάτων ηλεκτρονικού επιχειρείν και του αυτοματοποιημένου συστήματος προμηθειών (σε ένα πρώτο επίπεδο), την καινοτομία (που είναι ένας από τους πιο πολυσυζητημένους στην βιβλιογραφία μηχανισμούς –διαμεσολαβητές της επίδρασης των ΤΠΕ στην απόδοση των επιχειρήσεων (π.χ. Antonelli et al 2000, Bresnahan 2003, Hempell 2005)) και τα οφέλη που προκύπτουν από τη χρήση ΤΠΕ (σε ένα δεύτερο επίπεδο), και τέλος την απόδοση των επιχειρήσεων (σε ένα τρίτο επίπεδο). Στόχος της διατριβής είναι να διερευνήσει και να συγκρίνει τα τρία αυτά είδη πληροφοριακών συστημάτων, ως προς την επίδρασή τους στην καινοτομία, τα οφέλη από τη χρήση ΤΠΕ και την απόδοση των επιχειρήσεων. Επίσης στοχεύει να διερευνήσει και να συγκρίνει σε τι βαθμό οι επιδράσεις αυτών των τριών πληροφοριακών συστημάτων στην απόδοση των επιχειρήσεων διαμεσολαβούνται από την καινοτομία. Τέλος, στοχεύει να εξετάσει τις επιδράσεις που έχουν κάποιοι κλαδικοί και εθνικοί παράγοντες στο παραπάνω δίκτυο σχέσεων.

Εντοπισμός ερευνητικών κενών και αδυναμιών υπάρχουσας βιβλιογραφίας

Η προηγούμενη εμπειρική βιβλιογραφία έχει διερευνήσει μόνο κάποια μέρη του πολύ σημαντικού δικτύου των σχέσεων με το οποίο ασχολείται η παρούσα μελέτη, ενώ κάποια άλλα μέρη έχουν ερευνηθεί σε μικρό βαθμό ή καθόλου. Επομένως λείπουν ολιστικές εμπειρικές μελέτες (βασισμένες σε κοινά δεδομένα) του όλου δικτύου των σχέσεων ανάμεσα σε διάφορους τύπους πληροφοριακών συστημάτων, την καινοτομία και τα επιχειρησιακά οφέλη που προκύπτουν, που θα επιτρέψουν την καλύτερη κατανόηση αυτών των κρίσιμων αλληλεξαρτήσεων.

Έχουν πραγματοποιηθεί αρκετές εμπειρικές μελέτες που αφορούν την επίδραση των εσωτερικών ERP συστημάτων στην απόδοση των επιχειρήσεων (Hitt et al 2002, Hunton et al 2003, Nicolaou & Reck 2004, Nicolaou & Bhattacharya 2006, Wieder et al 2006, Hendricks et al 2006) με ανάμεικτα αποτελέσματα: μερικές μελέτες παρέχουν ενδείξεις θετικής επίδρασης των ERP συστημάτων σε κάποια μέτρα-διαστάσεις της επιχειρησιακής απόδοσης, ενώ κάποιες άλλες μελέτες δεν βρήκαν στατιστικά σημαντική επίδραση των ERP συστημάτων στις ίδιες ή σε άλλες διαστάσεις της επιχειρησιακής απόδοσης. Αυτό φανερώνει πως υπάρχουν επιπρόσθετες μεταβλητές που επηρεάζουν αυτή τη σχέση.

Επίσης υπάρχουν μελέτες σχετικά με την επίδραση της υιοθέτησης συστημάτων ηλεκτρονικού επιχειρείν σε διάφορες μη οικονομικές (Devaraj et al 2007, Sanders 2007, Soto-Acosta & Meroño-Cerdan 2008) και οικονομικές διαστάσεις της επιχειρησιακής απόδοσης (Zhu & Kraemer 2002, Barua et al 2004, Johnson et al 2007, Quan 2008). Αυτές οι μελέτες παρήγαγαν σημαντικές αποδείξεις ότι το ηλεκτρονικό επιχειρείν έχει θετική επίδραση σε διάφορες οικονομικές και μη οικονομικές μετρήσεις της απόδοσης των επιχειρήσεων, αν και υπάρχουν ακόμα μερικές μελέτες που δεν βρήκαν στατιστικά σημαντική επίδραση. Επίσης προσδιόρισαν έναν αριθμό διαμεσολαβητικών παραγόντων σε αυτή τη σχέση, όπως η ανάπτυξη εσωτερικών και εξωστρεφών δυνατοτήτων ηλεκτρονικού επιχειρείν, η ψηφιοποίηση επιχειρηματικών δραστηριοτήτων που σχετίζονται με πελάτες και προμηθευτές, κ.λπ. Όμως ο διαμεσολαβητικός παράγοντας της καινοτομίας στη σχέση μεταξύ ηλεκτρονικού επιχειρείν και απόδοσης δεν έχει εξεταστεί.

Ένα άλλο ερευνητικό ρεύμα ανέπτυξε θεωρητική επιχειρηματολογία σχετικά με το ενδεχόμενο των ΤΠΕ να επιτρέπουν αλλά και να δρουν ως καταλύτες σημαντικών

καινοτομιών (π.χ. Porter & Millar 1985, Hammer 1990, Hammer & Champy 1993, Davenport 1993, Bresnahan & Trajtenberg 1995, Antonelli et al 2000, Brynjolfsson &Hill 2000, Bresnahan et al 2002, Bresnahan 2003). Αυτή η έρευνα προσδιορίζει ένα μοναδικό χαρακτηριστικό των ΤΠΕ σε σύγκριση με τις άλλες τεχνολογίες που οι επιχειρήσεις χρησιμοποιούν: Οι ΤΠΕ είναι «τεχνολογίες γενικού σκοπού», που χαρακτηρίζονται από υψηλή ελαστικότητα και υιοθέτηση, έτσι μπορούν να χρησιμοποιηθούν από όλη την οικονομία με πολλούς διαφορετικούς τρόπους και για πολλούς σκοπούς, προκειμένου να επιτρέψουν σημαντικές καινοτομίες. Για αυτό το λόγο οι ΤΠΕ μπορούν να αλλάξουν τον τρόπο με τον οποίο η ανθρώπινη δουλειά εκτελείται, μετριέται, ελέγχεται και αναφέρεται. Επίσης επιτρέπουν σημαντική αναδόμηση της εργασίας, προκειμένου να κατανεμηθεί ο συνηθισμένος τρόπος ενεργειών, καλά προσδιορισμένα καθήκοντα που σχετίζονται με την επεξεργασία συμβόλων σε υπολογιστές και να χωριστούν και να επανασχεδιαστούν τα καθήκοντα που απαιτούν ανθρώπινες δεξιότητες. Επιπλέον οι ΤΠΕ επιτρέπουν στον εργαζόμενο να έχει όλες τις απαιτούμενες πληροφορίες για την ολοκλήρωση ενός μεγαλύτερου μέρους της διαδικασίας, έτσι ο υπάρχων διαχωρισμός σε πολλές διαδικασίες μπορεί δραματικά να μειωθεί με αποτέλεσμα μεγάλο κέρδος σε αποδοτικότητα.

Όμως αυτά τα θεωρητικά επιχειρήματα και οι προσδοκίες σχετικά με το καινοτομικό ενδεχόμενο των ΤΠΕ έχουν εμπειρικά ερευνηθεί μόνο σε περιορισμένο βαθμό (Bartel et al 2007, Hempell and Zwick 2008, Engelstätter and Sarbu 2010, Ollo-Lopez and Muneta 2012). Επίσης, αυτή η περιορισμένη εμπειρική βιβλιογραφία εξετάζει τη σχέση ανάμεσα σε ΤΠΕ γενικά και στη καινοτομία, έτσι η σχέση ανάμεσα σε συγκεκριμένους τύπους πληροφοριακών συστημάτων, όπως συστήματα ηλεκτρονικού επιχειρείν, αυτοματοποιημένα συστήματα προμηθειών και ενδοεπιχειρησιακά - εσωτερικά συστήματα (που έχουν αρκετά διαφορετικούς σκοπούς, χρήστες και λειτουργίες), δεν έχει εξεταστεί και συγκριθεί.

Συνεισφορά της παρούσας Διατριβής

Η παρούσα διδακτορική διατριβή συνεισφέρει στην υπάρχουσα βιβλιογραφία συμπληρώνοντας τα κενά που προσδιορίστηκαν και αναφέρθηκαν προηγουμένως. Πιο συγκεκριμένα:

- Παρουσιάζει μια εμπειρική μελέτη των σχέσεων ανάμεσα στην υιοθέτηση τριών διαφορετικών και ευρέως υιοθετημένων πληροφοριακών συστημάτων, των εσωτερικών πληροφοριακών συστημάτων, των συστημάτων ηλεκτρονικού επιχειρείν και του αυτοματοποιημένου συστήματος προμηθειών (σε ένα πρώτο επίπεδο), την καινοτομία και τα οφέλη που προκύπτουν από τη χρήση ΤΠΕ (σε ένα δεύτερο επίπεδο), και τέλος την απόδοση των επιχειρήσεων (σε ένα τρίτο επίπεδο). Διερευνά και συγκρίνει τα τρία αυτά είδη πληροφοριακών συστημάτων, ως προς την επίδρασή τους στην καινοτομία, τα οφέλη από τη χρήση ΤΠΕ και την απόδοση των επιχειρήσεων.

- Εξετάζει εμπειρικά σε τι βαθμό η επίδραση των τριών αυτών πληροφοριακών συστημάτων στην απόδοση των επιχειρήσεων προέρχεται διαμέσου της καινοτομίας στην οποία οδηγούν και σε τι βαθμό οι ενθουσιώδεις προσδοκίες της σχετικής θεωρητικής βιβλιογραφίας επιβεβαιώνονται εμπειρικά.

- Εξετάζει γενικά την διαμεσολαβητική επίδραση της καινοτομίας στη σχέση ανάμεσα σε πληροφοριακά συστήματα και απόδοση των επιχειρήσεων.

- Εξετάζει εμπειρικά τα παραπάνω θέματα για τον κλάδο του Τουρισμού που είναι ιδιαιτέρως σημαντικός για την οικονομία της χώρας μας και του Ευρωπαϊκού Νότου γενικότερα.

- Εξετάζει και συγκρίνει τις παραπάνω σχέσεις για τον κλάδο του Τουρισμού για τις περιοχές τις Μεσογείου, της Κεντρικής Ευρώπης και της Σκανδιναβίας λαμβάνοντας υπόψη τις υπάρχουσες συζητήσεις για την διαφορά στην οικονομική απόδοση ανάμεσα σε Ευρωπαϊκό Νότο και Μεσόγειο από τη μια και Κεντρική Ευρώπη και Σκανδιναβία από την άλλη.

Ευρήματα και συμπεράσματα

Τα κύρια ευρήματα και συμπεράσματα της διδακτορικής διατριβής μπορούν να συνοψιστούν στα ακόλουθα (τα οποία παρουσιάζονται λεπτομερώς στα επόμενα κεφάλαια):

- Τα εσωτερικά πληροφοριακά συστήματα, τα συστήματα ηλεκτρονικού επιχειρείν και το αυτοματοποιημένο σύστημα προμηθειών οδηγούν όλα σε καινοτομία.

- Τα εσωτερικά συστήματα έχουν μεγάλη επίδραση στην καινοτομία, τα συστήματα ηλεκτρονικού επιχειρείν μικρότερη και το αυτοματοποιημένο σύστημα προμηθειών πολύ μικρότερη. Επομένως οι ενθουσιώδεις προσδοκίες της σχετικής θεωρητικής βιβλιογραφίας ότι το ηλεκτρονικό επιχειρείν και το αυτοματοποιημένο σύστημα προμηθειών θα έχουν μια πολύ πιο ισχυρή και δραματική επίδραση στην καινοτομία από ότι τα «παραδοσιακά» εσωτερικά πληροφοριακά συστήματα δεν επιβεβαιώνονται.

- Τα εσωτερικά ΠΣ έχουν πολύ μεγάλη επίδραση στα ΤΠΕ οφέλη και στην απόδοση των επιχειρήσεων, ακολουθούν τα συστήματα του ηλεκτρονικού επιχειρείν, ενώ το αυτοματοποιημένο σύστημα προμηθειών έχει την μικρότερη επίδραση.

- Η επίδραση των εσωτερικών ΠΣ και των συστημάτων ηλεκτρονικού επιχειρείν στα ΤΠΕ οφέλη και διαμέσου αυτών στην απόδοση των επιχειρήσεων μερικώς διαμεσολαβείται από την καινοτομία. Όσον αφορά τα εσωτερικά ΠΣ ένα μικρότερο μέρος της επίδρασής τους στην απόδοση των επιχειρήσεων (41%) προέρχεται διαμέσου της καινοτομίας στην οποία οδηγούν, ενώ το μεγαλύτερο μέρος (59%) προέρχεται διαμέσου της αυτοματοποίησης των υπαρχουσών επιχειρησιακών διαδικασιών για τα υπάρχοντα προϊόντα/υπηρεσίες. Αντίθετα, το μεγαλύτερο μέρος της πολύ μικρότερης επίδρασης των συστημάτων ηλεκτρονικού επιχειρείν στην απόδοση των επιχειρήσεων προέρχεται διαμέσου της καινοτομίας στην οποία οδηγούν (63%) και ένα πολύ μικρότερο μέρος της (37%) είναι διαμέσου της αυτοματοποίησης των υπαρχουσών επιχειρησιακών διαδικασιών για τα υπάρχοντα προϊόντα/υπηρεσίες. Τέλος, η επίδραση του αυτοματοποιημένου συστήματος προμηθειών στην απόδοση των επιχειρήσεων προέρχεται όλη διαμέσου της καινοτομίας.

- Αναφορικά με την καινοτομία βρέθηκε ότι έχει θετική επίδραση στην απόδοση των επιχειρήσεων και η σχέση αυτή μερικώς διαμεσολαβείται από την αύξηση σε ΤΠΕ οφέλη που αυτή προκαλεί.

Ειδικότερα για τον κλάδο του Τουρισμού βρέθηκε ότι:

- Γενικά, τα εκτιμώμενα μοντέλα για τον τομέα του τουρισμού οδηγούν σε παρόμοια συμπεράσματα με αυτά του γενικού μοντέλου. Παρείχαν αποδείξεις θετικής επίδρασης των εσωτερικών ΠΣ, των συστημάτων ηλεκτρονικού

επιχειρείν και του αυτοματοποιημένου συστήματος προμηθειών στην καινοτομία, με τα εσωτερικά ΠΣ να έχουν την μεγαλύτερη επίδραση στην καινοτομία, ακολουθούμενα από αυτά του ηλεκτρονικού επιχειρείν και του αυτοματοποιημένου συστήματος προμηθειών.

▪ Η επίδραση των εσωτερικών ΠΣ, των ΠΣ ηλεκτρονικού επιχειρείν και του αυτοματοποιημένου συστήματος προμηθειών στα οφέλη που οι τουριστικές επιχειρήσεις αποκτούν από την υποδομή τους σε ΤΠΕ, διαμεσολαβείται από την καινοτομία (μερικώς για τα δύο πρώτα και εξολοκλήρου για το τρίτο).

▪ Η μόνη διαφορά σε σύγκριση με το γενικό μοντέλο είναι ότι στο εκτιμώμενο μοντέλο για τον τομέα του τουρισμού ο διαμεσολαβητικός ρόλος της καινοτομίας στην επίδραση των εσωτερικών ΠΣ και των συστημάτων ηλεκτρονικού επιχειρείν στην απόδοση των επιχειρήσεων είναι πιο αδύναμος (17% και 27% αντίστοιχα, αντί 39% και 63% για το γενικό μοντέλο)

▪ Η σύγκριση ανάμεσα στις περιοχές της Μεσογείου, της Κεντρικής Ευρώπης και της Σκανδιναβίας για τον τομέα του τουρισμού έδειξαν πως η πρώτη χαρακτηρίζεται από υψηλότερα επίπεδα καινοτομίας, μεγαλύτερα επιχειρηματικά οφέλη από τη χρήση ΤΠΕ και μεγαλύτερο επίπεδο χρήσης μερικών σημαντικών εσωτερικών εφαρμογών (ERP, διαμοιρασμός αρχείων, εφαρμογές για συνεργασία) σε σχέση με τις τουριστικές επιχειρήσεις της Κεντρικής Ευρώπης και τις Σκανδιναβίας.

▪ Η επίδραση της καινοτομίας στην απόδοση των επιχειρήσεων είναι μεγαλύτερη στον Μεσογειακό τουριστικό τομέα σε σχέση με την Κεντρική Ευρώπη και την Σκανδιναβία. Αντίθετα, η επίδραση της χρήσης εσωτερικών ΠΣ στα ΤΠΕ οφέλη είναι μικρότερη για τις τουριστικές επιχειρήσεις της Μεσογείου σε σχέση με την Κεντρική Ευρώπη και τη Σκανδιναβία, κάτι το οποίο σημαίνει ότι οι τελευταίες κάνουν πιο αποτελεσματική χρήση των εσωτερικών ΠΣ σε σχέση με την πρώτη.

Chapter 1

Introduction

1.1 The problem

Information and communication technologies (ICT) are increasingly adopted and used by organizations for supporting their internal functions and their interactions with their external environment (e.g. customers, suppliers, business partners, public authorities, business partners, etc.). Organizations make big investments for developing various types of information systems (IS) and gradually rely to a considerable extent on them. According to OECD (2003) the investment in ICT in its member countries has risen from less than 15% of the total non-residential investment in the early 1980s, to between 15% and 30% in 2001 and has an increasing trend. Irani et al (2006) in the Introduction to the AMCIS 2007 Mini-Track on Information Systems Evaluation emphasizes that '..ICT is becoming more pervasive and central to the success of an organization. As ICT becomes more and more embedded within the organization, so the survival and growth of the organization becomes more dependent on the health of its ICT infrastructure'. In the same direction Gunasekaran et al (2006) argues that 'Information technology has spread to the extent that it is hard to envision any organization in an industrialized nation, and even in a developing nation, not using some form of IT/IS'. Therefore, a critical issue that is posed to both researchers and practitioners is to understand and assess the multiple dimensions of the value generated by these ICT investments and also to find ways of increasing and optimizing it, and also to identify and analyze moderators and mediators of the relationships between ICT and various aspects of business performance.

In addition to the above 'generic' firm level ICT business value research, recently there is a growing research interest in investigating the business value generated by particular types of IS, such as e-business systems (Zhu 2004, Zhu & Kraemer 2005, Soto-Acosta & Merono-Cerdan 2008), Enterprise Resource Planning (ERP) systems (Poston and Grabski 2001, Hunton et al 2003, Nicolaou 2004, Hendricks et al. 2006), etc. This trend is well founded on the previous IS literature, which has been emphasizing for long time (e.g. Farbey 1995) that different types of IS have different objectives and impacts, so they differ in the nature and the extent of the business benefits and the value they generate. It is therefore important to investigate the impacts of various types of IS on a wide range of aspects of business performance, and also the moderators and mediators of these relationships.

1.2 Motivation

Taking into account the literature review we conducted in the above areas, which is presented in the following chapters and the main motivations for conducting the present research, as mentioned in the previous section there is a need to investigate the impacts of various types of IS on business performance, and also the moderators and mediators of these relationships. One of the factors that have been discussed among both researchers and practitioners as possible mediator of the relationships between IS and business performance is innovation (e.g. Antonelli et al 2000, Bresnahan 2003, Hempell 2005).

There is a considerable theoretical background advocating the affordance of ICT to act as catalysts and enablers of important innovations (e.g. Bresnahan & Trajtenberg 1995, Antonelli et al 2000, Bresnahan et al. 2002, Bresnahan 2003). This theoretical literature initially focused on the internal IS, but later expanded into other types of IS, such as e-business. Considerable theoretical literature has been developed concerning the potential of e-business to drive radical innovations in the business models, value propositions, products, and services of firms, and also in their internal business processes, which can result in significant increases of business performance (Timmers 1998, Afuah and Tucci 2001, Amit and Zott 2001, Zwass 2003, Jackson and Harris 2003, Wu and Hisa 2004, Tavlaki and Loukis 2005, Wu and Hisa 2008).

However, the above expectations and arguments of the literature have not been sufficiently investigated empirically using large data sets. It is therefore important to examine to what extent these high expectations are realized in 'real life': to what extent various types of IS (both 'traditional' and 'new') drive innovations in firms, and what part of their impact on business performance is through innovation. This should be examined in various different sectoral and national contexts.

1.3 Aims of the study and research objectives

The current PhD dissertation aims to address this abovementioned fundamental question: to investigate and compare the impacts of three fundamental types IS, the internal IS, the e-procurement IS, and the e-business IS, on innovation, and what part of their impact on business performance is through innovation.

The particular research questions that the present study attempts to address are:

1. What is the impact of internal IS, e-business and e-procurement on innovation?

2. What is the role of innovation in the relationships between internal, e-business and e-procurement IS on one hand and business performance on the other?

3. Investigate the above research questions in the tourism sector, which is particularly important for the economy of our country and the European South in general.

4. Are there any similarities and/or differences in the above variables and the relations about them between the Mediterranean region on one hand (which in general faces problems of lower economic productivity and competitiveness in comparison to the European North, which have currently severe political consequences), and Central Europe and Scandinavian region on the other?

For addressing the above four questions, a three level empirical study is conducted, which investigates the relations between the following variables: the exploitation level of these three types of IS (at a first level of analysis); the innovation activity (which represents one of the most widely discussed intermediate mechanisms enabling the ICT impact on business performance (e.g. Antonelli et al 2000, Bresnahan 2003, Hempell 2005)); the resulting ICT business benefits (at a second level); and finally, the impact of the previous constructs and processes on the aggregate business performance (at a third level).

1.4 Contribution

The present PhD Dissertation makes the following contributions to the existing literature:

- It presents an empirical investigation of the relations between three different widely adopted types of IS, the internal, the e-business and the e-procurement IS (at a first level), the level of innovation and the business benefits obtained from ICT (at a second level), and finally business performance (at a third level). It examines and compares these three fundamental IS types as to their impact on innovation, on the benefits provided to the firm by its ICT infrastructure, and finally on business performance.

- It examines empirically to what extent the effect of these three types of IS on business performance is through the innovation they drive, and to what extent the enthusiastic expectations of the relevant theoretical literature are empirically

confirmed. It examines in general the mediating effect of innovation in the relation between IS and business performance.

- It investigates empirically the above issues for the tourism sector, which is particularly important for the economy of our country and the European South in general.

- It examines and compares the above mentioned relations in the Mediterranean, Central European and Scandinavian region, taking into account the existing current debate for the economic performance differences between the European South, Mediterranean region on the one hand and the Central Europe and Scandinavian on the other.

Based on the contributions and results of this Dissertation, the following publications have been made or are currently prepared:

Journal papers

- Euripidis Loukis, **Fotini Michailidou**, "Intra-organizational and E-Business Systems, Innovation and Business Performance-An Empirical Investigation", Industrial Data and Management Systems (under preparation).

Conference Papers

- Euripidis Loukis, **Fotini Michailidou**, Anthi Sergi (2008), "Towards a Theory of ERP Systems Firm-Level Value", European and Mediterranean Conference on Information Systems (EMCIS) 2008, Dubai.

- **Fotini Michailidou,** Euripidis Loukis, Anthi Sergi (2006), "ERP Systems Business Value: A Critical Review of Empirical Literature", Panhellenic Conference on Informatics (PCI) 2008, Samos Island, Greece.

- Euripidis Loukis, Sigala Marianna, **Fotini Michailidou** (2009)**,** "Internal and E-sales Information Systems: Impact on Innovation and Business Performance in the Tourism Sector", Mediterranean Conference on Information Systems (MCIS) 2009, Athens, Greece.

- Euripidis Loukis, **Fotini Michailidou** (2012), "ERP and E-Business Systems Development, Innovation and Business Performance-An Empirical Investigation", Hawaiian International Conference on System Sciences (HICSS) 2012, Hawaii.

1.5 Structure of the Dissertation

This introductory chapter is followed by chapter 2 reviewing the existing relevant literature regarding the effects of ICT in general, intra-organizational IS, ERP systems, e-business systems, e-procurement systems on business performance and innovation.

In chapter 3 the research methodology and data collection process of this empirical study are described. The main tools that have been used for data analysis (such as Structural Equation Modeling (SEM)) are described.

Chapter 4 examines empirically the mediating effect of innovation in the relation among three types of IS (internal, e-procurement, e-business) and business performance, while chapter 5 empirically investigates the same network of relations for the Tourism sector.

In the next chapter 6 the above relationship is compared among three different regions: Mediterranean, Central Europe and Scandinavian, in order to shed light on the role of national context on these effects.

Finally, chapter 7 summarizes the conclusions drawn in this Dissertation.

CHAPTER 2

Literature Review

2.1 The impact of ICT on business performance

Extensive research has been conducted concerning the impact of ICT on business performance, and ICT business value in general, aiming mainly at the assessment and deeper understanding of the multiple dimensions of ICT business value at the firm, sector and national economy level and also their main determinants. Most of the above research has focused on the firm level, since it is at this level that most of the ICT investment decisions are made. This firm level ICT business value research can be broadly divided into four periods:

I. In the first period (from the mid 1980s until the mid 1990s) the main objective has been to find empirical evidence of a positive association between ICT investment and business performance. However, in this period very little empirical evidence were found in this direction (e.g. Roach 1987, Brynjolfsson 1993, Strassman 1997), 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). This lack of association between ICT investment and business performance can be explained by the following factors a) mis-measurement of outputs (Kaplan and Norton 2001) and inputs, b) lags due to learning and adjustment, c) redistribution and dissipation of profits, d) mismanagement of information and technology (Brynjolfsson 1993, Brynjolfsson and Yang 1996).

II. In the second period (from the mid 1990s until mainly the mid 2000s) there are many studies providing empirical evidence of positive impact of ICT investment on some 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 processes 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

the external context of the adopting organization, have to be taken into account as well. During this period considerable research has also been conducted for understanding better the main dimensions of ICT business value and for identifying the main organizational variables affected by ICT at the operational, tactical and strategic level (e.g. labor 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, the research focuses mainly on the identification and deeper understanding of the 'ICT complements' – moderators and also mediators in the relationship between ICT and business performance. Through the first 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 2008a). As mediators are meant factors through which ICT affect business performance.

IV. In the fourth period (from 2005 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, sectoral context, national context, etc., on ICT business value (Loukis et al 2006, Melville et al 2007, Loukis et al 2008b).

2.2 The impact of intra-organizational IS on business performance

Several empirical studies have been conducted concerning the impact of intra-organizational (internal) IS on firm performance with mixed results. Some of these studies provide evidence of positive impact of internal IS on some business performance measures (e.g. Brynjolfsson and Hitt 1996, Lucas 1999, Weber 1988, Venkatesh 2000, Gill 1996), however some other studies did not find a statistically significant effect on the same or other organizational measures (e.g.Cragg dan King 1992, Raymond et al. 1995, Millman and Hartwick 1987), which indicates that there are some other variables that

affect this impact. Shin (2001) argued that IT is an essential tool, but not sufficient by itself, to be truly effective. Rather, IT needs to be coupled with other factors such as: business strategy (Cragg et al. 2002), organizational learning (Tippins and Sohi 2003), worker quality and quality strategy (Gargallo-Castel and Galve-Górriz 2012) and others to have an impact on performance.

Recently, a growing number of IS researchers use the resource based view of the firm as a way to examine the ''productivity paradox'' regarding the impact of internal IS on firm performance (Feeny and Ives 1990, Clemons and Row 1991, Mata et al 1995, Powell and Dent-Micallef 1997, Lado and Zhang 1998, Bharadwaj 2000, Byrd 2001, Sambamurthy et al 2003, Zhu and Kraemer 2005). One important insight generated from this research is that competitive advantage from IS investments may occur from their influence on value-creating, firm-specific and hard-to-copy resources and capabilities (Feeny and Ives 1990, Clemons and Row 1991, Lado and Zhang 1998, Bharadwaj 2000, Byrd 2001, Sambamurthy et al. 2003). Barua et al (2004) relying on the resource-based view of the firm, proposed a model positing that a firm's abilities to coordinate and exploit firm resources (processes, information technology, and readiness of customers and suppliers) create online informational capabilities (a higher order resource) which then leads to improved operational and financial performance.

Another research stream in the same subject tries to explain ''productivity paradox'' through of the identification of intermediate variables between investments in internal IS and organizational performance, such as variables associated with IT capabilities, IT infrastructure, human IT resources, and IT-enabled intangibles (Bharadwaj 2000, Huan et al. 2006). Bulchand-Gidumal and Melian-Gonzalez (2011) divides IT resources into human and physical (technological), which are combined and organized in a manner that generates IT impact on the organization by developing IT applications, providing IT training and support to users, and guaranteeing the existence of secure and reliable IT systems and communications. In turn, this impact has positive effects on organizational performance.

Furthermore, there is another research stream consisting of studies that try to explain the firms' productivity acceleration that was observed from 1996 to 2000 and from 2001 to 2003 (Gordon 2004, Jorgenson et al. 2008, Brynjolfsson and Saunders 2010) based on ICT. The first surge was led by ICT investment and productivity improvements in ICT producing firms and the second surge was driven by innovations in both products and

processes in the industries that are the most intensive users of IT (Brynjolfsson and Saunders 2010).

Recently there is a growing research interest in the business value generated by particular types of IS, such as Enterprise Resource Planning (ERP) systems, e-business systems etc.

2.2.1 The impact of ERP on business performance

In Table 2.1 we can see the main empirical studies that have been conducted concerning the business value of the ERP systems and their basic conclusions; these studies have examined the impact of ERP adoption on various financial and non-financial measures of organizational performance.

Authors	Conclusion
Poston & Grabski (2001)	• number of employees/revenues and cost of goods sold/revenues decreased • selling, general and administrative expenses/revenues and residual income show no significant improvement
Hitt et al (2002)	• firms that invest in ERP tend to show higher business performance in several financial performance indices • a reduction in business performance and productivity appears shortly after the ERP implementation was completed
Hunton et al (2003)	• ROA, ROI and ATO significantly better for the ERP adopters in comparison with similar non-adopters • financial performance of ERP adopters is steady, while at the same time non-adopters' financial performance decreases
Akkermans et al (2003)	• ERP systems will play only a modest role in improving future supply chain effectiveness • there is a positive contribution of ERP to only 4 of the top 12 future supply chain issues: customization of

	products and services; standardized processes and information; need for worldwide ICT systems; transparency of the marketplace • possible risk of ERP actually limiting progress in SCM
Nicolaou (2004)	• firms adopting ERP systems exhibit higher differential performance only after two years of continued ERP use • in the year of completion and in the following one there is a negative differential impact on performance
Nicolaou & Bhattacharya (2006)	• early enhancements (in the form of either add-ons or upgrades) lead to higher differential financial performance • late enhancements and both early and late abandonments lead to differential performance deterioration
Hendricks et al (2006)	• ERP adopters: improvement in profitability but not in stock returns • SCM adopters: improvement in profitability and positive stock returns • CRM adopters: no improvements in profitability or in stock returns
Wieder et al (2006)	• no significant performance differences were found between ERP adopters and non-adopters, either at the business process level, or at the overall firm level • only those ERP system adopters that also adopted SCM systems achieved significantly higher performance.
Wier et al (2007)	• the combined use of ERP and NFPI leads to significantly higher short-term and long-term ROA and SR than the use of each of them alone (in ERP-only or NFPI-only firms)

Table 2.1.   Empirical investigations of the impact of ERP adoption on various financial and non-financial measures of organizational performance.

In the first of these studies Poston & Grabski (2001) examined the effect of ERP systems on firm financial performance over a 3-year period by comparing basic financial performance indices of 50 ERP adopters before ERP implementation and for a period of three years after it. The results show a statistically significant decrease only in the ratio of cost of goods sold (COGS) to revenues three years after the ERP system implementation (but not in the first or second year after implementation). On the other hand they found no significant improvement in the ratio of selling, general and administrative expenses (SG&A) to revenues and also in the residual income. Also there has been a significant reduction in the ratio of employees to revenues for each of the three years after the ERP implement. Finally the authors note that the results reveal a contradiction: while ERP systems appear to yield efficiency gains in some areas, e.g. in reducing cost-to-revenue, they leave residual income unaffected; also they propose some possible explanations of this contradiction (e.g. high costs for fine-tuning and running the ERP, organizational culture, human issues, passing some of the gains to customers as an increased customers surplus due to competition, etc.) and suggest that 'future research is needed to clarify and examine the multitude of factors affecting the ERP and firm performance relationship'.

Hitt et al (2002) using multiyear multi-firm ERP implementation and financial data concluded that firms investing in ERP tend to show higher values in several financial performance indices, though there is a slowdown in business performance and productivity shortly after the implementation. Concerning stock value they found that financial markets reward the ERP adopters with higher market valuation, as measured by Tobin's q, both during and after the ERP implementation. These results suggest that ERP systems yield substantial benefits to the firms adopting them, and that the adoption risks do not exceed the expected value, although there is some evidence suggesting that firms do perceive ERP projects to be risky. Another interesting conclusion is that higher level of ERP implementation (i.e. implementation of more ERP modules) is associated with higher business performance, but only up to an optimal level, while exceeding this level results in declining benefits; this provides some evidence that there is an optimal level of integration and that the broadest ERP implementation can face diseconomies of scale.

Hunton et al (2003) examined the longitudinal impact of ERP adoption on financial firm performance by matching and comparing 62 firms that have adopted ERP systems with 'similar' firms that had not adopted ERP systems. Results indicated in three of the examined financial performance indices, return on assets (ROA), return on investment (ROI), and asset turnover (ATO), adopters were significantly better over a 3-year period as compared to the non-adopters, while for the fourth one, the return on sales (ROS), there was no statistically significant difference. Also, they found that the above three significant differences arise because the financial performance decreased over time for the non − adopters, while it remained steady for the adopters. Another interesting finding of this study was a significant interaction between firm size and financial health for ERP adopters with respect to ROA, ROI, and ROS: a positive (negative) relationship was found between financial health and performance for small (large) firms.

Akkermans et al. (2003) presented results from a Delphi study on the future impact of ERP systems on supply chain management (SCM), which was conducted with 23 Dutch supply chain executives of European multi-nationals. Initially these executives identified the following five key SCM issues for the coming years: 1) higher integration of activities between suppliers and customers across the entire supply chain, 2) changes in supply chain needs and required flexibility from IT, 3) more mass customization of products and services leading to increasing assortments while decreasing cycle times and inventories, 4) the locus of the driver's seat of the entire supply chain and 5) bigger supply chains consisting of several independent enterprises. A second finding was that with regard to ERP systems the panel experts saw only a modest role for ERP in improving future supply chain effectiveness and a clear risk of ERP actually limiting progress in SCM. ERP was seen as offering a positive contribution to only 4 of the top 12 future supply chain issues: more customization of products and services; more standardized processes and information; the need for worldwide ICT systems; and greater transparency of the marketplace. A third interesting finding was that there are four characteristics of current ERP systems that limit the inter-organizational SCM support they can provide: a) their insufficient extended enterprise functionality in crossing organizational boundaries, b) their inflexibility to ever-changing supply chain needs, c) their lack of functionality beyond managing transactions, and (d) their closed and non-modular system architecture. These limitations are due to the fact that the first generation of ERP systems had been

designed to integrate the various operations within an individual firm but not between firms.

Investigating the effect of the adoption of ERP systems on a firm's long-term financial performance Nicolaou (2004) compares financial data of 247 firms adopting ERP systems with a matched control group of 'similar' (concerning industry and size) non-adopting firms before and after the adoption. The results show that firms adopting enterprise systems exhibit higher differential financial performance (i.e. in comparison with 'similar' non-adopter firms) only after two years of continued ERP use, while in the year of completion and the following one there is a decline of the differential financial performance. Another interesting finding of this study is that some ERP implementation characteristics affect its positive impact: implementing a system from a larger vendor, having system-led objectives, and implementing some particular types of modules increase the positive impact of ERP systems on financial performance in comparison to firms following different implementation strategies.

Nicolaou & Bhattacharya (2006) two years later examined the effects of various types of ERP system post-implementation changes (e.g. enhancements, upgrades, abandonments, switches) in firms that have adopted ERP systems on the impact of ERP on long-term financial performance. Two research hypotheses were developed in this study, which posit that both the nature and the timing of system changes affect the extent of ERP post – implementation success. The empirical testing of these hypotheses, based on a subset of the sample of the above study of Nicolaou (2004) that had made such changes, provided support to both these hypotheses: ERP-adopting firms, which initiate early enhancements in the form of either add-ons or upgrades, exhibit higher differential financial performance in comparison to other ERP-adopting firms' differential performance. These changes seem valuable, because they resolve implementation problems based on the experience gained during the first period of usage, and affect positively the subsequent level of ERP success. This finding shows the importance of post-implementation ERP management and leads to the conclusion that a significant part of value adding occurs in on-going activities that closely follow the period of the 'basic' ERP implementation. On the contrary it was found that late enhancements and both early and late abandonments lead to differential performance deterioration in comparison to other ERP-adopting firms.

The effect of firms' investments in three types of Enterprise Systems (ES), Enterprise Resource Planning (ERP) systems, Supply Chain Management (SCM) systems, and Customer Relationship Management (CRM) systems, on long-term stock price performance and various profitability measures, such as return on assets and return on sales, has been empirically examined by Hendricks et al. (2006). The conclusions are summarized by the authors in the final section of the paper stating that 'Our analysis of the financial benefits of ES implementations yields mixed results'. Their results provide evidence that the adoption of ERP systems leads to significant improvements in the profitability, which are stronger in the case of early adopters of ERP systems, but not in increases of the stock returns. Also, the adopters of SCM systems experience positive abnormal stock returns as well as improvements in profitability. On the contrary, there was no evidence of improvements in stock returns or profitability for firms that have invested in CRM systems. Another interesting finding of this study is that, despite the high implementation costs, it does not find evidence of negative performance associated with ES investments, which helps alleviate the concerns expressed about the viability of ES given the highly publicized implementation problems at some firms.

The empirical study of Wieder et al. (2006) provides further insights into the effects of ERP systems adoption on firm level and business process level performance. It was based on data on several aspects of organizational performance collected through a survey from companies that adopted ERP systems and/or SCM systems and respective control groups on non-adopters. Its theoretical foundation was the generic framework suggested by Dehning and Richardson (2002). The overall firm performance has been measured through a set of basic financial key performance indicators; the measurement of performance at the business process level was based on the 'supply-chain operations reference model' (SCOR-model) published by the Supply Chain Council (www.supply-chain.org). As independent variables were used ERP systems adoption, ERP systems history and ERP system extension with a SCM system. The results contradict the claims of ERP systems vendors, since no significant performance differences were found between ERP adopters and non-adopters, either at the business process level, or at the overall firm level. It was also found that the longer the experience of firms with ERP systems, the higher their overall performance, though no evidence was found of a similar effect on business process (supply chain) performance. Only those ERP systems adopters

that extended ERP with SCM systems achieved significantly higher performance only at the business process level, but not at the firm level.

Wier et al (2007) investigated empirically the existence of complementarity between ERP systems adoption and non-financial performance indicators (NFPI) in executive compensation contracts in regard to business performance. In particular, they examined whether the joint adoption of an ERP system and the inclusion of non-financial performance indicators (NFPI) in executive compensation contracts significantly enhance business performance, which is measured by the return on assets (ROA) and the return on stocks (ROS), as compared to either of them alone. For this purpose they used a sample consisting of three types of firms: ERP-only, NFPI-only and ERP-NFPI ones. The results support the above complementarity hypothesis: they indicate that the combined use of ERP and NFPI leads to significantly higher short-term and long-term ROA and ROS compared with the use of each of them alone (in the ERP-only or the NFPI-only firms). From these results it can be concluded that ERP and NFPI are complementary organizational strategies, so the impact of ERP on business performance can be increased if it is combined with NFPI.

The conclusions drawn from these studies concerning the impact of ERP systems on organizational performance are mixed: most of these studies provide evidence of positive impact of EPR systems on some measures of organizational performance; however, some other studies did not find a statistically significant effect of ERP systems on the same or other measures of organizational performance, which indicates that the existence of additional variables that affect this relationship.

2.2.2 CFS in ERP systems implementation

Considerable research has been conducted for identifying the critical success factors (CFS) of ERP systems implementation motivated by the big difficulties, problems and risks experienced by firms implementing ERP systems. This research is related to the above research stream on the business value generated by the ERP systems outlined in the previous section, since it identifies and investigates factors and actions, which can increase the business value that ERP systems generate. Detailed reviews of the articles that have been published concerning ERP implementation CFSs are provided by Shehab

et al (2004), Botta-Genoulaz et al (2005) and Moon (2007). In the following paragraphs of this section we review the most important of them.

Cantu (1999) created an ERP implementation framework including five CSF, which are further analyzed into attributes, resulting in the identification of a total of 22 attributes that result in more successful ERP implementations. In particular the proposed CFS and their attributes (in parentheses) are:

- Management and Organization (Commitment, Education, Involvement, Project Team Selection, Training, Roles and Responsibility),
- Process (Alignment, Documentation, Integration, Process Redesign), Technology (Hardware, Software, Systems Management, Interface),
- Data (Master Files, Transaction Files, Data Structure, Maintenance and Integrity),
- People (Education, Training, Skills development, Knowledge management).

Nah (2001), by synthesizing the findings of a number of articles on the key critical factors for ERP implementation success, developed a unified framework, which includes the following eleven basic CSF: ERP teamwork and composition, Change management program and culture, Top management support, Business plan and vision, Effective communications, Project management, Software development, testing and trouble shooting, Monitoring and evaluation of performance, Project champion and Appropriate business and IT legacy systems.

Brown and Vessey (2003), based on in-depth case studies of ERP implementations, identified five basic CFS:

- Top management is engaged, not just involved
- Project leaders are veterans and team members are decision makers
- Third parties fill gaps in expertise and transfer their knowledge
- Change management goes hand-in-hand with project management
- A satisficing mindset, in which 80 per cent solutions are accepted as 'good enough', prevails.

Furthermore, they concluded that a project's position on the maturity curve (early adopter, early majority, or late majority) can significantly influence the implementation route.

According to Umble & Umble (2003) the most prominent CFS for ERP implementation are: clear understanding of strategic goals, commitment by top

management, good project management, organizational change management, good implementation team, data accuracy, extensive education and training, focused performance measures and appropriate management of multi – site issues.

Bradley (2005) examined the most important CSF proposed in the IT and ERP literature in a multiple case study of eight ERP implementation projects and identified three basic factors related to successful project but not to unsuccessful projects:

- Choosing the right project manager
- Quantity and quality of training
- Project champions

Esteves and Pastor (2000 and 2006) based on lists of CFS of ERP implementations produced by previous relevant studies and created a unified model of CSF. This model included the following CFS grouped according to their organizational or technological nature and their strategic or tactical orientation into four categories:

I. Strategic – Organizational factors: Sustained management support, Effective organizational change management, Good project scope management, Adequate project team composition, Comprehensive business process reengineering, Adequate project champion role, User involvement and participation, Trust between partners.

II. Tactical - Organizational factors: Dedicated staff and consultants, Strong communication inwards and outwards, Formalized project plan/schedule, Adequate training program, Preventive trouble shooting, Appropriate usage of consultants, Empowered decision-makers.

III. Strategic - Technological factors: Adequate ERP implementation strategy, Avoid customization, Adequate ERP version.

IV. Tactical – Technological: Adequate infrastructure and interfaces, Legacy systems knowledge, Formalized testing plan, Adequate data migration process.

These two studies also concluded that while both the organizational and the technological perspectives are essential for a successful ERP implementation project, their importance shifts as the project moves through its lifecycle: in the early and the final phases the organizational CSF are more important, while in the intermediate phases the technological CSF prevail; for this reason ERP project management is highly complex as it involves a dynamic 'multi-success-factor management' and the most relevant CSF may change significantly along the project.

In conclusion, this category of studies of the CSF of ERP implementation have identified a useful set of factors and corresponding actions, which can increase the business value that ERP systems generate for the adopting organizations.

As mentioned earlier, the empirical studies that have been conducted concerning the impact of ERP systems on business performance have resulted in mixed conclusions: some of these studies provided evidence of positive impact of EPR systems on some measures of business performance, however, some other studies did not find a statistically significant effect of ERP systems on the same or other measures of business performance. For explaining these mixed results the knowledge gained from these four periods of the ICT business value research can be useful. Based on this knowledge, possible explanations of these mixed results are:

I.   The ERP stakeholders (ERP vendors, consultants and adopting organizations) have not yet reached a high level of expertise and maturity in implementing ERP systems, adapting them to the processes and needs of a particular organization and redesigning accordingly its business processes; there are still big differences in this expertise and maturity between different ERP vendors, consultants, adopting organizations, regions and industries.

II. In the models, which have been constructed in the studies that have been conducted for investigating the association between various business performance measures (used as dependent variables) and ERP adoption (used as independent variable), some important independent variables have not been taken into account; these variables correspond to significant 'success factors', which are associated with the internal context, the implementation strategy and the external context of the adopting organization, that affect ERP implementation success and benefits; some of these factors have been identified by the research that has been conducted concerning the CFS of ERP implementation.

However, it should be noted that the existing situation of the ERP systems value research has also some elements similar to the ones found in the third period of the ICT business value research: the above CFS of ERP implementation are – to some extent - analogous to the 'ICT complements' (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.) identified and investigated in the third period of the ICT business value research. However, the difference is that these CFS of ERP implementation have not been sufficiently associated by the relevant empirical literature with the impact of ERP on organizational performance. On the contrary the above ICT complements have been very well associated with ICT business value by the relevant empirical literature, which has investigated whether and to what extent the presence of these ICT complements affects ICT business value (e.g. Devaraj & Kohli 2000, Arvanitis 2005a, Hempell 2005, Loukis et al 2008b).

2.3   The impact of e-business on business performance

There have been some studies concerning the impact of e-business adoption on various non-financial (Devaraj et al 2007, Sanders 2007, Soto-Acosta and Meroño-Cerdan 2008, Soto-Acosta et al.2010, Zhu and Kraemer 2005) and financial measures of business performance (Zhu and Kraemer 2002, Barua et al 2004, Johnson et al 2007, Meroño-Cerdan and Soto-Acosta 2007, Quan 2008). These studies have produced considerable evidence that e-business has a positive impact on various financial and non-financial measures of business performance. Also, they have identified a number of mediating factors in this relationship, such as the development of internal and external e-business capabilities, the digitization of business activities with customers and suppliers, etc.

This positive impact can be explained taking into account that the Internet enables information provision with high reach and richness (Evans and Wruster, 1999) and connects firms to consumers or potential consumers in geographic areas that would be costly to reach otherwise (Steinfield and Whitten 1999). Also, virtual communities enable frequent interactions with customers on a wide range of topics and thereby create a loyalty and enhance transaction frequency (Amit and Zott, 2001). These can result in increasing sales and number of customers. At the same time, e-business allows innovation in the way firms do business (new business models) and also in their products and services (earlier described in more detail), which may again influence sales and number of customers. In addition, selling online can provide value through the automation of the sales processes, which reduces overall load on staff supporting the customer and allows staff to focus on more complex tasks or on exceptions instead of routine tasks.

Initially we review the empirical literature concerning the impact of e-business adoption on various non-financial measures of business performance. Wu et al (2003) empirically examined the impact of e-business adoption intensity on non-financial measures (efficiency, sales performance, customer satisfaction, relationship development) of business performance by using data of 144 firms. They found that supplier and customer communication positively influenced performance outcomes, while e-procurement and online order taking did not. Zhu and Kraemer (2005) empirically examined e-business use impact on sales, internal operation and procurement and found that firms with greater e-business use are more likely to generate e-business value. Sanders (2007) used a sample of 245 large manufacturing firms to test the relation between e-business use and organizational performance including organizational collaboration as a mediator and found that e-business impacts performance both directly and indirectly by promoting organizational collaboration. The non-financial measures of organizational performance that he used were: cost improvement, product quality improvement, new product introduction time and delivery speed improvement. Kayabaşi and Gümüş (2012) based on Sanders' (2007) model examined the same relationships for Turkey's manufacturing firms (using 3 non-financial measures of business performance and 1 financial) and found that e-business impacts performance only indirectly by promoting organizational collaboration. Devaraj et al (2007) found that there is a relationship between e- business and supplier integration that leads to better performance. Abid et al. (2011) examined the benefits of e-business adoption by using data from 47 SME suppliers. They found that the most wanted and achieved benefit was customers' improved services. Similar conclusions have been drawn from the study of Mora-Mong et al. (2010), who empirically examined the impact of web-based electronic commerce use on organizational benefits and found a significant impact of the former on the latter. Harrigan et al. (2011) developed a research model in order to explore the relationships between generic internet technologies, eCRM capabilities, and the resulting performance benefits (improved market awareness, personalization of interactions, improved levels of customer service, increases in customer loyalty and sales, efficiencies in marketing and improved profitability). They used data from 286 SMEs from Ireland and found strong empirical evidence in support of the hypotheses regarding these benefits. Soto-Acosta and Meroño-Cerdan (2008) used data from 1010 firms and examined the relationships between Internet resources, e-business capabilities and e-business value, measured by

improvement of e-procurement effectiveness. They found that while Internet resources are not directly related to e-business value, they are critical for creating internal and external e-business capabilities, which are major drivers of e-business value.

Also, there is empirical literature investigating the impact of e-business adoption on various financial measures of business performance. The main measures of the financial performance of a company are: revenue growth and structure, costs' reduction and assets utilization. Kaplan and Norton (2001) suggested that when a company is in its growth phase, such as e-business companies, it is better to focus on revenue growth and structure, than on costs' reduction. Usually companies in this phase aren't profitable and thus profitability ratios are not appropriate to measure assets utilization. Instead other measures such as sales growth rates by products, market segments, revenue sources, investments to sales ratio, R&D expenditures to sales etc. are more appropriate because at this phase company's strategy must be oriented to the introduction of new products or services, the expansion of its capacities and the acquisition of new customers and markets.

Few empirical studies deal with the effect of e-business on objective measures of financial business performance. In this direction Konings and Roodhooft (2000) empirically studied the impact of e-business on financial firm performance based on a large data set of Belgian firms. They found positive effect of e-business on firm performance in large firms which were the most engaged in e-business. Barua et al. (2001) proposed an e-business value model which associated e-business drivers with operational excellence and financial performance and found that firms that succeeded better financial performance through e-business adoption had higher levels of operational excellence. Singh and Byrne (2005) tested the same model and found that Australian organizations managed to achieve some financial improvements from e-business although they were at an early stage of e-business adoption. Zhu and Kraemer (2002) examined the effect of e-commerce on firm performance in the manufacturing industry. They used financial measures of firm performance (sales per employee, gross margin, cost of goods sold, inventory turnover) and they concluded that e-commerce capability and IT infrastructure must be combined together in order to succeed higher levels of firm performance. Barua et al. (2004) examined the effect of information exchange capabilities with customers and suppliers on the level of digitization of business activities with them and finally on financial business performance. Four measures of financial performance

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were used: revenue per employee, gross profit margin, return on assets and return on investment. They used data from 1.076 firms in manufacturing, retail, wholesale and distribution and found that online information capabilities on customer side leads to improved financial performance. Johnson et al (2007) used case studies and survey data in order to examine how industry context, firm characteristics and firm-level strategic resources, such as purchasing teams, affect the exploitation of e-business technologies and the relationship between e-business technology use and firm performance. They concluded that only e-business technologies that are designed to reduce coordination costs can lead to improved financial performance. Meroño-Cerdan and Soto-Acosta (2007) found a positive relationship between external Web content and firm performance. They compared their model in two sectors: manufacturing and services industry and found that Web sites from service businesses had richer information.

In conclusion, previous empirical literature has produced considerable evidence that e-business has a positive impact on various measures of organizational performance, including both non-financial and financial measures. Also, it has revealed a number of mediating factors in the relationship between e-business and performance, such as intra-organizational and inter-organizational e-collaboration, internal and external e-business capabilities, information exchange capabilities and digitization of business activities with customers and suppliers. However, previous research has not investigated the mediating role of innovation in the relationship between e-business adoption and business performance.

2.4.   The impact of e-procurement on business performance

E-business has dramatically changed the ways in which firms interact with their suppliers (Phillips 2003). Furthermore, continuous improvements in Internet–related technologies and especially in internet connectivity provide an opportunity to make procurement for goods and services more transparent and efficient (Carayannis and Popescu 2005). E-procurement is not a single application but consists of many different tools. The most frequent mentioned forms in the relevant literature are: e-sourcing, e-tendering, e- informing, e-reverse auctions, e-MRO and web-based ERP (Knudsen 2003, Schoenherr and Tummala 2007). Hawking and Stein (2004) considered e-procurement as

a major driver in the extended supply chain except from being a strategic player in the value chain.

Over the last decade e-procurement turned up to be an integral part of the supply chain. It has changed the ways businesses purchase goods. Previous research has shown that e-procurement affects operational performance by offering a variety of benefits, (Croom and Johnston 2003, Hawking et al. 2004, Mukhopadhyay and Kekre 2002, Radovilsky and Hegde 2004) which include: reduction of purchasing transactions costs (Croom and Johnston 2003, Davila et al. 2003, Lin and Hsieh 2000, Radovilsky and Hegde 2004, Subramaniam and Shaw 2002), reduction in order fulfillment or purchasing cycle time (Davila et al. 2003, Lin and Hsieh 2000, Raghavan and Prabhu 2004, Radovilsky and Hegde 2004), reduction of the number of suppliers (Davila et al. 2003), increase in the number of products supplied by main suppliers (Muffatto and Payaro 2004), inventory savings (Subramaniam and Shaw 2002, Raghavan and Prabhu 2004), reduction in the price paid (Davila et al. 2003), reduction in administrative costs (Raghavan and Prabhu 2004), reduction of the number of staff purchase transactions (Davila et al. 2003), improved relationships with vendors, improved purchasing effectiveness and improved service (Panayiotou et al. 2004).

Piotrowicz and Irani (2010) classified e-procurement benefits according to their level (operational, tactical, strategic), area of impact, applying scorecard dimensions (customer, process, financial, learning and growth) and captured benefits' characteristics (tangible, intangible, financial and non-financial). They examined their taxonomy framework in four case studies and they concluded that while e- procurement affects organizational performance, in many cases the benefits are intangible and non-financial and thus traditional, accounting-based evaluation methods, such as ROI, are not able to capture them. (This is consistent with the conclusions of Brynjolfsson 1993, Brynjolfsson and Yang 1996, Kaplan and Norton 2001). Piotrowicz and Irani (2010) provided a comprehensive review of some other taxonomies less integrated and earlier than theirs, some of them are the followings: Croom's (2000) taxonomy, which distinguish e-procurement benefits in operational and strategic, Attaran's (2001) taxonomy of operational (e.g. more efficient purchasing), strategic (like organizational changes and market advantage) and opportunity benefits (such as improved relationships with existing suppliers and exploring relationships with new suppliers), De Boer's et al. (2002) taxonomy which suggests the categories of operational, tactical and strategic, direct and

indirect benefits, Bartezzaghi and Ronchi's (2003) taxonomy with market efficiency, process efficiency and effectiveness as benefits' categories.

Mukhopadhyay and Kekre (2002) classified the impact of e-procurement on business performance into three classes: direct operational, (based on transaction process improvement), direct strategic, (through sales increases), and long-term indirect strategic impact. Gunasekaran and Ngai (2008) noted impact of e-procurement on short and long-term organizational performance, cost-performance, competitiveness, alliances and networking. Phillips and Piotrowicz (2006) found that an alignment among business strategy, e-procurement strategy, e-procurement tool, strategic IT capability and strategic typology have a positive influence on a company's strategic performance. Gunasekaran et al. (2009) based on data from 39 companies examined the realized perceived benefits from e-procurement use and found that the greatest benefits had been realized were: improved relations with suppliers, increased customer service, increased customer satisfaction, better staff utilization, reduced costs, greater efficiency, and improved supply chain management. Croom and Brandon-Jones (2007) developed a model of the e-procurement effect. They found that e-procurement leads to reduction of the cost of acquiring goods and services, through improvements to the procurement system and price reductions through increased visibility, compliance, management information, demand aggregation, and increased leverage in negotiations. Tai et al. (2010) specified the operational and strategic impact of Web-based e-procurement on organizational performance. They found evidence of transaction cycle time and error rate reduction, integration of purchasing processes, reduction of inventory and supplier delivery time and better partnership between buyers and suppliers. Thompson and Kee-hung (2009) found that cost reduction due to e-procurement use was related positively to financial performance. Furthermore, internal efficiency has also a positive impact on financial performance through its relation with cost reduction. Chang and Wong (2010) empirically examined the effect of e-procurement adoption and the participation in e-marketplace on firm's performance. Their results showed that e-procurement adoption had a positive relationship on e-marketplace participation. E -procurement adoption enhanced the firm's competitive advantage by increasing procurement activity efficiency and serving customers efficiently. This in turn increased sales performance due to increased customer satisfaction.

2.5   The impact of ICT on innovation

2.5.1. Theoretical literature

There has been an extensive theoretical literature concerning the potential of ICT to act as catalysts and enablers of important innovations (e.g. Porter and Millar 1985, Hammer 1990, Hammer and Champy 1993, Davenport 1993, Bresnahan and Trajtenberg 1995, Antonelli et al 2000, Brynjolfsson and Hitt 2000, Bresnahan et al 2002, Bresnahan 2003, Orlikowski 1992, Orlikowski 2000, Champy 2002, Avgerou 2003, Lyytinen and Newman 2008). This research identifies a unique characteristic of ICT in comparison to the other technologies firms are using: ICT are 'general purpose technologies', characterized by high flexibility and adaptability, so they can be used in the whole economy in numerous different ways and for many purposes, and enable important innovations. For this reason ICT can change the way that human work is performed, measured, controlled and reported; also they enable significant restructuring of the work, in order to allocate routine, well-defined tasks associated with symbols processing to computers and separate and redesign tasks that require human skills; furthermore, ICT enable an individual worker to have all the required information for completing a bigger part of a process, so the existing fragmentation of many processes can be dramatically reduced resulting in large efficiency gains. This literature emphasizes 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 imposed by the manual mode of work at that times ; therefore, taking into account that modern ICTs can reduce dramatically both these costs and removed many of the limitations that the manual mode of work imposes with respect to time and place: co-operation between individuals is now possible from a distance and asynchronously through digital networks. Thus 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 increasing output quality, and subsequently by designing new products and improving important intangible aspects of existing products, such as convenience, timeliness, quality, personalization etc.

Davenport (1993) proposes nine basic modes of using ICT for making highly beneficial process innovations: automational, informational, sequential, tracking, analytical, geographical, integrative, intellectual and disintermediating. Champy (2002)

argues that ICTs can be of critical importance for improving dramatically not only the internal processes of firms, but also the processes of transaction and cooperation with their customers, suppliers and partners. However, a significant part of this theoretical literature (Orlikowski, 1992 and 2000; Avgerou, 2003; Lyytinen and Newman, 2008) warns that this innovation potential of ICT is to a considerable extent shaped by the context (social, organizational, national).

2.5.2 Empirical Literature

Several empirical studies have been conducted concerning the determinants of innovation at firm level; comprehensive reviews of them are provided by Cohen and Levin (1989), Cohen (1995), Kleinknecht (1996), Raymond et al. (2004), Wan et al. (2005), Van Beers et al (2008) and Buesa et al. (2010). From these studies it has been concluded that demand prospects, type and intensity of competition, market structure, factors affecting the production of knowledge (such as technological opportunities and appropriability) and firm size are the main determinants of firm's innovation activity.

However, limited empirical research has been conducted on the impact of ICT on innovation, despite the above extensive theoretical background outlined in the previous section, in order to find out to what extent the high expectations of this theoretical literature are realized. Bartel et al (2007) using data from valve manufacturing plants comes to the conclusion that plants adopting IT-enhanced equipment tend to shift their products range towards more customized valve products (which is considered as product innovation) and new IT embedded machines improved considerably production processes increasing their efficiency. Hempell & Zwick (2008), using data from 4.500 German firms, conclude that ICT investment and share of employees working mainly on a computer have a positive impact on functional flexibility and through it on product and process innovation, while ICT has a direct effect on both types of innovation as well. Engelstätter and Sarbu (2010) investigated the relationship between the use of sector-specific and customized software on service innovation using data from 335 German firms and concluded that primarily customized software contributes significantly to innovation. Ollo-Lopez and Muneta (2012) used data from 676 firms from glass, ceramics and cement concrete industry collected through the e-Business Watch Survey of 2009.

Their results showed that the use of some ICT favors innovation in firms, by the improvement and introduction of new processes and new products or services.

Also, it should be mentioned that there are some other empirical studies focusing on the investigation of the effect of innovation on the impact that ICT has on business performance (Licht & Moch 1997, Hempell et al 2004, Hempell 2005, Loukis et al 2008a); they conclude that the combination of ICT investment with innovations increases the contribution of the former to various measures of business performance.

Therefore, it can be concluded that there are only a limited number of empirical studies that have investigated directly the impact of ICT on innovation. Furthermore, this limited empirical literature i) does not examine and compare different types of ICT as to their capacity to drive innovation, though they differ in pervasiveness in the firm and influence on its processes, products and services, ii) does not test the above impact in different sectoral and national contexts, iii) it does not examine what part of the impact of ICT on business performance is through the innovation the former drives.

2.5.3 The impact of e-business on innovation

The emergence of the Internet gave rise to a new stream of theoretical literature concerning its innovative potential. This literature argues that Internet changes the ways and costs of firms' communication, collaboration and transaction with their customers, vendors and business partners, and for this reason can be enablers and drivers of radical innovations in business models, value propositions, products, services and business processes of firms, and which can offer substantial performance improvements (Timmers 1998, Tapscott et al. 2000, Afuah and Tucci 2001, Amit and Zott 2001, Applegate 2001, Zwass 2003, Lyytinen and Rose 2003, Wu and Hisa 2004, Rappa 2004, Tavlaki and Loukis 2005, Wu and Hisa 2008).

Timmers (1998) classifies the eleven generic e-business models he outlines, according to their degree of innovation and their functional integration. He argues that internet gives rise to new business models, and describes the most important of them: e-shop, e-procurement, e-auction, e-mall, third party marketplace, virtual community, value chain service provider, value chain integrator, collaboration platform, information brokerage and trust services.

Tapscott (2000) suggests a set of innovative business models based on the Internet,

called 'business webs', which "are inventing new value propositions, transforming the rules of competition and mobilizing people and resources to unprecedented levels of performance [...]. A b-web is a distinct system of suppliers, distributors, commerce services providers, and customers that use the Internet for their primary business communications and transactions». These business webs are classified in accordance to their level of integration and control of the value creation process into: agora, aggregator, alliance and value chain. Agora stands for self-organized electronic marketplaces with negotiable pricings in contrast to the more hierarchically organized aggregator. For business models of higher integration, Tapscott positioned the alliance as a self-organized value creating community while the value chain is the most hierarchical and highly integrated form of a distributed network.

Amit and Zott (2001), from a broad theoretical foundation concerning virtual markets, value chain analysis, Schumpeterian innovation, resource based view of the firm, strategic networks and transaction cost economics, proposed four dimensions of innovation and value creation in e-business: transaction efficiency, novelty, complementarities (between various products and services, on-line and off-line assets, activities) and customers lock-in.

Zwass (2003) argues that the WWW/Internet compound enables significant innovations in the way organizations arrange their business processes, address their marketplaces and partner with other organizations; also, he proposes a large number of innovation opportunities grouped in eleven categories associated with marketplace, universal supply-chain linkage, network of relationships, collaboration, use of forum, interactive media, goods and services delivery, anytime-anywhere connectivity, development platforms, universal telecommunications networks and computing utility.

Rappa (2004) identified and conceptualized a series of e-business models primarily from the perspective of revenue generation. The main categories of these models were: brokerage, advertising, infomediary, merchant, manufacturer, affiliate, community, subscription, utility.

Wu and Hisa (2004, 2008) categorize the innovations caused by e-commerce based on the extent of change in product's core components (defined as 'the distinct portions of the product that embody the core design concept and perform a well-defined function') and on the extent of change in the business model (defined as 'the way in which the

components are integrated and linked into a coherent whole') into four groups: incremental innovation (no significant changes in core components and business models), modular innovation (considerable changes in core components but not in business model), architectural innovation (considerable changes in business model but not in core components) and radical innovation (considerable changes in both core components and business model).

Tavlaki and Loukis (2005) propose a methodology for designing new 'digital business models', which consists of six stages: design of value proposition, design of production architecture (value chain), definition of value chain actors, analysis of competition, design of economic model and elaboration of relations among actors.

Another research stream focuses on analyzing how the web supports 'distributed' collaborative innovation creation both within and among firms (e.g. Sawhney and Prandelli 2000).

However, the impact of various types of e-business on the innovation activity of firms has not been empirically investigated using large datasets.

CHAPTER 3

Methodology and Data

3.1 Introduction

As mentioned in the Introduction, one of the main objectives of this PhD dissertation is to investigate the mediation effect of innovation in the relation between IS and business performance. For this purpose the most appropriate technique is the structural equations modeling (SEM) (Kline 2005), as it allows the estimation of complex networks of relations, in which a variable can be dependent (= affected by some variables) and at the same time independent (= affecting some other variables).

The detailed survey instruments used for collecting the data on which our empirical investigation has been based (from which the SEM were estimated) will be presented and analyzed, together with the whole methodological approach in chapters 4, 5 and 6 respectively. In this chapter is described our basic technique, the SEM, and then the data we used.

3.2 Structural Equation Modeling

3.2.1 Introduction to SEM

SEM was introduced in the early years of the 20th century, and it is based on the work of Spearman (1904) on exploratory factor analysis (EFA) and the work of Wright (1918) on path analysis. SEM is a combination of factor analysis and path analysis. SEM came to eliminate the limitations posed by 'first generation' statistical techniques (e.g. Multiple Regression Analysis, Analysis of Variance (ANOVA), Principal Components Analysis, etc.) such as: their inability to handle complex models and their assumption that all the variables are observable and measurable without error. (Sharma 1996, Gefen et al 2000, Haenlein and Kaplan 2004, Kline 2005, etc.) SEM as a 'second generation' technique overcomes those limitations, since it enables:

a) modeling complex networks of relationships among multiple independent and dependent variables, in which one variable can be at the same time dependent and independent,

b) constructing unobservable latent variables, which are estimated from observed variables,

c) modeling errors in measuring the observed variables,

d) testing concurrently structural and measurement assumptions using empirical data.

Structural equation modeling is a statistical methodology for testing and estimating a set of causal relationships and assigning a quantitative value (parameter estimate) to each of them, based on the covariances among the variables. Parameter estimates, are functions of the covariances that might be observed in the sample (Bollen 1989, Kline 2005). SEM calculates simultaneously multiple regression coefficients aiming at the identification of a single set of parameter estimates (e.g., path coefficients, error terms, etc.) that minimizes the total difference between the covariances implied by a structural or path model and the covariances observed among the data. A SEM consists of a structural model and a measurement model. The structural model specifies the relationships among unobserved variables (referred to as constructs or latent variables), and the measurement model specifies the relationships between the constructs and the observed variables related to them (referred to as items, indicators or manifest variables). An estimation method is then required to determine parameter estimates of those relationships (Bollen 1989, Kline 2005).

Confirmatory factor analysis, path analysis and regression are subsets of SEM. (Jackson et al 2005).

- CFA is a type of factor analysis which assesses whether the data fit a hypothesized measurement model. By using CFA researchers can test the hypothesis that a relationship between constructs and the observed variables related to them exists. CFA models are comprised of observed variables which load on constructs.

- Structural regression models attempt to evaluate constructs of observed variables and model the relationships among them.

- Path analysis is used to estimate the network of relationships among a set of measured variables (Bollen 1989). This estimation comprised of simultaneously calculation of direct, indirect and total effects of relationships between variables.

SEM uses part of McArdle-McDonald reticular action model (RAM) symbolism for diagrams' representation. Particularly SEM uses:

- circles or ellipses to represent the constructs
- squares or rectangles for items

- single headed arrow for direct effects, with the variable at the tail of the arrow causing the variable at the point
- a curved line with two arrowheads for covariances between independent variables

In figure 3.1 we can see an example of a typical SEM model with three (reflective) constructs and a total of nine items, with three items per construct, as well as the measurement errors of each item.
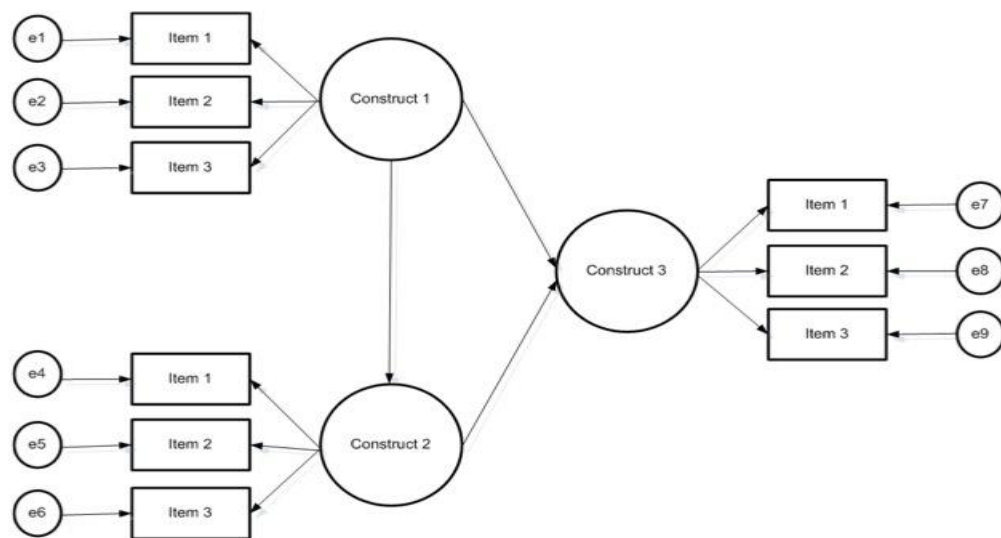
Figure 3.1: A Structural Equation Model

3.2.2 Reflective and formative indicators

In SEM every factor must have at least two indicators. There are two types of indicators: formative and reflective. Reflective indicators are caused by the latent construct whereas formative indicators 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. Researchers usually regard indicators as reflective, without careful consideration because there is an underlying assumption that the items used to measure a construct are reflective in nature (Chin 1998), and this leads to misspecification errors. Thus the direction of causality between a construct and its items is a very important aspect.

3.2.3 Total, mediating and moderating effects

In path analysis, there are three types of effects:

- total effect (it quantifies 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. The total effect equals the direct effect plus all indirect effects),

- direct effect (it quantifies the degree to which a change in an exogenous variable produces a change in an endogenous variable directly, without "going through" any other variable) and

- indirect effect (it quantifies the degree to which a change in an exogenous variable produces a change in an endogenous variable by means of an intervening variable).

In figure 3.2 we can see a graphical representation of such mediating effects. In this figure, Y represents the dependent variable, X represents the independent variable, and M the represents the mediation variable. A variable serves as a complete mediator under the following conditions:

- X has a direct effect on M

- M has a direct effect on Y, controlling for X.

- M completely mediates the X-Y relation, the direct effect of X on Y (controlling for M) must approach to zero.

- X must precede Y in time

- and M must precede Y in time (Cole and Maxwell 2003)
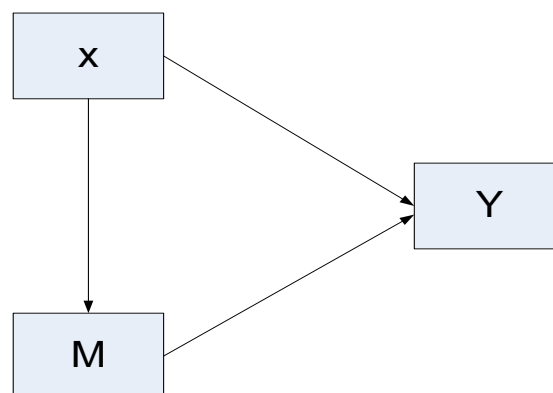
Figure 3.2: Graphical representation of mediating effects

However, it is possible that M is a partial mediator, if X has both a direct effect of Y, and indirect one through M. In the present Dissertation chapters 4, 5 and 6 deal with the investigation of total, mediating and direct effects between our main variables (extent of use of the three main types of IS (intra-organizational, e-business, e-procurement), innovation, ICT benefits and business performance).

In figure 3.3 we can see a graphical representation of moderating effects. A variable serves as a moderator under the following conditions:

- X has direct effect on Z,

- Y has a direct effect on Z,

- and a third variable, which is the combination or interaction of X and Y, has also a direct effect on Z.
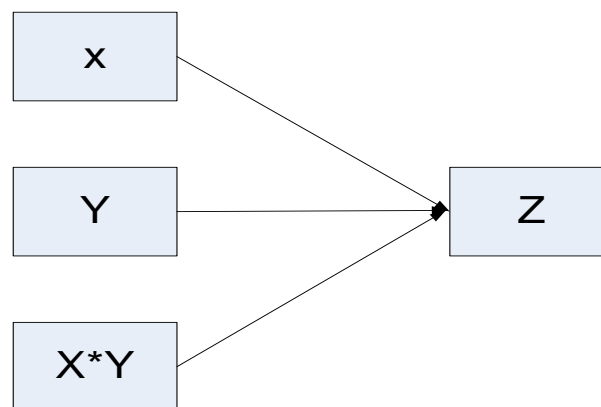
Figure 3.3 Graphical representation of moderating effects.

3.2.4 Model validation

Model validation depends on the direction of relationships between the measures and the construct (i.e. whether constructs are reflective or formative). Construct validation for reflective constructs is realized through CFA (convergent and discriminant validity) and reliability testing (Cronbach's a). Convergent validity is defined as the extent to which the selected items reflecting the construct "converge" showing significant high correlations with one another, whereas discriminant validity is defined as the extent to which the items measuring one construct differ from the ones that measure other 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, Kline 2005, 2011). 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 2007). 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. These limitations are due to the fact that the value of x^2 can be affected by: multivariate non-normality (it can increase or decrease x^2), correlation size (bigger correlations among observed variables can lead to higher values of x^2), unique variance (loss of statistical power due to analysis of variables with high proportions of unique variance) and sample size (in very large samples chi-square test may be failed even though differences between observed and predicted covariances are slight) (Kline 2011).

The limitations of chi-square lead to the development to other alternative fit 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 x^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, SEPATH, COSAN etc.) (Byrne 2001) and the variance-based (or component-based) ones (supported by software tools such as LVPLS, PLS-GUI, VisualPLS, PLS-Graph, SPAD-PLS, SmartPLS etc.) (Chin 1998, Haenlein and Kaplan 2004).

3.3 Parameter Estimation

3.3.1 Maximum Likelihood Estimation

The principle of maximum likelihood estimation (MLE), originally developed by R.A. Fisher in the1920s. MLE, is a typical covariance-based SEM approach that has two steps: firstly the estimation of the model parameters and secondly the calculation of the values of the latent variables for all cases. These estimations are all calculated at once and thus MLE is a full information method. The idea behind MLE is to determine the parameters that maximize the likelihood that the data were drawn from a particular normal population (Kline 2011). 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 addition, it provides 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.

In general, MLE is a standard approach to parameter estimation and inference in statistics. It has many highly desirable estimation properties: sufficiency (complete information about the parameter of interest contained in its MLE estimator); consistency (true parameter value that generated the data can be 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.

3.3.2. Bayesian Estimation

Whereas MLE views parameters as constants and works to identify the estimates for those parameters that produce the best model-data fit, Bayesian estimation views parameters as random variables and works to assign them a probability distribution (Muthén 2010, Muthén & Asparouhov 2011). Bayesian estimation has four main

advantages compared to MLE. The first is that it allows the user to specify the prior distribution, which may reduce the amount of time required for the model to converge and result in more accurate estimates (Lee & Song 2004), as such estimates are expected to be closer to the final answer than a random start value might be. The second advantage is that Bayesian methods do not carry the assumptions of asymptotic theory, which means that a large sample size is not necessary for drawing valid statistical inferences. The third advantage is that it is not based on the normality assumption (i.e. all indicators follow a normal distribution). Finally, it does not have the limitation of MLE that all indicators should be continuous, so it can be used for discrete valued indicators.

3.3.3 The Partial Least Squares (PLS) approach

Covariance-based SEM requires large samples and has several distributional assumptions. In contrast, PLS is a variance-based SEM approach (first introduced by H. Wold (1975)) with very few assumptions concerning the distributions of the data which can be performed even with smaller samples.

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 as well as the measurement paths, it also includes a third component, the weight relations, which are used to estimate case values for the latent variables - LVs as linear combinations of their corresponding manifest variables - 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: it has very few distributional assumptions, 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, it uses composite reliability indices to assess the reliability of the estimated LVs,

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).

3.3.4 Generalized Structured Component Analysis.

Generalized Structured Component Analysis (GSCA) is a component-based estimation method which was developed as a response to the primary disadvantage of PLS, the lack of an overall model fit index, something that in GSCA is available as a natural outcome of the estimation process (Hwang & Takane 2004). Furthermore GSCA is able to estimate multiple group models while imposing equality constraints across groups (Hwang & Takane 2004). GSCA estimates the measurement and structural models simultaneously and works toward the minimization of a global least squares criterion. GSCA has a lot of advantages: it accommodates higher-order components (Hwang & Takane 2004), fuzzy clustering (Hwang, DeSarbo, & Takane 2007) and multicollinearity (Hwang 2009), it produces unique component score estimates, it does not require strict distributional assumptions (Hwang & Takane 2004), it appears to perform well regardless of sample size (Hwang, Ho, & Lee 2010; Hwang & Takane 2004). GSCA was developed quite recently (in 2004) and thus an extensive research is required about the performance of GSCA in different situations.

Hwang et al. (2010) was the first who proceeded to a comparison of GSCA and PLS to MLE and found that under conditions of correct model specification, MLE produces more accurate parameter estimates than both GSCA and PLS, but in contrast, under conditions of model misspecification, GSCA outperformed MLE and PLS. Overall, GSCA was found to produce more precise standard errors than either MLE or PLS regardless of whether the model was correctly specified.

3.3.5 Generalized Least Squares (GLS), Unweighted Least Squares (ULS)

Generalized Least Squares (GLS) and Unweighted Least Squares (ULS) are based on the least squares criterion, but unlike multiple regression they are full-information methods that estimate all parameters at once. A drawback of the ULS method is that it requires all observed variables to have the same scale; this method is neither scale free nor scale invariant. It is also generally less efficient than MLE estimation, which means that standard errors tend to be somewhat larger in ULS estimation. (Kline 2005)

3.3.6 Asymptotic Distribution Free (ADF)

Asymptotic Distribution Free (ADF) estimation makes no distributional assumptions. This is because it estimates the degree of both skew and kurtosis in the raw data. However, ADF estimation typically requires very large samples in order to have reasonably accurate. For example, relatively simple models may require sample sizes of 200- 500, and thousands of cases may needed for more complex models. (Kline 2005)

3.3.7 Estimation choice

The choice of estimation method is a very important decision. There are a lot of issues that must be considered before the final choice, concerning variables' scale (categorical or continuous), variables' distribution (normal, non-normal), sample size (large or small) etc. As the data in the present study are categorical, selection of the appropriate estimation methods was required.

3.3.7.1 Analysis of categorical data as continuous data

According to Byrne (2001) the use of MLE estimation requires the satisfaction of the following conditions a) the sample must be very large, b) the distribution of the observed variables must be multivariate normal, c) the hypothesized model must be valid and d) the scale of the observed variables must be continuous. However, most SEM applications of the last 15 years are based on Likert-type scaled data with estimation of parameters using MLE procedures. When analyzing categorical data as continuous data the number of variables' categories and the degree of skewness play a key role. If the number of

categories is less than three, skewness is greater than 1.0, and differential skewness occurs across variables then: Pearson correlation coefficients will appear to be higher, x^2 values will be increasingly inflated, factor loadings and factor correlations will be underestimated and standard error estimates for all parameters will be too low (Byrne 2010). More recent findings support these earlier contentions and have further shown that the x^2 statistic is influenced most by the two-category response format and becomes less influenced as the number of categories increases (Byrne 2010).

3.3.7.2 Analysis of categorical data as categorical data

Applications involving the use of categorical data are based on three critically important assumptions: (a) Underlying each categorical observed variable is an unobserved latent counterpart, the scale of which is both continuous and normally distributed; (b) the sample size is sufficiently large to enable reliable estimation of the related correlation matrix; and (c) the number of observed variables is kept to a minimum" (Byrne 2010). In the area of categorical data analysis Jöreskog's (1990, 1994) and Muthén's (1984) approaches are the most widely used. They both use ADF estimation method, but ADF requires huge sample sizes, which in combination with the ultra-restrictive assumptions noted above makes these approaches impractical and difficult to use. Furthermore ADF estimation (and WLS family of estimators) is subject to technical problems in the analysis, such as the failure of the employed numerical methods to derive the inverse of the weight matrix (Finney & DiStefano 2006, pp. 281–288). Attempts to resolve these difficulties over the past few years have resulted in the development of several different approaches to modeling categorical data (Byrne 2010).

Another approach is to correct the test statistic, rather than use a different mode of estimation (Chou, Bentler, and Satorra 1991, Hu et al. 1992). In contrast to ADF that requires huge sample sizes Satorra and Bentler (1988, 1994) developed a statistic method that works very well with smaller sample sizes (Byrne, 2006). Satorra and Bentler method takes into account the estimation method that it is used, the model and the degree of kurtosis of the sample data and provides a scaling correction for the x^2 statistic (S–B x^2) when distributional assumptions are violated. The S–B x^2 is considered as the most reliable test statistic for evaluating mean and covariance structure models under various distributions and sample sizes (Curran et al. 1996). Unfortunately this method is not

available in the AMOS program that is used in the present study. Instead, Amos provides bootstrapping for situations where the assumptions underlying maximum likelihood chi-squares and standard errors may be violated. In fact, for large samples (like these of the present study), both Amos and the Satorra-Bentler scaled Chi- square have the same p-value. Some simulation results show that bootstrapping is even better than the Satorra-Bentler scaled Chi-square (Fouladi 1998, Nevitt and Hancock 1998).

So another alternative is Bayesian estimation, which as mentioned above can be used for categorical data and also is not based on normality assumptions (Byrne 2010). In the present study we have a large sample of data (as described in more detail in 3.6), with categorical variables without normal distribution. For the above mentioned reasons we used the both MLE and Bayesian estimations, and bootstrapping to correct the test statistic. In the same direction with Byrne's (2010) findings of the comparison of MLE and Bayesian estimation we found that there wasn't much difference between the results of these two methods.

3.4. Software tools for SEM

The selection of the right SEM software according to the type of the data that we have and the estimation method that we chose is another critical issue. Ease of use and user-friendliness shouldn't play the key role in our selection. In this section we review some software tools initially for covariance-based SEM techniques, and then for variance-based SEM techniques

3.4.1 Software tools for covariance-based SEM techniques

There are many programs designed for covariance-based SEM techniques. Some of them are mentioned below with emphasis in the strengths and limitations of each:

LISREL

This is the most widely used program. This program was developed around 1970. LISREL is a very flexible program with high level of sophistication. It has a lot of advantages, including multiple group comparisons and latent growth curves, but it is more complicated than other programs.

AMOS

Another program is AMOS. The literature on AMOS is not nearly as extensive as that for LISREL. AMOS is characterized by ease of use, user-friendliness, good customer support, documentation, easy handling of missing data, and ability to export files to SPSS, but it may be too simple, meaning that the process is simplified to such an extent that it can be possible to run analyses or models that you can't interpret appropriately. AMOS can read data files generated by a variety of different software packages and can estimate models by simply drawing a path diagram (Albright and Park 2009). It has some very useful features such as: it can generate bootstrapped estimates of standard errors and confidence intervals for all parameter estimates, it has a special maximum likelihood (ML) method for raw data files, it has special estimation methods for categorical variables (Bayesian estimation) (Kline 2011).

EQS

Other program is EQS. This program is much more user friendly than the others. The program allows the user to draw a path diagram and proceed from there in the development and testing of the model. So EQS advocates emphasize the program's quick learning curve. EQS has special strengths such as: it offers several different estimation methods for non- normal data, model-based bootstrapping, and the ability to correctly analyze a correlation matrix without standard deviations (Kline 2011). One the other hand it has sporadic use support, a lot of bugs when using the model drawing feature and it simplifies things too much.

Other programs less popular are:

- PISTE which is a Macintosh-based program for path analysis available from the University of Montreal.
- MX for which advocates mention that it seems to be able to do all that LISREL can do.
- MPLUS has an easier-to-use graphical interface than EQS, and the syntax is superior as well. Model specification is more sensible with Mplus than with other programs, but it has poor data management capability and does not support a path diagram.
- RAMONA is very easy to use, but limited in the kinds of analyses it can do.

- SAS/STAT CALIS has the systematic grammar structure in the integrated environment, but it has messy output and does not support advanced models with missing values.

Albright and Park (2009) estimated various models using AMOS, LISREL, MPLUS and SAS/STAT CALIS. They found the followings: AMOS and LISREL are the most user-friendly. LISREL, MPLUS, and SAS/STAT CALIS can handle ordinal observed variables using WLS methods. AMOS encounters accuracy problems when the observed variables are categorical. All four software packages handle models assuming the latent variable to be continuous, although MPLUS (and recently AMOS) can also estimate models in which the latent variables are assumed to be categorical.

For the above mentioned reasons and based firstly on the type of the available data for the present study, secondly on the estimation method that we chose and finally on the sample size of our data, we selected to use AMOS software. Other complementary factors but not so critical were the existence of an extensive literature on Amos, its user-friendliness and its easy to use.

3.4.2 Software tools for variance-based SEM techniques

There are many programs designed for variance-based SEM techniques. Some of them are: LVPLS (the oldest one), PLS-GUI, VisualPLS, PLS-Graph, SPAD-PLS, SmartPLS.

Dirk et al (2006) compared the above mentioned software tools and found the following: Path specification in LVPLS was inconvenient, but there wasn't the same problem in newer programs. VisualPLS, SPAD-PLS and SmartPLS were all found to be characterized by user-friendliness, the first two thanks to support of the estimation of interaction effects and the last two thanks to helpful export options. All software packages were supporting the bootstrap procedure for assessing the significance of parameter estimates. A specific strength of SPAD-PLS was the estimation of bootstrap confidence intervals for the parameters.

3.5 Advantages and Limitations of SEM

A primary advantage of SEM which differentiates it from other simpler, relational modeling processes is the ability to distinguish between indirect and direct relationships between variables and to analyze relationships between latent variables without random

error. Another advantage is the ability to construct unobservable latent variables, which are estimated from observed variables. Furthermore, structural models allow more precise formulation of measurement models, and can be used to test factorial invariance over populations of interest, something that is essential to the meaningful comparison of different populations on any set of variables. On a common construct it is not easy to interpret group differences on variables (if variables measure different constructs, or the same constructs differently in two populations (Francis 1988)).

SEM, as all statistical procedures, is not without pitfalls. There is a tendency to disregard assumptions underlying the analysis and quite usually to let the statistics guide the question rather than vice versa. Other problems unique to SEM include the complexity of model assessment, parameter estimation, model and parameter identification, demand for large sample sizes (size > 200 is necessary for most applications, but collecting data that are adequate for use is difficult, time consuming, and expensive). Nevertheless, the previously cited advantages far outweigh the disadvantages and difficulties encountered in using these techniques (Francis 1988, Petraitis et al. 1996).

3.6 Data, tools and techniques

The data source for the present study was the e-Business Watch Survey 2006, which has been conducted by European e-Business Market W@tch (www.ebusiness-watch.org), a well-established observatory organization sponsored by the European Commission. This survey was based on 13231 telephone interviews with decision-makers of firms from 29 countries, including the 25 EU Member States, the European Economic Area (EEA) and the Acceding/Candidate Countries. The population considered in this survey were all active firms of these countries that use computers and have their primary business activity in one of the following nine highly important sectors (from both manufacturing and services): Food and Beverages, Footwear, Pulp and Paper, ICT Manufacturing, Consumer Electronics, Shipbuilding and Repair, Construction, Tourism and Telecommunication Services. From this population a stratified sampling was made with respect to sector and company size (so that firms of all sizes are included).

For processing the data in the present thesis we have used SPSS (version 15) and AMOS (version 7) (for SEM for the reasons mentioned above) software packages. The particular statistical techniques we used are:

- Descriptive Statistics,
- Confirmatory Factor Analysis (CFA),
- Principal Component Analysis (PCA),
- Convergent and Discriminant Validity Analysis,
- Reliability Analysis with Cronbach Alpha coefficient
- Structural Equation Modeling (SEM) with Model Fit testing.

The use of these techniques is going to be explained throughout the following three chapters during the empirical testing of the research hypotheses of this Dissertation.

CHAPTER 4

IS, E-business, E-procurement, Innovation and performance

4.1 Introduction

As mentioned in chapter 2 there has been extensive theoretical literature concerning the great potential of information and communication technologies (ICT) to enable and drive innovations in business processes, products and services of firms, which can significantly increase their business performance (Porter & Millar 1985, Hammer 1990, Davenport 1993, Hammer and Champy 1993, Bresnahan and Trajtenberg 1995, Gunasekaran and Nath 1997, Brynjolfsson and Hitt 2000, Bresnahan et al 2002, Champy, 2002). Also, considerable theoretical literature has been developed concerning the potential of e-business to drive radical innovations in the business models, value propositions, products, and services of firms, and also in their internal business processes, which can result in significant increases of business performance (Timmers 1998, Afuah and Tucci 2001, Amit and Zott 2001, Zwass 2003, Jackson and Harris 2003, Wu and Hisa 2004, Tavlaki and Loukis 2005, Wu and Hisa 2008). Similar research has been conducted about the e-procurement's potential of improving business performance (Schoenherr and Tummala 2007, Gunasekaran and Ngai 2008, Tai et al. 2010, Thompson and Kee-hung 2009, Chang and Wong 2010).

However, the above expectations and arguments of the literature have not been sufficiently investigated empirically using large data sets. It is therefore important to examine to what extent these high expectations are realized in 'real life': to what extent various types of IS (both 'traditional' and 'new') drive innovations in firms, and what is the impact on business performance. Only a limited number of empirical investigations of the effect of ICT on innovation have been conducted, which are reviewed in 2.5.2, focusing mainly on internal IS.

This chapter presents an empirical investigation of the relations among three widely adopted types of IS, the internal IS, the e-business IS and the e-procurement IS (at a first level), the level of innovation and the business benefits obtained from ICT (at a second level), and finally business performance (at a third level). It aims to examine and compare these three fundamental IS types (the former having a long history and maturity, and being oriented mainly to the interior of the firm, and on the contrary the latter being new, less mature and oriented to firm's external environment), as to their impact on innovation, on the benefits provided to the firm by its ICT infrastructure, and finally on business performance. Our empirical investigation has been based on firm-level data collected

from 13231 European firms through the e-Business Watch Survey sponsored by the European Commission; using them a structural equation model (SEM) connecting the above variables has been estimated. Its conclusions are interesting and useful to researchers, practitioners, managers, firms, consulting companies and ICT vendors interested in ICT-based innovation and ICT business value maximization.

The chapter is structured in five sections. In the following section 4.2 the research model and hypotheses are formulated, while the method and the data of this study are described in section 4.3. The results are presented and discussed in section 4.4 and, finally, in section 4.5 the main conclusions and are outlined and discussed.

4.2 Research Model and Hypotheses

The present study contributes to filling the abovementioned research gaps. The abovementioned existing theoretical background concerning the extensive potential of IS in general and e-business and e-procurement in particular to drive innovation constitutes its main theoretical foundation. The research model of this study is shown below in Figure 4.1.
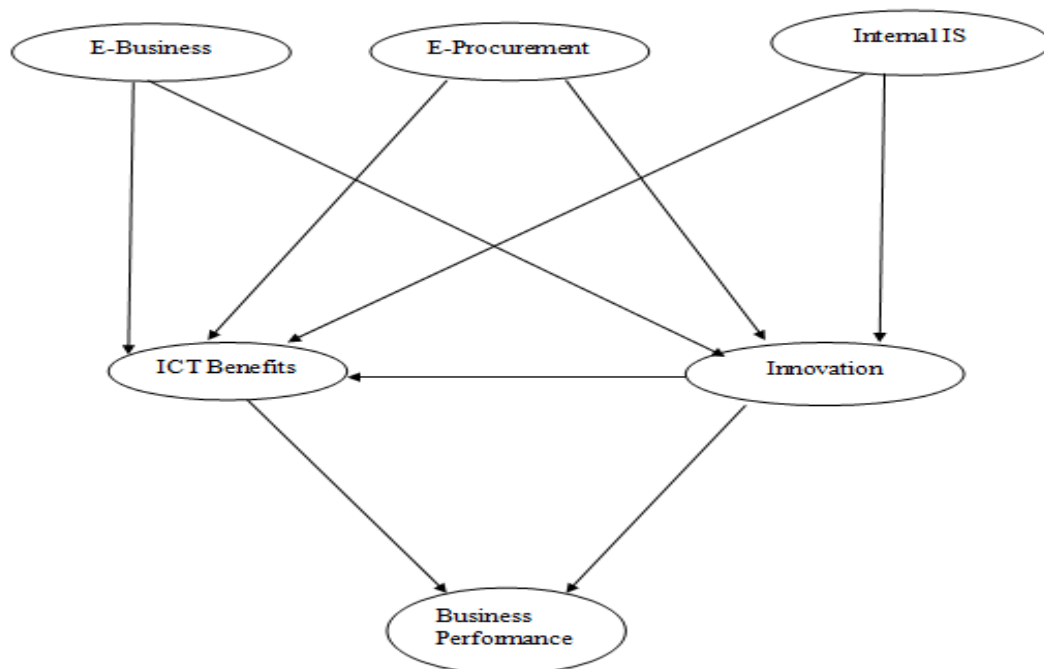

Figure 4.1.   The hypothesized research model.
The first research hypothesis concerns the role of innovation in the relation between the level of use of e-business IS and the benefits generated for the firm from its ICT

infrastructure. E-business systems offer to the firms the capability to reach much wider geographic areas and prospective customers' groups. Also they enable the firms to provide more and better information (e.g. enriched with multimedia) to current and prospective customers on their offerings (products and services), to receive online orders for their products and services and also online payments from their customers. Furthermore, they enable offering better after-sales support and services to customers. Therefore we expect that the level of use of e-business systems by a firm has a positive effect on the ICT benefits it obtains. However, we expect that part of this relationship to be through business models, products, services and processes innovations driven by the adoption of e-business, as mentioned in chapter 2, which enhance the benefits that ICT infrastructure generates. For the above reasons our first research hypothesis is:

Hypothesis 1: The level of e-business systems use has a positive effect on the level of ICT benefits, which is partially mediated by the level of innovation.

The second research hypothesis concerns the role of innovation in the relation between the level of use of e-procurement IS and the ICT benefits for the firm. E-procurement changes radically the way firms communicate and transact with their suppliers, and also reduce dramatically the corresponding costs, so it can lead to significant changes initially of some processes (mainly related to purchasing) and later of products and services (e.g. Amit and Zott 2001, Garrido et al. 2008, Garrido-Samaniego et al. 2010). In particular, e-procurement at a first level pervades and influences the processes of the firm associated with purchasing various raw materials, components and services it requires, so it can result in innovations concerning these processes. Also, gradually e-procurement leads to a better understanding of the capabilities offered by the digital network for finding new suppliers from a wider geographical area than before, and for transacting with them quicker and at a low cost, and this can at a second level lead to improvements of existing products and services or even development of new ones. These innovations and improvements as mentioned above will increase the benefits generated by the ICT infrastructure. So our second research hypothesis is:

Hypothesis 2: The level of e-procurement systems use has a positive effect on the level of ICT benefits, which is partially mediated by the level of innovation.

The third research hypothesis concerns the role of innovation in the relation between the level of use of internal systems and the ICT benefits for the firm. Internal systems automate or support important functions and processes of the firm, reducing cost and

time, and enable a better management and exploitation of firm resources; also, they improve coordination and control within the firm, while they also provide reliable data for supporting decision making. The above capabilities offered by internal systems to firms increase the benefits they get from their total ICT infrastructures. However, we expect that part of this relationship to be through products, services and processes innovations driven by internal systems, resulting in higher ICT benefits. Internal systems, as mentioned in chapter 2, facilitate and enable innovations in business processes (e.g. processes simplifications, improvements, abolitions, or creation of new horizontal interdepartmental processes), and also new or improved products and services. These innovations, as mentioned above, will increase the benefits generated by the ICT infrastructure. For the above reasons our third research hypothesis is:

Hypothesis 3: The level of internal systems use has a positive effect on the level of ICT benefits, which partially mediated by the level of innovation.

Finally we expect that higher ICT business benefits will result in higher business performance. Furthermore, we expect that the extent of innovation will also result to higher business performance, both directly and indirectly through the increase of ICT benefits. The development of new products and services by a firm creates new markets, which are monopolized by the firm for some time, until the competitors imitate the new product or service; also, the substantial improvement of existing products and services provides differentiation over competitors, while process innovation improves efficiency. These will result in higher business performance. Also, there is considerable empirical evidence that innovation has a positive impact on business performance (e.g. Cainelli et al 2004, Dunk 2005, Thornhill 2006, Koellinger 2008, De Clerk et al 2008). For the above reasons our fourth and fifth research hypotheses are:

Hypothesis 4: The level of ICT benefits has a positive effect on business performance.

Hypothesis 5: Innovation has a positive effect on business performance, which is mediated by the level of ICT benefits.

4.3 Method and Data

All the six basic variables of this study, which are shown in Figure 4.1, were measured as reflective constructs using several items, which correspond to appropriate questions of

this survey and are shown in Table 1 of the Appendix A, so that high levels of validity and reliability can be achieved (Straub et al, 2004, Kline, 2005). In particular:

- for measuring the level of e-business use we used four items, which measure whether the firm uses ICT for publishing offers to customers, answering calls for proposals or tenders, receiving orders from customers and also for enabling customers to pay online for ordered products or services,

- the level of e-procurement use was measured through three items, which measure whether the firm uses IT solutions for finding suppliers in the market, inviting suppliers to quote prices or submit proposals and also for ordering goods or services,

- the level of internal IS use was measured through six items, which measure whether the firm uses ICT to enable sharing documents between colleagues or performing collaborative work in an online environment, to track working hours or production time, to manage capacity or inventories, and also whether it uses an Intranet, an Enterprise Resource Planning (ERP) system and accounting software.

- the extent of innovation was also measured through four items: two of them measure whether the firm during the past 12 months has launched any new or substantially improved products or services (product/service innovations), or has introduced any new or significantly improved internal processes (process innovations); the other two items measure whether any of these product or service innovations, or any of these process innovations, has been directly related to or enabled by ICT,

- in order to measure the extent of benefits the firm obtained from ICT we used six items, which measure whether ICT has had positive influence, no influence at all or negative influence on revenue growth, efficiency of business processes, internal work organisation, quality of products and services, quality of customer service and firm productivity,

- and finally business performance was measured through three items, which measure whether the turnover, the market share and the productivity of the firm has increased, stayed roughly the same or decreased over the past 12 months.

Using the above data the hypothesized research model shown in Figure 4.1 was estimated through covariance-based SEM (Kline 2005), which offers the advantage of

estimating at the same time both the measurement part of the model (i.e. paths between each construct and its corresponding items) and the structural part of the model (i.e. paths between constructs), using the AMOS 6 software (Byrne, 2001) and ML, Bayesian estimation methods.

4.4 Results

Initially we examined the measurement part of the estimated model and assessed the validity and reliability of each constructs. We assessed its most important dimension of constructs' validity, the convergent validity (Straub et al, 2004), by examining the loadings of the items for each construct, which are shown in Table 2 of the Appendix A (for a comparison of ML- Bayesian results see Table 8 of the Appendix A). We can see that all of them are statistically significant, most of them exceed the cut-off level of 0.6 suggested by Chin (1998), and only a few items have loadings slightly lower than 0.6, which were however regarded as marginally acceptable, so they were retained. Therefore we can conclude our constructs are characterized by convergent validity. Next we assessed the discriminant validity of the constructs. For this purpose the factor structure behind the above 26 items of these six constructs was examined by performing Principal Components Analysis (PCA) with Varimax rotation using the SPSS 15.0 software. Its results shown in Appendix B Table 1 indicated that six factors were formed (having Eigen values exceeding 1.0), and each of them is characterized by high loadings of all the items corresponding to one of the constructs and much lower loadings of all the other items. These results indicate the discriminant validity of the six constructs developed and used in this study. Finally, we assessed the reliability of each construct by calculating its Cronbach Alpha using the SPSS 15.0 software, and the results are shown in Table 3 of the Appendix A. Since all constructs have values exceeding the cut-off level of 0.7 recommended by the relevant literature (Gefen et al, 2000; Straub et al, 2004), we can conclude that all constructs are characterized by reliability as well.

Then we assessed the goodness of fit of the whole model by examining the values of its basic fit indices, which are shown in Table 4 of the Appendix A. We can see that we have acceptable values, in accordance with the recommendations of the relevant literature (Gefen et al, 2000, Straub et al, 2004; Kline, 2005), for both the incremental fit indexes

NFI, RFI, IFI, TLI and CFI (> 0.9) and for the RMSEA (<0.05), so we can conclude that the model we estimated is characterized by acceptable fit to the data.

Having confirmed acceptable model fit and validity and reliability for all constructs, we finally focused our attention on the structural model, which is shown in Figure 4.2. We remark that the level of use of e-business, e-procurement and internal systems has a positive and statistically significant effect on the extent of innovation (standardized coefficients 0.128, 0.055 and 0.518 respectively). Therefore we conclude that these types of IS are drivers of innovation, with the internal systems having a much stronger effect on innovation than the e-business and e-procurement systems.
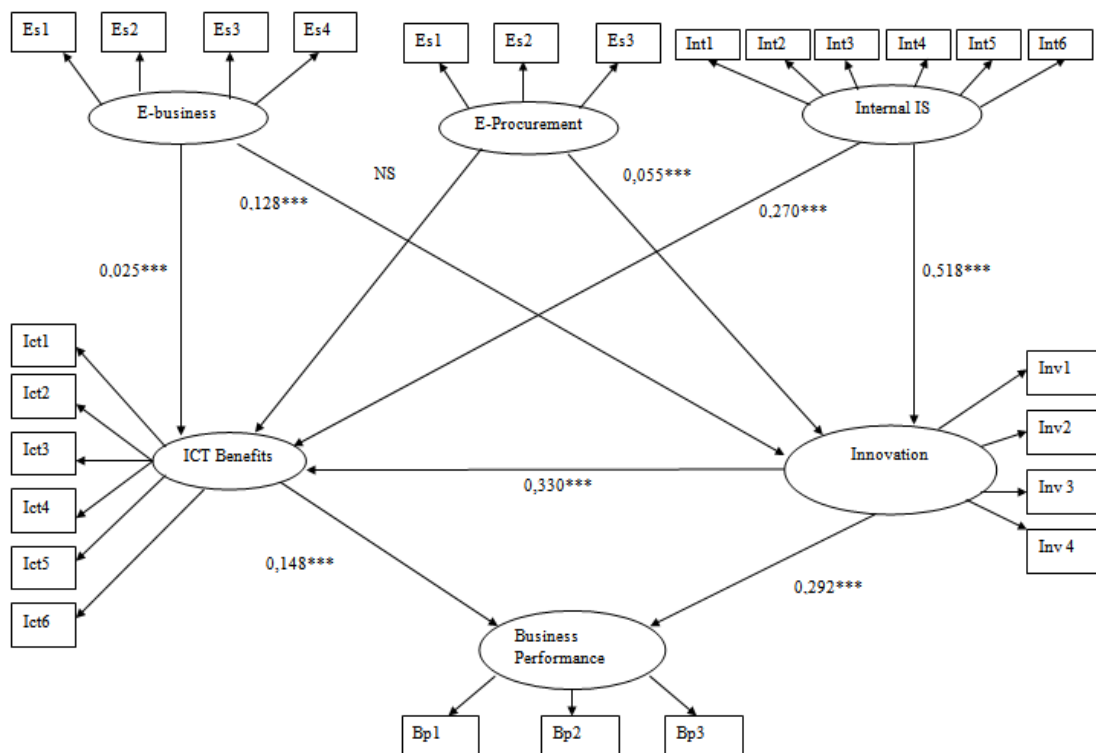
Figure 4.2.   The estimated structural model

Also, we can see that the extent of innovation has a positive and statistically significant effect (standardized coefficient 0.330) on the extent of benefits firms obtain from ICT. This result is in agreement with conclusions of previous literature that innovation increases the business benefits and contribution of ICT (Licht & Moch 1997, Hempell et al 2004, Hempell 2005, Loukis et al 2008a). At the same time we remark that the level of use of e-business and internal systems have both a positive and statistically significant

direct effect as well on the level of ICT benefits (standardized coefficients 0.025 and 0.270 respectively). From the abovementioned results it is concluded that the level of use of e-business and internal systems have both positive effects on the level of ICT benefits, which are both partially mediated by the levels of innovation, so hypotheses 1 and 3 are supported. We also remark that the level of use of e-procurement has not got a positive and statistically significant direct effect on the level of ICT benefits, so hypothesis 2 is only partially supported. This indicates that e-procurement has effect on ICT benefits only indirectly through innovation.

In particular, the level of e-business systems use has a positive and statistically significant total effect on ICT benefits equal to 0.025 (direct effect) + 0.128*0.330 (indirect effect through innovation) = 0.067, which is in agreement with previous relevant empirical literature (see Chapter 2) concluding that e-business has a positive impact on business performance (Zhu and Kraemer 2002, Barua et al 2004, Devaraj et al 2007, Sanders 2007, Johnson et al 2007, Quan 2008, Soto-Acosta and Meroño-Cerdan 2008). We also remark that 63% of this total effect (0.128*0.330/0.067) is through the innovations that e-business systems drive, which enhance the benefits from ICT. With respect to the internal systems, they also have a positive and statistically significant total effect on ICT benefits equal to 0.270 (direct effect) + 0.518*0.330 (indirect effect through the extent of innovation) = 0.441; this in agreement with previous relevant empirical ERP literature concluding that they have a positive impact on business performance (Hitt et al 2002, Hunton et al 2003, Nicolaou and Reck 2004, Nicolaou and Bhattacharya 2006, Wieder et al 2006, Hendricks et al 2006). We remark that 39% of this total effect (0.518*0.330/0.441) is through the innovations that internal systems drive, which enhance the benefits from ICT. From the above results we can conclude that internal systems have a much larger effect on the level of benefits firms get from ICT than the e-business systems. However, the effect of the e-business systems on ICT benefits is mediated by innovation to a higher extent than the effect of the internal systems of ICT benefits.

Finally, we remark that the level of ICT benefits has a positive and statistically significant effect on business performance (standardized coefficient 0.148), so hypothesis 4 is supported. Also, we can see that the level of innovation has a direct positive and statistically significant effect as well on business performance (standardized coefficient 0.292). This leads to the conclusion that the positive effect of the extent of innovation on business performance is partially mediated by the extent of ICT benefits, so hypothesis 5

is supported. In particular, we found that the level of innovation has a statistically significant total effect on business performance equal to 0.292 (direct effect) + 0.330*0.148 (indirect effect through the extent of innovation) = 0.341, in agreement with previous relevant empirical literature concluding that innovation has a positive impact on business performance (e.g. Koellinger, 2008; De Clerk et al, 2009). We also remark that 14% of this total effect (0.330*0.148/0.341) is through the increase of ICT business benefits resulting from innovation, which enhance business performance.

4.5 Conclusions

It has been concluded that these three types of IS are drivers of innovation, with the internal systems having a strong effect on innovation (standardized path coefficient 0.518), the e-business systems having a smaller (standardized path coefficient 0.128) and e-procurement systems having a much smaller effect (standardized path coefficient 0.055). This shows that firms, having a long history and experience of using internal IS, have gradually learnt how to use them for making innovations in their processes, products and services. On the contrary with respect to e-business and e-procurement, despite their great potential for driving radical innovations according to previous theoretical literature, firms have not yet learnt to exploit this innovation potential;. Also, we have found that both internal and e-business IS have a positive impact on the benefits firms obtain from ICT, and through them on business performance, with the internal systems having a much higher impact on ICT benefits and business performance (total effect 0.441) than the e-business ones (total effect 0.067). This can be explained similarly, taking into account that firms have more history, experience and maturity in using internal systems and much less in e-business, which results in higher efficiency, effectiveness and more business benefits from internal systems.

Another conclusion was that the effects of both these types of IS on ICT benefits are partially mediated by innovation, but not to a large extent (taking into account the high expectations of theoretical literature): 39% of the effect of internal systems on ICT benefits and a much higher 63% of the impact of e-business on ICT benefits are through innovation. Therefore the benefits from e-business come to a higher extent from innovation driven by it than the benefits from internal systems. Also we found that e-procurement has effect on ICT benefits only through innovation. Finally, with respect to

innovation, it has been concluded that it has a positive impact on business performance, which is partially mediated to a small extent (14%) by the better exploitation of the ICT infrastructure and the higher ICT benefits that innovation drives.

Our findings have interesting implication for research and practice. The significant differences identified in this study among the internal systems and the extrovert e-business systems and e-procurement systems, as to their effect on innovation, ICT benefits and business performance, indicate that future IS research on such issues should not deal with IS in general, but should focus on particular types of IS. With respect to IS management practice, the conclusions of this study indicate that firms should combine the development of internal systems, e-business systems and e-procurement systems with innovations in order to get more business benefits from them and have a larger positive impact on business performance. Future research is required on the relations of other types of IS with innovation, ICT business benefits and business performance, and comparison between them from the above perspectives. Also, further research should be conducted for increasing our knowledge on Internet/e-business related innovations in products, services and processes, the business benefits they provide and also their main barriers and inhibitors.

CHAPTER 5

IS, E-business, E-procurement, Innovation, and performance in the Tourism Sector

5.1   Introduction

As ICT applications have been widely advocated as a critical necessity for the survival and the competitive advantage of tourism firms, research aiming to explore the impact of ICT on the performance of tourism firms is of critical importance. Similar to research in the mainstream field, tourism studies have also focused on investigating in more depth the mechanisms and the factors driving and enabling the materialization of the ICT impacts on business performance. Hence, studies have analyzed issues such as: the intermediate impacts of ICT on business processes (e.g. Sigala 2003c, Sigala 2004, Orfila-Sintes, Cladera and Ros 2005); the specific operational benefits of certain ICT applications such as CRM, e-marketing and e-procurement (Sigala 2003b and 2006, Martin 2004, Kothari et al. 2005, Fuchs et al. 2010, Theodosiou and Katsikea 2012). All studies concluded that there is not a simple and direct relationship between ICT and business performance but rather a perplex process that grants further investigation. Consequently, different studies advocated the (inter)mediated impact of factors such as business process reengineering (Sigala 2003a), ICT operational diffusion and knowledge management (Sigala 2003c and 2004), business innovation (Vadell & Orfila-Sintes 2008, Orfila-Sintes et al. 2005) and networking (Baggio 2006, Novelli et al. 2006). However, none of these studies actually measured and provided evidence of such (inter)mediated effects and relationships between ICT and business performance.

In this vein, this study aims to investigate and compare the impacts of three fundamental IS applications on the intermediate and aggregate performance of tourism firms: a) the internal IS, used by staff for supporting their internal functions and processes, and b) the e-business and e-procurement IS representing 'extrovert' applications used by firms' partner companies, suppliers and customers. The tourism sector is particularly important for the economy of our country and the European South in general.

In particular, this chapter presents a three level empirical study investigating the relations between the following constructs: the exploitation level of these three quite different and widely adopted types of IS (namely the internal, the e-business and e-procurement IS) (at a first level of analysis); the impact of the exploitation levels of the three IS applications on the degree of innovation (which represents one of the most widely discussed intermediate mechanisms enabling the ICT impact on business

performance (e.g. Antonelli et al 2000, Bresnahan 2003, Hempel 2005)) and on the resulting ICT business benefits (at a second level); and finally, the impact of the previous constructs and processes on the aggregate business performance (at a third level). For this purpose the model of Figure 5.1 was estimated for the tourism sector, using the data collected in the e-Business W@tch Survey 2006 from the 2665 tourism sector firms of the sample.

This chapter is structured in three sections. In the following section 5.2 the results for the tourism sector are presented and discussed. Finally, section 5.3 provides the main conclusions and the implications of the findings.

5.2 Data Analysis and discussion

The hypothesized research model shown in Figure 4.1 was estimated for the tourism firms of our sample through covariance-based SEM (Kline 2005), which offers the advantage of estimating at the same time both the measurement part of the model (i.e. paths between each construct and corresponding items) and the structural part of the model (i.e. paths between constructs), using the AMOS 6 software (Byrne, 2001) and ML, Bayesian estimation methods.

Initially we examined the measurement part of the model and assessed the validity and reliability of all constructs. Concerning constructs' validity we assessed its most important dimension, the convergent validity (Straub et al 2004) by examining the loadings of the items for each construct, which are shown Appendix A Table 5 (for a comparison of ML- Bayesian results see Table 9 of the Appendix A). We can see that all of them are statistically significant and exceed the cut-off level of 0.6 suggested by Chin (1998) (a few items with loadings slightly lower than 0.6 were regarded as marginally acceptable, so they were retained), therefore our constructs are characterized by convergent validity. Next we assessed the reliability of each construct by calculating Cronbach's Alpha using the SPSS 15.0 software, which are shown in Appendix A Table 6; since all of them have values exceeding the cut-off level of 0.7 recommended by the relevant literature (Gefen et al 2000, Straub et al 2004), we can conclude that all constructs are characterized by reliability as well.

Then we assessed the goodness of fit of the whole model by examining the values of its basic fit indices, which are shown in Appendix A Table 7. We can see that we have

acceptable values, in accordance with the recommendations of the relevant literature (Gefen et al 2000, Straub et al 2004), for both the incremental fit indexes NFI, RFI, IFI, TLI and CFI (> 0.9) and for the RMSEA (<0.05), so we can conclude that the model we estimated is characterized by acceptable fit to the data.

Having confirmed acceptable model fit and validity and reliability for every construct, we finally focused our attention on the structural model, which is shown in Figure 5.1. We remark that the extent of adoption of e-business, e-procurement and internal systems have both a positive and statistically significant effect on the extent of innovation (standardized coefficients 0.141, 0.095 and 0.326 respectively). Therefore we conclude both these fundamental types of IS are drivers of innovation in tourism sector firms, with the internal systems having a strong effect on innovation, the e-business systems having a smaller effect and the e-procurement systems having a much smaller. Also, we can see that the extent of innovation has a positive and statistically significant effect (standardized coefficient 0.208) on the extent of benefits a firm obtains from its ICT infrastructure. This result is in agreement with conclusions of previous literature that innovation increases the business benefits and contribution of ICT (Licht & Moch 1997, Hempell et al 2004, Hempell 2005, Loukis et al 2008a).
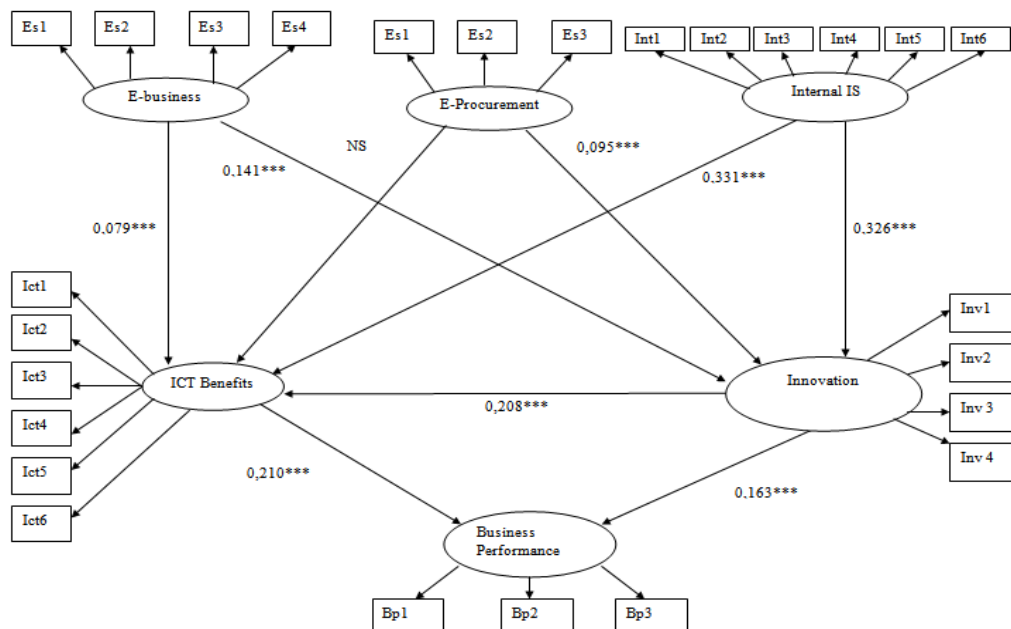
Figure 5.1. The estimated structural model for the tourism sector.

At the same time we remark that the extent of adoption of e-business and internal systems have both a positive and statistically significant direct effect as well on the extent

of ICT benefits (standardized coefficients 0.079 and 0.331 respectively). From all the above mentioned results it is concluded that the extent of e-business and internal systems adoption have positive effects on the extent of ICT benefits, which are both partially mediated by the extent of innovation. On the contrary e-procurement systems have not got a statistical significant direct effect on ICT benefits. In particular, we found that the extent of e-business system adoption has a statistically significant total effect on ICT benefits equal to 0.079 (direct effect) + 0.141*0.208 (indirect effect through the extent of innovation) = 0.108, in agreement with previous relevant empirical literature concluding that e-business adoption has a positive impact on business performance (Zhu and Kraemer 2002, Barua et al 2004, Devaraj et al 2007, Sanders 2007, Johnson et al 2007, Quan 2008, Soto-Acosta and Meroño-Cerdan 2008); we remark that 27% of this total effect (0.141*0.208/0.108) is through the innovations that e-business systems drive, which enhance the benefits that ICT infrastructure generates. Concerning the extent of internal systems adoption, we found that it has a statistically significant total effect on ICT benefits equal to 0.331 (direct effect) + 0.326*0.208 (indirect effect through the extent of innovation) = 0.399; this in agreement with previous relevant empirical literature concluding that the adoption of internal ERP systems has a positive impact on business performance (Hitt et al 2002, Hunton et al 2003, Nicolaou and Reck 2004, Nicolaou and Bhattacharya 2006, Wieder et al 2006, Hendricks et al 2006). We remark that 17% of this total effect (0.326*0.208/0.399) is through the innovations that internal systems drive, which enhance the benefits that ICT infrastructure, generates. From the above results we can conclude that the extent of internal systems adoption has a much larger effect on the extent of benefits a firm gets from its ICT infrastructure than the extent of adopting e-business systems.

Finally, we remark that the extent of ICT benefits has a positive and statistically significant effect on business performance (standardized coefficient 0.210). Also, we can see that the extent of innovation has a direct positive and statistically significant effect as well on business performance (standardized coefficient 0.163). This leads to the conclusion that the positive effect of the extent of innovation on business performance is partially mediated by the extent of ICT benefits. In particular, we found that the extent of innovation has a statistically significant total effect on business performance equal to 0.163 (direct effect) + 0.208*0.210 (indirect effect through the extent of ICT benefits) = 0.207, in agreement with previous relevant empirical literature concluding that innovation

has a positive impact on business performance (e.g. Cainelli et al 2004, Dunk 2005, Thornhill 2006, Koellinger 2008, De Clerk et al 2008); we also remark that 21% of this total effect (0.208*0.210/0.207) is through the increase of ICT business benefits resulting from innovation, which enhance business performance.

5.3 Conclusions

The previous sections presented an empirical study of the relations between the extent of adoption of three quite different and widely adopted types of IS, the internal the e-business and the e-procurement ones, the extent of innovation, the ICT business benefits and finally business performance in the tourism sector. It has been concluded that all the three examined types of IS are drivers of innovation in tourism sector firms, with the internal systems having a stronger effect on innovation than the e-business and e-procurement systems. Internal IS, e-business and e-procurement systems have an impact on the benefits generated for the firms from ICT, and through them on business performance, with the internal systems having a much higher impact on ICT benefits and business performance than the e-business systems, and the e-procurement ones. The impacts of internal and e-business IS on ICT benefits and the whole impact of e-procurement are partially mediated by innovation: 17% of the impact of internal systems on ICT benefits is through the innovation they drive, while a much higher 27% of the impact of e-business systems on ICT benefits is through the innovation driven by them. Concerning innovation, it has been concluded that it has a positive impact on business performance of tourism sector firms, partially mediated by the increase of ICT benefits that innovation causes. We remark that the estimated tourism model is similar to the general one, and there are not substantial differences among them. The only difference we can mention is that in the estimated tourism model the mediation effect of innovation on the impacts of internal IS and e-business IS on business performance is weaker (17% and 27% respectively instead of 39% and 63% for the general model).

CHAPTER 6

Comparison among Mediterranean, Central European and Scandinavian regions

6.1 Introduction

Finally a comparison was made concerning the main variables of this study (use of internal IS, e-business, e-procurement, innovation, ICT benefits and business performance) and the relationships among them of the Mediterranean region with the Central Europe and Scandinian region. Currently there is an extensive debate for the economic performance differences between the European South, Mediterranean region on the one hand and the Central Europe and Scandinavian on the other. Therefore it is interesting to compare the European South Tourism with the European North Tourism with respect to two highly important elements of modern economy: ICT use, innovation, the relations between them and with business performance.

For this purpose and the data from the tourism firms of our dataset were used for estimating a structural equation model (SEM) connecting these variables for each of the following three European regions: Mediterranean (data from 501 firms), Central European (data from 585 firms) and Scandinavian (data from 510 firms). Descriptive statistical analyses of these variables (i.e. use of internal and e-business IS, innovation, ICT benefits and business performance) as well as SEM models were first conducted for each region separately and then compared for identifying any similarities and/or differences. This comparison aimed to investigate whether the tourism sector of the Mediterranean region has any specificities in comparison to the 'Central' and 'North' Europe that may affect the relations amongst ICT, innovation and business performance. In general, the Mediterranean region (the 'South') is characterized by lower levels of economic development, gross domestic product (GDP), adoption of ICT and innovation than the Central Europe and the Scandinavian region (the 'North') (read more on this in section 6.4), so it is interesting to investigate whether these general characteristics appear in the Mediterranean tourism sector as well, or there is a different situation. The theoretical model of tourism innovation developed by Sundbo et al. (2007) presented in section 6.3 is used for explaining any differences amongst the three regions.

This chapter is structured in seven sections. In section 6.2 the main characteristics of the Mediterranean region are outlined and discussed concerning the economic development in general and the above variables in particular, while in section 6.3 is presented the Sundbo's et al (2007) theoretical model of tourism innovation. Then section 6.4 describes the research model and hypotheses. The instruments validation for the

tourism sector is described in section 6.5, and the descriptive statistics are presented and discussed in section 6.6. Then the Mediterranean model is presented in section 6.7, and the Central European and Scandinavian ones in section 6.8, followed by a discussion in section 6.9. Finally, section 6.10 provides the main conclusions and the implications of the findings.

6.2 Characteristics of the Mediterranean region

The Mediterranean region (the 'South') has significant economic, technological and cultural differences from the Central Europe and the Scandinavian region (the 'North'). In particular, it is characterized by lower levels of economic development (e.g. gross domestic product (GDP)), adoption of ICT and innovation than the Central Europe and the Scandinavian region (OECD 2005, OECD 2006a, OECD 2006b, Aiginger 2007, OECD 2008, Eurostat 2008, OECD 2009, also data from the Eurostat retrieved through http://epp.eurostat.ec.europa.Eu/portal/page/ portal/statistics/search_database and from G. Hofstede's website http://www.geert-hofstede.com/). Table 6.1 provides the average values of some important indicators (one economic, one technological, two innovation-related and one cultural) confirming this comparative context of the three regions included in the sample of this study: the 'northern' Mediterranean countries (Portugal, Spain, Malta, Italy, Greece, Turkey, Cyprus), the Central European countries (Germany, Austria, Netherlands, Belgium, France, Luxembourg, Great Britain, Ireland) and the Scandinavian countries (Sweden, Norway, Finland, Denmark). When looking at GDP per capita, i.e. the basic indicator of economic development, the Mediterranean countries have a lower average of 83.47 (shown in Purchasing Power Standards (PPS) with EU-27 = 100) in comparison with the Central European and Scandinavian countries (123.65 and 131.87 respectively). Concerning ICT investments, the Mediterranean countries spend on average 1.55% of their GDP, while the Central European and Scandinavian countries spend a much higher amount of their GDP for ICT (2.85% and 3.22 respectively). When looking at innovation indexes, the Mediterranean countries are characterized by a lower average gross domestic R&D expenditure of 0.68% of their GDP than the Central European and Scandinavian countries that spend 1.87% and 2.74% of their GDP for R&D respectively. Concerning innovation output, the comparisons amongst the three regions provide similar conclusions: the percentage of innovative firms in the Mediterranean

countries is on average 35.75%, while in the Central European and Scandinavian regions it is at the much higher levels of 47.90% and 45.58% respectively. Similar conclusions are also drawn by comparing other innovation output indicators, such as patents and patent applications. Finally, from a cultural perspective the Mediterranean countries are characterized by an 85 average value of the 'Uncertainty Avoidance Index', while the Central European and Scandinavian countries are characterized by higher average values of 50.17 and 35.25 respectively. This cultural dimension is particularly relevant to the adoption and use of ICT and innovation, since it is defined (Hofstede & Hofstede, 2005) as 'the extent to which the members of a culture feel threatened by ambiguous or unknown situations'; i.e. the higher the uncertainty avoidance, the more likely it is that firms would avoid to use an ICT and innovation as the latter foster organizational change that creates ambiguous and unknown situations. In conclusion, the above indicators reveal some particular characteristics of the firms operating in the Mediterranean region, which are highly relevant to our study: the region is characterized by lower economic development, lower expenditure for ICT and R&D, lower percentage of innovative firms and higher uncertainty avoidance attitude.

Table 6.1.   Average GDP per capita (average 1997-2008), ICT Expenditure as percentage of GDP (average 2004-2006), Gross Domestic Expenditure on R&D as percentage of GDP (1997-2007) Percentage of Innovative Firms (2004) (source: Eurostat) and Uncertainty Avoidance Index (source: G. Hofstede's website http://www.geert-hofstede.com/) in the Mediterranean region, the Central Europe and the Scandinavian region

Region	GDP per Capita	ICT Expendit. as perc. GDP	R&D Expend. as perc. GDP	Percentage of Innovative Firms	Uncertainty Avoidance Index
Mediterranean	83.47	1.55	0.68	35.75	85
Central Europe	123.65	2.85	1.87	47.90	50.17
Scandinavian	131.87	3.22	2.74	45.58	35.25

6.3 Sundbo's et al (2007) Theoretical Model of Tourism Innovation

By extending and elaborating the innovation framework of Coriat & Weinstein (2002), which views innovation in a firm as being generated from a combination of 'organizational' factors (associated with characteristics of the firm) and 'institutional' factors (associated with its external environment),   Sundbo et al. (2007) have provided a

three levels' theoretical framework for explaining innovation in tourism. It defines three levels of factors affecting the innovative performance of the tourism firms:

- Factors at the level of the individual firm (i.e. firm internal characteristics that affect innovation), which coincides with the organizational level of Coriat & Weinstein's (2002) framework.

- Factors at the level of innovation networks (i.e. loosely coupled external relations of the firm with other firms of the same or different sector), which is located between the organizational and the institutional level of Coriat & Weinstein's (2002) framework.

- Factors at the innovation system level (defined as "... all parts and aspects of the economic structure and the institutional setup affecting learning as well as searching and exploring" (Edquist 1997, p. 17; Sundbo et al., 2007), referring mainly to public policy makers and authorities, educational and research organizations, support industries, legal frameworks, etc., which are involved in the production and diffusion of tourism related knowledge; this level coincides with the institutional level of Coriat & Weinstein's (2002) framework.

6.4 Research Model and Hypotheses

Due to the smaller amount of data we had available for each regional model (for Mediterranean: data from 501 firms, for Central Europe: data from 585 firms, for Scandinavian: data from 510 firms), we calculated a smaller version of the initial model shown in fig. 4.1, which does not include e-procurement (which had the smallest effects of the three examined types of IS on innovation and ICT benefits). Therefore the research model of this part of the study is shown in Figure 6.1.
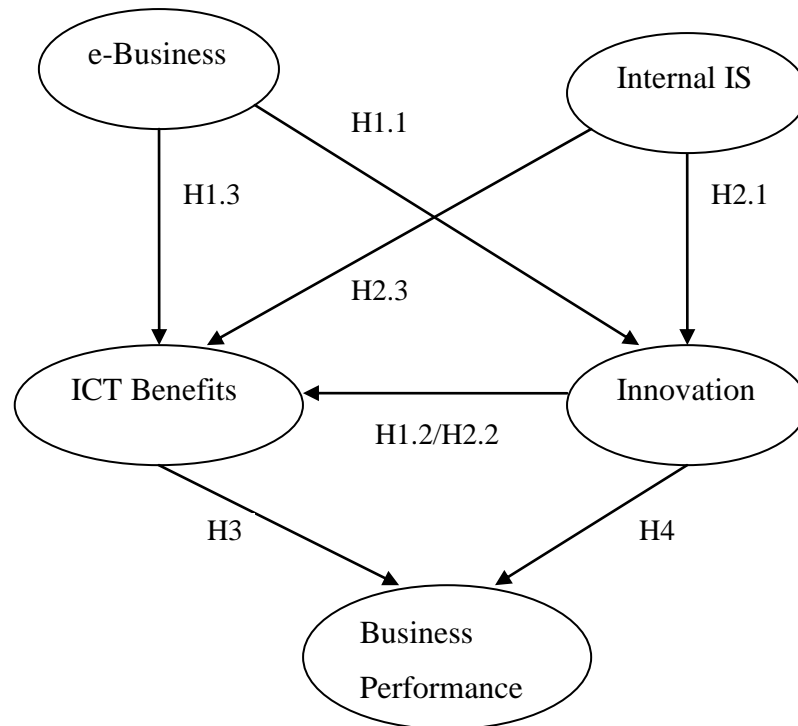
Figure 6.1.   The hypothesized research model.

So the corresponding research hypotheses are:

Hypothesis 1: The level of e-business systems use has a positive effect on the level of ICT benefits, which is partially mediated by the level of innovation.

It can be analyzed into the following three sub-hypotheses:

Hypothesis 1.1: The level of e-business systems use has a positive effect on the level of innovation.

Hypothesis 1.2: The level of innovation has a positive effect on the level of ICT benefits.

Hypothesis 1.3: The level of e-business systems use has also a direct positive effect on the level of ICT benefits.

Hypothesis 2: The level of use of internal systems has a positive effect on the level of ICT benefits, which is partially mediated by the level of innovation.

It can be analyzed into the following three sub-hypotheses:

Hypothesis 2.1: The level of use of internal systems has a positive effect on the level of innovation.

Hypothesis 2.2: The level of innovation has a positive effect on the level of ICT benefits (it is identical to hypothesis 1.1).

Hypothesis 2.3: The level of use of internal systems has also a positive effect on the level of ICT benefits.

Hypothesis 3: The level of ICT benefits has a positive effect on business performance.

Hypothesis 4: The level of innovation has a positive effect on business performance, which is both direct and indirect through the level of ICT benefits.

6.5 Instruments Validation

The above five instruments formulated for measuring the level of e-business and internal IS use, the level of innovation, the level of benefits from ICT and business performance were validated for the tourism sector through the established methods proposed by related statistical literature (e.g. Gefen et al., 2000; Straub et al., 2004; Kline, 2005). Initially, construct validity was examined, which quantifies the extent to which the selected items for a construct constitute a reasonable operationalization of what they are expected to measure (Gefen et al., 2000; Straub et al., 2004). Its main dimension, convergent validity, defined as the extent to which the selected items reflecting the construct "converge" show significant high correlations with one another, was assessed through Confirmatory Factor Analysis (CFA) (Straub et al., 2004; Kline 2005). In particular, for each construct a separate CFA model was estimated using the AMOS 6 software (Byrne, 2001); also, an additional 'total' CFA was conducted, including all five constructs with all possible correlations among them. Table 6.2 provides the values of the incremental goodness-of-fit indexes NFI, RFI, IFI, TLI and CFI for all these models, which all exceed the recommended minimum level of 0.9 (Gefen et al., 2000; Straub et al., 2004). Table 6.2 also gives results about the RMSEA (Root Mean Square Error of Approximation) values, which are all lower than the recommended maximum level of 0.08 (Browne and Cudeck, 1993), and the AVE (Average Variance Extracted) values, which all exceeded the recommended minimum level of 0.5 (Gefen et al., 2000; Straub et al., 2004). It should be noted that the model of the Business Performance instrument has three items, so it is 'just-identified' (Klein, 2005) and the incremental fit indexes and the RMSEA are meaningless. In addition, the items' loadings for all constructs were also examined; all of them were statistically significant (most of them exceeded 0.6, so they can be characterized as 'strong' according to Chin (1998)), consequently there was no need for 'purification' (i.e. dropping insignificant items). Taking into account all the

above results, it can be concluded that all five instruments are characterized by convergent validity.

Table 6.2.   *Incremental goodness-of-fit indices, RMSEA, AVE and Cronbach Alpha values of the models*

Model	NFI	RFI	IFI	TLI	CFI	RMSEA	AVE	Cronbach Alpha
Internal IS	0.970	0.926	0.989	0.971	0.988	0.035	0.511	0.688
E-Business	0.985	0.956	0.987	0.960	0.987	0.068	0.708	0.907
Innovation	0.991	0.947	0.992	0.951	0.992	0.024	0.535	0.829
ICT Benefits	0.978	0.961	0.987	0.977	0.987	0.058	0.529	0.851
Business Perf.	-	-	-	-	-	-	0.647	0.842
Total	0.933	0.922	0.974	0.969	0.974	0.034	-	-

Discriminant validity, defined as the extent to which the items measuring one construct differ from the ones not measuring it, but measuring other constructs (Straub, 2004), was also examined. To do this, the criterion proposed by Fornell and Larcker (1981) was used; according to it, there is sufficient discriminant validity when the AVE of each construct is higher than the squared correlations of it with the other constructs. Looking at Table 6.3, that gives the values of AVE for all five constructs (as diagonal elements) and also the correlations between the constructs (as off-diagonal elements), it is clear that the above criterion is clearly satisfied for all constructs. Moreover, the factor structure behind the 23 items of these five constructs was also examined by performing Principal Components Analysis (PCA) with Varimax rotation using the SPSS 15.0 software. The results (shown in Appendix B Table 2) indicate that: five factors have been formed (having eigenvalues exceeding 1.0); each of them is characterized by high loadings of all the items corresponding to one of the constructs and much lower loadings of all the other items. Overall, the above results proved the discriminant validity of the five constructs developed and used in this study.

Table 6.3.   Discriminant Validity test (the diagonal elements are equal to the AVE of the corresponding construct, and the off-diagonal elements are equal to the squared correlations between the corresponding constructs)

	Internal IS	E-Business	Innovation	ICT Benefits	Business Perfor.
Internal IS	0.511				
E-Business	0.301	0.708			
Innovation	0.440	0.286	0.535		
ICT Benefits	0.397	0.239	0.383	0.529	
Business Perfor.	0.258	0.198	0.302	0.274	0.647

Finally, the reliability of the constructs was also examined. Reliability is defined as the extent to which the items of a construct, taken together, constitute an error-prone operationalization of it (Straub et al, 2004). For assessing it, the Cronbach Alpha coefficient of each construct was calculated (shown in the last column of Table 6.2). As all Alpha coefficients [with the only exception of the Internal IS construct, which is marginally lower (0.688)] exceed the recommended minimum acceptable level of 0.7 (Gefen et al, 2000; Straub et al, 2004; Kline, 2005), the reliability of the constructs is proved.

6.6 Descriptive Statistics

Initially, for all the items used for measuring the levels of e-business and internal IS use, innovation, ICT benefits and business performance, descriptive statistics were calculated for firms located in the Mediterranean region, the Central Europe and the Scandinavian region; also, X^2 tests were performed for examining whether there are significant differences among the three regions. In Table 6.4a are shown the percentages of tourism firms having the examined internal and e-business IS and types of innovation in the three regions (in the second, third and fifth column), and also the results of the X^2 tests (statistical significance of X^2) concerning differences between Mediterranean region and Central Europe (in the fourth column), and between Mediterranean and Scandinavian region (in the sixth column). Also, in Table 6.4b are shown the percentages of tourism firms experiencing negative influence, no influence at all or positive influence of ICT on

the six examined aspects of firms' operation, and also the ones having increase, stability or decrease in the three examined measures of business performance (relative frequencies of ICT benefits' and business performance variables/items) in the three regions; in the final column are shown the results of the X^2 tests (statistical significance of X^2) concerning the differences of Central Europe and Scandinavian region from the Mediterranean region.

Table 6.4a.   Percentages of firms having the examined internal and e-business IS and innovation types in the Mediterranean region, Central Europe and Scandinavian region

	Mediterranean	Central Europe	Significance of X^2	Scandinavian	Significance of X^2
Int1-Intranet	36.7%	33.8%	0.322	33.7%	0.318
Int2-ERP	20.4%	10.8%	0.000	12.2%	0.000
Int3-Account. SW	72.5%	67.7%	0.088	67.8%	0.098
Int4-Share Doc.	31.7%	21.9%	0.000	26.7%	0.076
Int5-Track Hours	10.6%	13%	0.221	25.5%	0.000
Int6-Invent. Man	21%	18.6%	0.337	26.9%	0.028
Eb1-Publish Offers	16%	19.3%	0.150	16.5%	0.828
Eb2-Answer Calls	12.4%	13.3%	0.639	13.9%	0.467
Eb3-Receive Ord.	13.2%	15.9%	0.206	15.7%	0.256
Eb4-Payment	9.4%	9.1%	0.855	8%	0.449
Inv1-Prod/Serv. Innov.	42.3%	29.4%	0.000	36.7%	0.130
Inv2 – ICT based	28.9%	14.7%	0.000	22.9%	0.029

Pr/Serv. Inn.					
Inv3- Process Innovation	39.3%	27.7%	0.000	28.8%	0.000
Inv4– ICT based Process Inn.	33.9%	19.1%	0.000	23.3%	0.000

Table 6.4b.   Relative frequencies of ICT benefits' and business performance variables in the Mediterranean region, Central Europe and Scandinavian region

	Region	Negative Influence	No Influence	Positive Influence	Significance of X^2
Ict1-Rev. Growth	Mediterranean	1.4%	39.7%	58.9%	
	Central Europe	1.7%	43.3%	55%	0.433
	Scandinavian	0.8%	45.5%	53.7%	0.202
Ict2-Proc. Effic.	Mediterranean	1%	31.1%	67.9%	
	Central Europe	2.4%	34%	63.6%	0.110
	Scandinavian	0.8%	28.4%	70.8%	0.786
Ict3- Int.Work Or.	Mediterranean	1.2%	26.5%	71.3%	
	Central Europe	2.6%	38%	59.4%	0.000
	Scandinavian	1%	41.2%	57.8%	0.000
Ict4-Pr/Ser. Qual.	Mediterranean	1.4%	44.3%	54.3%	
	Central Europe	2.4%	59.5%	38.1%	0.000
	Scandinavian	0.8%	63.7%	35.5%	0.000
Ict5 –Cust. Qual.	Mediterranean	0.8%	28.7%	70.5%	
	Central Europe	2.2%	39.9%	57.9%	0.000
	Scandinavian	0.8%	38.6%	60.6%	0.008

Ict6-Productivity	Mediterranean	1.6%	30.5%	67.9%	
	Central Europe	1.7%	38.1%	60.2%	0.035
	Scandinavian	1.2%	38.4%	60.4%	0.052
		Decrease	Stability	Increase	
Bp1-Market Share	Mediterranean	11.4%	55.1%	33.5%	
	Central Europe	6.7%	48.7%	44.6%	0.000
	Scandinavian	5.9%	52.1%	42%	0.000
Bp2-Turnover	Mediterranean	11.4%	55.1%	33.5%	
	Central Europe	6.7%	48.7%	44.6%	0.000
	Scandinavian	5.9%	52.1%	42%	0.001
Bp3-Productivity	Mediterranean	14.4%	43.5%	42.1%	
	Central Europe	9.9%	35.9%	54.2%	0.000
	Scandinavian	5.7%	43.8%	50.5%	0.060

Concerning the use of internal IS, we remark that the most widely used application by tourism firms of the Mediterranean region is the accounting software (used by 72.5% of firms), followed by Intranet (by 36.7% of firms) and document sharing/collaborative work applications (used by 31.7% of firms); the use of capacity or inventory management applications and ERP systems is much lower level (21% and 20.4% of firms use these IS respectively). The X^2 tests have shown that the use of ERP, accounting and document sharing/collaborative work applications is significantly higher by firms in the Mediterranean region in comparison with firms from both the Central Europe and the Scandinavian region. On the contrary, no significant differences were found related to the use of applications for tracking working hours or production time and for managing capacity or inventories between the firms from the Mediterranean region and the ones from the Central Europe, while in the Scandinavian countries there is a significantly higher use of these applications. Finally, tourism firms from all three regions reported

similar levels of use of their Intranet. Concerning 'extrovert' e-business IS, the findings showed that all tourism firms irrespective of their region make a low level of use of these extrovert IS. Moreover, none statistically significant difference was also found by the X^2 tests comparing the level of use by firms in the three regions. These low levels of use of IS systems are not surprising, since tourism firms have always been characterized by their low levels of use and adoption of new technologies (Sigala, 2006).

The most striking finding relates to comparative data concerning the innovation activity of tourism firms: findings in Table 6.4 show that a significantly greater percentage of firms from the Mediterranean tourism sector reported the introduction of a product/service and a process innovation (42.3 % and 39.3 % firms respectively) and the use of ICT for enabling such innovation (28.9% and 33.9% firms respectively) in comparison with the corresponding percentages of firms from both the Central Europe and the Scandinavian region (with the only exception of a similar percentage of product/service innovator firms in the Mediterranean and the Scandinavian region). Moreover, it is also evident that firms from the Mediterranean region also reported high levels of ICT benefits (revenue growth, efficiency of business processes, internal work organization, quality of products and services, quality of customer service and productivity). Most of these positive ICT impacts are higher for tourism firms in the Mediterranean region in relation to the ICT benefits reported by firms in both the Central Europe and the Scandinavian region (with the only exceptions of ICT's similar impacts on revenue growth and efficiency of business processes). The higher innovative performance of firms in the Mediterranean region is in agreement with the findings of Sundbo et al. (2007). Finally, in relation to the Central European and Scandinavian firms, the Mediterranean tourism firms reported significantly lower business performance in terms of the two variables (namely increase of market share and turnover), but similar performance related to the third variable (productivity).

In summarizing, it can be concluded that in comparison with firms from the Central Europe, tourism firms in the Mediterranean region have: a) a higher use of three of the examined internal applications and similar level of use of the other three; b) similar level of use of e-business, c) higher levels of innovation and d) a higher level of benefits from ICT in four out of the six examined aspects of tourism firms' operation. Similarly, in comparison with the firms from the Scandinavian region, tourism firms in the Mediterranean region have: i) a higher level of use of three of the examined internal

applications, but lower level of use of the two other IS types, and similar level of use of one; ii) similar level of use of e-business; iii) higher levels of innovation; and iv) higher level of benefits from ICT in four out of the six examined aspects of tourism firms' operation. Therefore, although the Mediterranean region is generally characterized by lower levels of economic development, lower expenditure for ICT and R&D, lower percentage of innovative firms and higher uncertainty avoidance attitude than the Central Europe and the Scandinavian region (section 6.4), this study's findings from the tourism sector have revealed a different comparative context for the firms of these three regions. So, the Mediterranean tourism firms reported higher levels of innovation, greater business benefits from ICT (which means more efficient use of them) and higher level of use of some important internal applications (ERP, accounting and document sharing/collaborative work applications) in comparison with Central European and Scandinavian tourism firms. In addition, the reported level of use of e-business was found to be similar for all tourism firms across the three regions.

6.7 Mediterranean Model

The research model of this study (Figure 6.1) was first estimated for the Mediterranean region by using the data from the 501 tourism firms from Mediterranean countries through covariance-based SEM (Kline 2005), which offers the advantage of estimating at the same time both the measurement part of the model (i.e. paths between each construct and corresponding items) and the structural part of the model (i.e. paths between constructs), using the AMOS 6 software (Byrne, 2001). As all the fit statistics of this model have acceptable values in accordance with the recommendations of the relevant literature (Gefen et al., 2000; Straub et al., 2004) (NFI=0.936, RFI=0.926, IFI=0.975, TLI=0.971, CFI=0.975, RMSEA=0.034), it is concluded that the model is characterized by acceptable fit to the data. The results concerning the structural part of this model (statistically significant standardized path coefficients) are shown in Figure 6.2.
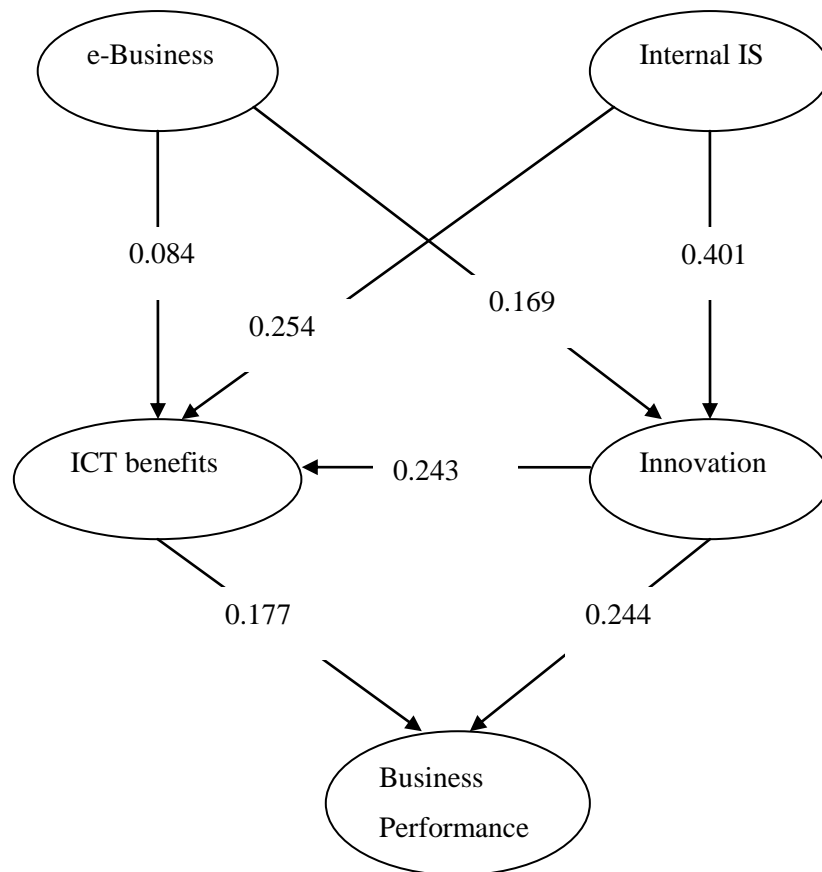
Figure 6.2.   The estimated structural model for the Mediterranean region.

We remark that the levels of use of e-business and internal systems have both positive and statistically significant effect on the level of innovation (with standardized coefficients 0.169 and 0.401 respectively), so hypotheses 1.1 and 2.1 are both supported. Therefore, we conclude both these types of IS are drivers of innovation in tourism sector firms, with the internal systems having a stronger effect on innovation than the e-business systems. It is also evident that the level of innovation has a positive and statistically significant effect (standardized coefficient 0.243) on the level of benefits that tourism firms obtain from their ICT infrastructure, and so, hypotheses 1.2/2.2 are supported as well. This result is in agreement with conclusions of previous literature that innovation increases the business benefits and contribution of ICT (e.g. Licht & Moch 1997, Hempell et al. 2004, Hempell 2005, Loukis et al. 2008a).

It is also worth mentioning that the levels of use of e-business and internal systems have both a positive and statistically significant direct effect on the level of ICT benefits (standardized coefficients 0.084 and 0.254 respectively), and so, hypotheses 1.3 and 2.3 are both supported. Hence, it is concluded that the levels of use of e-business and internal

systems have positive effects on the level of ICT benefits, which are both partially mediated by the level of innovation, and so, hypotheses 1 and 2 are supported. In particular, the level of e-business systems adoption has a statistically significant total effect on ICT benefits equal to 0.084 (direct effect) + 0.169*0.243 (indirect effect through innovation) = 0.125; this is in agreement with previous relevant empirical literature concluding that e-business adoption has a positive impact on business performance (Zhu and Kraemer 2002, Barua et al 2004, Devaraj et al 2007, Sanders 2007, Johnson et al 2007, Quan 2008, Soto-Acosta and Meroño-Cerdan 2008). It is also good to note that 33% of this total effect (0.169*0.243/0.125) is through the innovations that e-business systems drive, which enhances the benefits that ICT infrastructure generates. Similarly, the level of use of internal systems has a statistically significant total effect on ICT benefits equal to 0.254 (direct effect) + 0.401*0.243 (indirect effect through the extent of innovation) = 0.351; this in agreement with previous relevant empirical literature concluding that the adoption of internal systems has a positive impact on business performance (Hitt et al. 2002, Hunton et al. 2003, Nicolaou & Reck 2004, Nicolaou & Bhattacharya 2006, Wieder et al. 2006, Hendricks et al., 2006). It is also noted that 28% of this total effect (0.401*0.243/0.351) is through the innovations that internal systems drive, which enhance the benefits that ICT infrastructure generates. Based on these results, it is concluded that the level of internal systems use has a much larger total effect on the level of benefits a firm gets from its ICT infrastructure and on the level of innovation, than the level of e-business systems use; however, for the e-business systems it is higher the percentage of their effect on ICT benefits generated through innovation (33%) than for the internal systems (28%).

Finally, it is worth mentioning that the level of ICT benefits has a positive and statistically significant effect on business performance (standardized coefficient 0.177), and so hypothesis 3 is supported. It is also clear that the level of innovation has also a direct positive and statistically significant effect on business performance (standardized coefficient 0.244). This leads to the conclusion that the positive effect of the level of innovation on business performance is partially mediated by the level of ICT benefits, and so, hypothesis 4 is also supported. In particular, it is found that the level of innovation has a statistically significant total effect on business performance equal to 0.244 (direct effect) + 0.243*0.177 (indirect effect through the ICT benefits) = 0.287; this is in agreement with previous relevant empirical literature concluding that innovation has a positive impact on

business performance (e.g. Cainelli et al., 2004; Dunk, 2005; Thornhill, 2006; Koellinger, 2008; De Clerk et al., 2008). It is also noted that 15% of this total effect (0.243*0.177/0.287) is through the increase of ICT business benefits resulting from innovation, which enhance further business performance.

6.8 Central European and Scandinavian Model

The same research model (Figure 6.1) was also estimated for the Central European and Scandinavian region by using the data from the firms of these regions (585 tourism firms from Central European countries and 510 tourism firms from Scandinavian countries). All the fit statistics of both the Central European model (NFI=0.909, RFI=0.904, IFI=0.953, TLI=0.944, CFI=0.952, RMSEA=0.041) and the Scandinavian model (NFI=0.921, RFI=0.909, IFI=0.971, TLI=0.966, CFI=0.972, RMSEA=0.032) have acceptable values in accordance with the recommendations of the relevant literature (Gefen et al 2000; Straub et al 2004), and so, both models are characterized by acceptable fit to the data. The structural parts of these two models (statistically significant standardized path coefficients) are shown in Figures 6.3 and 6.4 respectively. We remark that in the Central European model (Figure 6.3) all paths are statistically significant, so all our research hypotheses are supported in this regions as well. However, in the Scandinavian model (Figure 6.4) three of the paths are not statistically significant (e-Business→Innovation, e-Business→ICT Benefits, Innovation→Business Performance), so hypotheses H1.1, H1.3 and H4 are not supported, while all the remaining are supported, in this region.
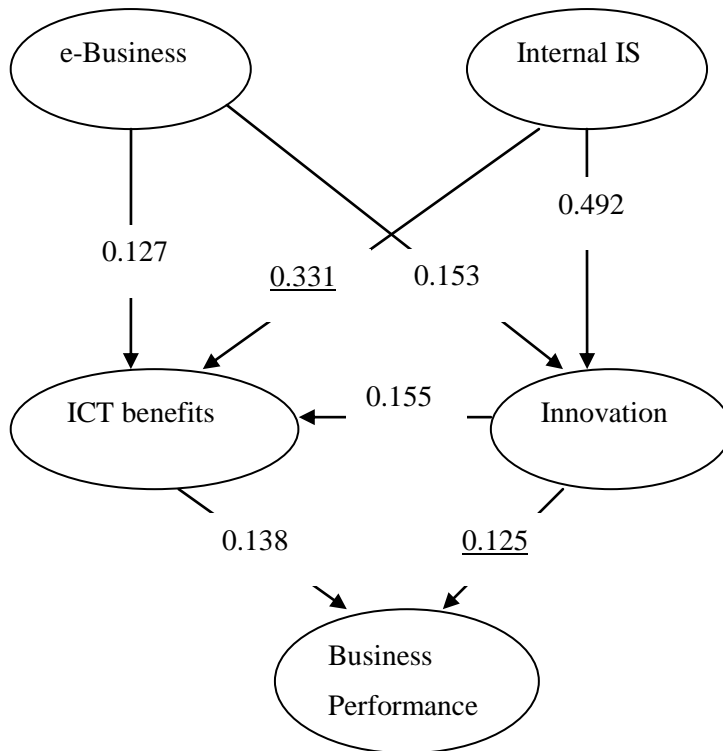
Figure 6.3.   *The estimated structural model for the Central Europe*
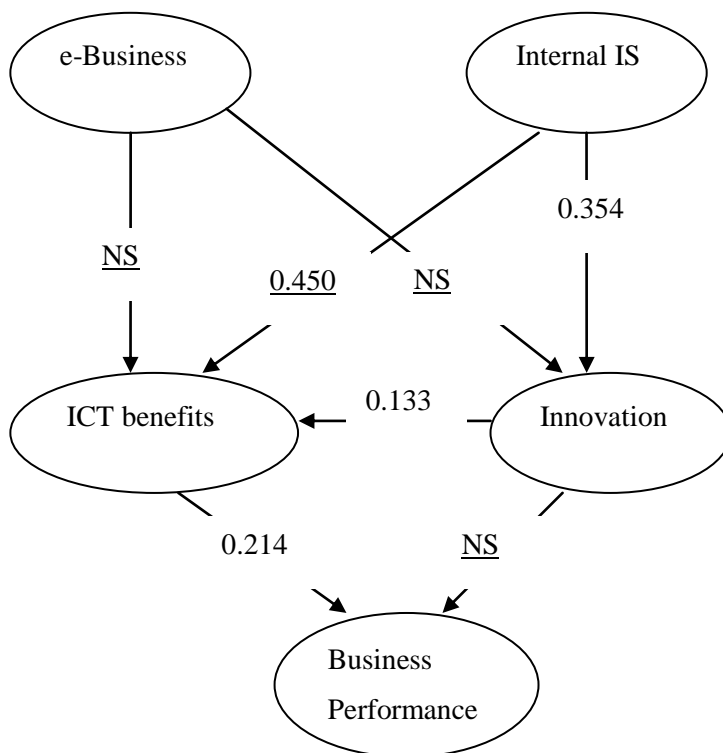
Figure 6.4.   *The estimated structural model for the Scandinavian region*

As a next step statistically significant differences between the paths of the Mediterranean model (Figure 6.2) and the corresponding paths of the Central European model (Fig. 6.3) were examined by performing 'multiple-groups' SEM (Byrne, 2001; Kline, 2005); the main objective of this technique is to test whether the paths of a SEM are invariant across two groups or not, and if not to identify which of the paths differ between the groups. In particular, the following steps and analyses were performed based on the above mentioned relevant literature:

i) Initially the two SEM were estimated in the two groups (Mediterranean and Central European tourism firms) simultaneously, without any equality constraints; the χ^2 value and the degrees of freedom (DF) of this 'unconstrained' model are shown in the first raw of Table 6.5.

ii) Next the two SEM were estimated again simultaneously, but constraining all the corresponding paths to be equal across the two models; the new χ^2 value and degrees of freedom of the 'constrained' model are shown in the second raw of Table 6.5, followed by the resulting differences (increases) of X^2 (ΔX^2) and DF (ΔDF) in comparison with the initial unconstrained model.

iii) The above increase of the X^2 value given the increase in the degrees of freedom is statistically significant (significance 0.026), so it is concluded that the paths of this SEM are not invariant across the two groups and some of the paths differ between the Mediterranean and Central European tourism firms.

iv) Finally, in order to identify which of the paths differ between the two groups, for each of the paths the two SEM were estimated simultaneously, but constraining only this particular path to be equal across the two models. If the resulting increase of the X^2 value in comparison with the initial unconstrained model given the increase in the degrees of freedom is not statistically significant, then it is concluded that this path is invariant across the two groups; on the contrary, if it statistically significant, then it is concluded that this path differs between the two groups. Based on this methodology, it was found that the paths Internal IS → ICT Benefits and Innovation → Business Performance differ between the Mediterranean and the Central European tourism firms (these two paths are underlined in Figure 6.3 in order to show that they are significantly different in relation to the Mediterranean model).

The same methodology was used for examining whether there are statistically significant differences between the paths of the Mediterranean model (Figure 6.2) and the corresponding paths of the Scandinavian model (Figure 6.4). The X^2 value and the degrees of freedom (DF) of the 'unconstrained' model are shown in the third raw of Table 6.5, while the ones of the 'constrained' model are shown in the fourth raw, followed by the resulting increases of ΔX^2 and ΔDF in comparison with the unconstrained model. This increase of the X^2 value given the increase in the degrees of freedom is statistically significant (significance 0.028), and so, it is concluded that some of the paths differ between the Mediterranean and Scandinavian models. Following the procedure described above in step iv), it was identified that the paths e-Business$\rightarrow$ ICT Benefits, e-Business $\rightarrow$ Innovation, Internal IS $\rightarrow$ ICT Benefits and Innovation $\rightarrow$ Business Performance differ between the Mediterranean and the Scandinavian models (these four paths are underlined in Figure 6.4 in order to denote that they are significantly different in relation to the Mediterranean model).

Table 6.5.   Multiple-groups SEM

	X^2	DF	ΔX^2	ΔDF	Significance
Unconstrained Medit – Central Eur.	789.9	432			
Constrained Medit – Central Eur.	805.8	439	15.9	7	0.026
Unconstrained Mediter. – Scandin.	690.9	432			
Constrained Mediter. – Scandin.	706.6	432	15.7	7	0.028

Overall, the findings from the comparisons of the three models have shown that the effect of innovations on business performance is higher in the Mediterranean tourism sector in relation to both the Central European and the Scandinavian tourism sectors. This illustrates that Mediterranean tourism firms make more mature use of the types of examined IS and for driving effective innovations than the firms in the other two regions, which in turn have a higher positive impact on business performance. Moreover, the effects of using e-business IS on both innovation and benefits obtained from ICT are higher for the Mediterranean tourism firms in comparison with the Scandinavian firms,

which means that the former make more effective use of e-business and have a more innovative approach to it than the latter. On the contrary, the effect of using internal IS on the benefits obtained from ICT is lower in the Mediterranean tourism firms in comparison with both the Central European and the Scandinavian ones; this means that the latter make more effective use of internal IS than the former. The longer and higher experience of the Central European and Scandinavian countries in using effectively internal IS, which are the most 'traditional' type of IS existing for more than four decades (while e-business IS are much more recent), in comparison with the Mediterranean countries is a possible explanation for this. All the other relations/effects we investigated are similar across these three regions. Finally, although the Mediterranean region is generally characterized by lower economic development, lower expenditure for ICT and R&D, lower percentage of innovative firms and higher uncertainty avoidance attitude than the Central Europe and the Scandinavian region (section 6.4), the study's results reveal that in the tourism sector the comparisons amongst firms from the three regions are quite different; concerning the use of e-business and internal ICT, the innovation activity, the ICT benefits and the relations among them, the Mediterranean tourism firms are in some aspects higher and in some others at a similar level with the Central European and the Scandinavian ones.

6.9 Discussion

Findings from the multiple-groups SEM comparing the SEM models estimated for each of the three regions have revealed that the capability of the two examined IS types to drive business performance improvements differs between the three regions, due the more mature and efficient use of internal IS by Scandinavian and Central European relative to the Mediterranean tourism firms, leading to a higher contribution to the benefits generated for firms by their ICT infrastructure. The fact that the ICT benefits and performance impacts of internal IS are lower for Mediterranean firms relative to that of the firms from the two other regions may be interpreted based on the following facts:

- Internal IS are relatively new technologies for Mediterranean firms and so, their use and incorporation in business processes require additional time until organizational change in business processes is achieved, and so, ultimately, ICT benefits can be materialized (e.g. Henderson and Venkatraman, 1993).

- Mediterranean tourism firms are small in size relative to tourism firms in the other two regions; in this vein, the impact and importance of internal IS for coordinating internal processes and increasing the business performance of the Mediterranean tourism firms is not so crucial as it is for larger firms mainly located in the other two regions (e.g. e-procurement was found to have a minimal performance impact on small tourism firms, (Sigala, 2006)).

Also, the comparison of the SEM models estimated for the three regions have revealed the higher innovative performance of Mediterranean tourism firms relative to the firms from the two other regions, leading to a higher contribution to business performance. Based on the tourism innovation framework of Sundbo et al. (2007), which defines three levels of factors that affect the tourism firms' innovative performance (at the firm, innovation network and innovation system level), the following arguments may explain the fact that Mediterranean tourism firms were found to possess this higher innovative performance:

I) Factors at firm level:

- Mediterranean tourism firms have been particularly too innovative in introducing new forms of tourism and new services in order to diversify their product offering and reposition their image from a "summer see, sand, sun holiday destination" to an "all year around" appealing destination. Tourism firms in the other two regions do not face such operational pressures to product innovation, as their destinations are well diversified in consumers' mind but also infrastructural.

- The Mediterranean tourism firms have been found to have a much higher labor turnover (also due to their higher seasonality) than tourism firms in other European countries (Chalkiti, & Sigala, 2010). This knowledge transfer and learning from (larger) competitors or other industries (depending from where the new staff of the firm comes from) can significantly increase the innovative performance of the tourism firm.

- Sundho et al. (2007) also found that Spanish firms were more innovative than Danish firms irrespective of their size: this was because large Spanish firms were frequently part of a hotel chain, so they shared and had access to know-how, professional management practices and resources through their corporations, while the small Spanish tourism firms were found to be managed in a more professional rather than artisan style by which the small Danish firms had adopted. In other words, it can be concluded that it is not only the

size of the tourism firm that determines its innovative performance, but rather the entrepreneurial mode of its owner-manager.

II) Factors at the innovation networks level:

- Mediterranean tourism firms are more dependent on third parties for their distribution (e.g. tour operators, travel agents etc.) than the tourism firms located in the other two regions. As a result, the former firms create close relations and strong bonds with such intermediaries, which in turn give them access to valuable sources of market and competitive intelligence.

- In order to decrease their reliance on tourism intermediaries, Mediterranean tourism firms have been very eager to join marketing and distribution consortia as well as distribution networks (e.g. the leading hotels of the world, the leading small luxury hotels of the world, Best Western etc.). Such networks and consortia have embedded knowledge from which Mediterranean tourism firms have benefited for innovating their products and processes.

- The impact of exchange relationships and membership in networks on innovation performance was proved by Sundbo et al. (2007), who showed that Spanish firms were more innovative than Danish firms as the former had more active exchange relationships with local - regional networks (e.g. educational and research institutions) as well as with international tourism firms (e.g. tour operators, tourism consortia etc.).

III) Factors at the innovation systems level:

- The development of tourism networks and clusters has been very active and dynamic in the Mediterranean regions specifically also because of the related funding provided by the EU (e.g. agro-tourism clusters based on Leader + programmes, Inter-regional projects for promoting cooperation amongst Mediterranean countries, tourism knowledge networks amongst the industry and educational institutions) (see an example by Bull, 1999).

- Tourism is recognized as one of the major industries generating a much higher contribution to the GNP in the Mediterranean countries than the other European countries. This importance of tourism has driven many Mediterranean political authorities to assume a more active role by creating and institutionalizing proper strategies and policies for supporting innovation in tourism (e.g. the creation of innovation systems, e.g. Svensson et al, 2005).

6.10 Conclusions

The previous sections presented an empirical study of the relations between the level of use of two quite different and widely adopted types of IS, the internal and the e-business ones, the level of innovation, the ICT business benefits and finally business performance in the tourism sector. It was based on firm-level data collected by the e-Business Survey 2006 from 2665 European tourism firms, which were used for estimating structural equation models (SEM) concerning the relations among the above variables in three European regions (Mediterranean, Central and Scandinavian). Based on the results of the models, it was concluded that both these types of IS are drivers of innovation in tourism sector firms, with the internal systems having a stronger effect on innovation than the e-business systems. Both types of IS have an impact on the benefits generated for the firms from ICT, and through them on business performance, with the internal systems having a much higher impact on ICT benefits and business performance than the e-business systems. The impacts of both these types of IS on ICT benefits are partially mediated by innovation. Concerning innovation, it has been concluded that it has a positive impact on business performance of tourism sector firms, partially mediated by the increase of ICT benefits that innovation causes. However, for the Scandinavian region it was found that some of the above effects are not statistically significant (the effects of e-business use on innovation and ICT benefits, and the direct effect of innovation on business performance), indicating the impact of the national context on these effects.

By comparing descriptive statistics of our variables across the three regions it was concluded that the Mediterranean tourism firms are characterized by higher levels of innovation, greater business benefits from ICT (which means more efficient use of them) and higher level of use of some important internal applications (ERP, accounting and document sharing/collaborative work applications) in comparison with Central European and Scandinavian tourism firms; the use of e-business was found to be similar for all tourism firms across the three regions. Also, 'multiple groups' SEM was performed for investigating any significant differences amongst the relevant paths of the three regional SEM models. It was found that the effect of innovations on business performance is higher in the Mediterranean tourism sector in relation to both the Central European and the Scandinavian tourism sectors. On the contrary, the effect of using internal IS on the benefits obtained from ICT is lower in the Mediterranean tourism firms in comparison

with both the Central European and the Scandinavian ones; this means that the latter make more effective use of internal IS than the former. The theoretical model of tourism innovation developed by Sundbo et al. (2007) was used for explaining any differences amongst the three regions. Therefore, although the Mediterranean region is generally characterized by lower levels of economic development, lower expenditure for ICT and R&D, lower percentage of innovative firms and higher uncertainty avoidance attitude than the Central Europe and the Scandinavian region, this study's findings from the tourism sector have revealed a different comparative context for the firms of these three regions.

The study's findings have interesting implication for both research and practice. The significant differences identified in this study between the internal systems and the extrovert external systems (regarding their effect on innovation, benefits generated by ICT and business performance) indicate that future IS research (in tourism and all other sectors) investigating IS performance impact should not deal with IS in general, but it should focus on particular types of IS. In this vein, future research focusing on other specific types of IS can be conducted in order to further test, refine, and/or expand the proposed model (Figure 6.1) for investigating the relations of specific IS with innovation, ICT business benefits and business performance. To better achieve that, future studies should try to incorporate and use theories from the innovation field and the role of ICT in driving innovation, since this study has highlighted the significant mediating role of innovation in materializing ICT benefits and business performance impacts. At a practical level, the findings highlight that if tourism firms wish to maximize the performance potential and business benefits of ICT, they should aim to combine the development of internal ICT and e-business systems with innovations. Moreover, comparative findings between the three regional SEM models have also shown that the tourism firms' willingness to exploit innovation systems' capabilities for better exploiting ICT may have affected their ability to generate maximum performance benefits from their ICT investments. Consequently, tourism firms wishing to maximize their ICT benefits should appropriately identify and manage their external and internal factors that can crucially facilitate and boost their innovative performance. For examples, firms should try to participate in networks (local or international), develop relations with other firms and research institutions as well as adopt more professional management practices, e.g.

through the use of tourism graduates, in order to increase their capacity to more innovatively exploit IS and their ICT performance benefits.

CHAPTER 7

Conclusions

7.1 Contribution of the present research

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

- It presents an empirical investigation of the relations between three different widely adopted types of IS, the internal, the e-business and the e-procurement IS (at a first level), the level of innovation and the business benefits obtained from ICT (at a second level), and finally business performance (at a third level). It examines and compares these three fundamental IS types as to their impact on innovation, on the benefits provided to the firm by its ICT infrastructure, and finally on business performance.

- It examines empirically to what extent the effect of these three types of IS on business performance is through the innovation they drive, and to what extent the enthusiastic expectations of the relevant theoretical literature are empirically confirmed. It examines in general the mediating effect of innovation in the relation between IS and business performance.

- It investigates empirically the above issues for the tourism sector, which is particularly important for the economy of our country and the European South in general.

- It examines and compares the above mentioned relations for the tourism sector in the Mediterranean, Central European and Scandinavian region, taking into account the existing current debate for the economic performance differences between the European South, Mediterranean region on the one hand and the Central Europe and Scandinavian on the other.

7.2 Findings and conclusions

The main findings and conclusions of this PhD Dissertation can be summarized as follows:

- Internal IS, e-procurement IS and e-business IS are all drivers of innovation.
- The internal systems have the strongest effect on innovation, the e-business systems have a much smaller effect and finally the e-procurement systems have the smallest effect. Therefore the enthusiastic expectations of the relevant

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theoretical literature that e-business and e-procurement will have a much stronger and dramatic impact on innovation that the 'traditional' internal IS is not conformed.

- The internal systems have a much higher impact on ICT benefits and business performance, followed by the e-business ones, while the e-procurement ones have the smallest impact.

- The effects of internal and e-business IS on ICT benefits and through it on business performance are partially mediated by innovation. With respect to the internal IS a smaller part of their effect on business performance (41%) is through the innovation they drive, while the largest part (59%) is through the automation of already existing business processes for existing products/services. On the contrary, the largest part of the much smaller effect of e-business IS on business performance is through the innovation they drive (63%), and a much smaller part of it (37%) is through automation of existing business processes for existing products/services. Finally, the effect of e-procurement IS on business performance is completely mediated by innovation.

- Concerning innovation it has been concluded that it has a positive impact on business performance, which is partially mediated by the increase of ICT benefits that it causes.

Particularly for the Tourism Sector the findings were:

- In general, the estimated models for tourism sector lead to similar conclusions to the ones drawn from the general model. They provided evidence of positive impact of internal, e-business and e-procurement IS on innovation, with the internal IS being a stronger driver of innovation, followed by the e-business and the e-procurement ones.

- The impact of the internal, e-business and e-procurement IS on the business benefits that the tourism firms achieve from their ICT infrastructures, is mediated by innovation (partially for the first two, and completely for the third).

- The only difference compared to the general model is that in the estimated tourism model the mediation effect of innovation on the impacts of internal IS and e-

business IS on business performance is weaker (17% and 27% respectively instead of 39% and 63% for the general model).

- The comparisons amongst the Mediterranean, the Central European and the Scandinavian regions' tourism sector have shown that the former is characterized by higher levels of innovation, greater business benefits from ICT and higher level of use of some important internal applications (ERP, accounting and document sharing/collaborative work applications) in comparison with Central European and Scandinavian tourism firms.

- The effect of innovations on business performance is higher in the Mediterranean tourism sector in relation to both the Central European and the Scandinavian tourism sectors. On the contrary, the effect of using internal IS on the benefits obtained from ICT is lower in the Mediterranean tourism firms in comparison with both the Central European and the Scandinavian ones, which means that the latter make more effective use of internal IS than the former.

Table 1.Survey questions for measuring each construct.

Constructs	Items
Innovation	Inv1: During the past 12 months, has your company launched any new or substantially improved PRODUCTS or SERVICES? ((1)yes (2)no (3)DK/refused/not applicable)
	Inv2: Have any of these product or service innovations been directly related to or enabled by information or communication technology? ((1)yes (2)no (3)DK/refused/not applicable)
	Inv3: During the past 12 months, has your company introduced any new or significantly improved internal PROCESSES, for example for producing or supplying goods and services? ((1)yes (2)no (3)DK/refused/not applicable)
	Inv4: Have any of these process innovations been directly related to or enabled by information or communication technology? ((1)yes (2)no (3)DK/refused/not applicable)
Internal IS	Does your company use online applications OTHER THAN e-MAIL, for example special software, to support any of the following business functions: Do you use online applications other than e-mail … [item]? ((1)yes (2)no (3)DK)
	Int1: to share documents between colleagues or to perform collaborative work in an online environment
	Int 2: to track working hours or production time

	Int 3: to manage capacity or inventories?
	Int 4: Does your company use an ERP system (that is Enterprise Resource Planning System)?
	Int 5: Do you use for managing information in the company an Intranet?
	Int 6: Do you use for managing information in the company a specific accounting software other than a spreadsheet such as Microsoft Excel?
Business Performance	Bp1: Has the share of your company in this market increased, decreased, or remained the same over the past 12 months? ((1)increased (2)decreased (3)stayed roughly the same (4)DK)
	Bp2: Has the turnover of your company increased, decreased or stayed roughly the same when comparing the last financial year with the year before?
	((1)increased (2)decreased (3)stayed roughly the same (4) DK (5) not applicable, e.g. if non-profit organisation)
	Bp3: Has the productivity of your company increased, decreased or stayed roughly the same when comparing the last financial year with the year before?
	((1)increased (2)decreased (3)stayed roughly the same (4) DK (5) not applicable, e.g. if non-profit organisation)
E-business	Which of the following marketing or sales related processes does your company support by specific IT solutions?
	Do you use IT solutions for ... [item]?((1)yes (2)no (3)DK)
	Eb1: Publishing offers to customers
	Eb2: Answering calls for proposals or tenders
	Eb3: Receiving orders from customers
	Eb4: Enabling customers to pay online for ordered products or services
ICT Benefits	All in all, in what ways have information and communication technologies influenced the business of your company? Please tell us for each of the following areas whether ICT has had a positive influence, a negative influence,

	or no influence at all.
	Would you say the influence of ICT on … [item] was …?
	((1) positive (2) negative (3) no influence (4) DK)
	Ict1: revenue growth
	Ict2: the efficiency of business processes
	Ict3: internal work organisation
	Ict4: quality of products and services
	Ict5: quality of customer service
	Ict6: the productivity of your company
E-procurement	Epro1: Do you use IT solutions for - Finding suppliers in the market? ((1)yes (2)no (3)DK)
	Epro2: Do you use IT solutions for - Inviting suppliers to quote prices or submit proposals? ((1)yes (2)no (3)DK)
	Epro3: Do you use IT solutions for - Ordering goods or services? ((1)yes (2)no (3)DK)

Table 2.   Loadings of constructs' items.

Item	Loading
Int1	.889
Int2	.790
Int3	.978
Int4	.601
Int5	.785
Int6	.672
Eb1	.873
Eb2	.840
Eb3	.872
Eb4	.608
Epro1	.825
Epro2	.899
Epro3	.883
Inv1	.659
Inv2	.701

Inv3	.798
Inv4	.734
Ict1	.681
Ict2	.718
Ict3	.643
Ict4	.892
Ict5	.742
Ict6	.740
Bp1	.701
Bp2	.872
Bp3	.732

Table 3.   Cronbach Alpha values of constructs

Construct	E-business	Internal IS	ICT benefits	Innovation	Business performance	E-procurement
Cronbach Alpha	.866	.700	.807	.773	.796	.896

Table 4.   Model fit indices

NFI	RFI	IFI	TLI	CFI	RMSEA
.990	.988	.992	.990	.992	.018

Table 5.   Loadings of constructs' items.

Item	Loading
Int1	.777
Int2	.627
Int3	.898
Int4	.866
Int5	.833
Int6	.638
Eb1	.904
Eb2	.845
Eb3	.908

Eb4	.650
Epro1	.830
Epro2	.911
Epro3	.869
Inv1	.654
Inv2	.620
Inv3	.881
Inv4	.927
Ict1	.632
Ict2	.718
Ict3	.789
Ict4	.741
Ict5	.613
Ict6	.738
Bp1	.679
Bp2	.818
Bp3	.765

Table 6.   Cronbach Alpha values of constructs

Construct	E-business	Internal IS	ICT benefits	Innovation	Business performance	E-procurement
Cronbach Alpha	.895	.701	.812	.807	.796	.902

Table 7.   Model fit indices

NFI	RFI	IFI	TLI	CFI	RMSEA
.966	.961	.976	.972	.976	.030

Table 8. Comparison of Factor Loading (i.e., Regression Weight) and Unstandardized Parameter Estimates for the whole dataset: Maximum Likelihood Versus Bayesian Estimation

Parameter	Estimation approach: ML	Bayesian
Bp2<- Business Performance	1,365	1,365
Bp3<- Business Performance	1,037	1,038
Inv2<- Innovation	0,946	0,945
Inv3<- Innovation	1,130	1,131
Inv4<- Innovation	1,081	1,081
Ict2<- ICT Benefits	1,027	1,028
Ict3<- ICT Benefits	0,954	0,955
Ict4<- ICT Benefits	0,882	0,883
Ict5<- ICT Benefits	0,961	0,961
Ict6<- ICT Benefits	1,098	1,098
Eb2<- e-Business	0,912	0,912
Eb3<- e-Business	0,997	0,997
Eb4<- e-Business	0,505	0,505
Epro2<- e-Procurement	1,119	1,119
Epro3<- e-Procurement	1,185	1,185
Int2<- Internal IS	0,685	0,685
Int3<- Internal IS	0,834	0,835
Int4<- Internal IS	0,737	0,737
Int5<- Internal IS	0,998	1
Int6<- Internal IS	0,626	0,627
ICT Benefits<- e-Business	0,032	0,032
Innovation<- e-Business	0,130	0,131
ICT Benefits<- e-Procurement	-0,008	-0,008
Innovation<- e- Procurement	0,068	0,068
ICT Benefits<- Internal IS	0,373	0,374
Innovation<- Internal IS	0,558	0,558
ICT Benefits<- Innovation	0,423	0,423
Business Performance<- Innovation	0,465	0,465
Business Performance<- ICT Benefits	0,183	0,185

Table 9. Comparison of Factor Loading (i.e., Regression Weight) and Unstandardized Parameter Estimates for the tourism sector: Maximum Likelihood Versus Bayesian Estimation

Parameter	Estimation approach: ML	Bayesian
Bp2<- Business Performance	1,34	1,34
Bp3<- Business Performance	1,134	1,133
Inv2<- Innovation	0,957	0.958
Inv3<- Innovation	1,836	1,845
Inv4<- Innovation	1,755	1,764
Ict2<- ICT Benefits	1,1	1,101
Ict3<- ICT Benefits	0,94	0,942
Ict4<- ICT Benefits	0,875	0,878
Ict5<- ICT Benefits	0,975	0,976
Ict6<- ICT Benefits	1,169	1,173
Eb2<- e-Business	0,837	0,837
Eb3<- e-Business	0,954	0,955
Eb4<- e-Business	0,523	0,524
Epro2<- e-Procurement	1,139	1,14
Epro3<- e-Procurement	1,169	1,169
Int2<- Internal IS	0,736	0,742
Int3<- Internal IS	0,915	0,919
Int4<- Internal IS	0,607	0,611
Int5<- Internal IS	0,961	0,966
Int6<- Internal IS	0,875	0,881
ICT Benefits<- e-Business	0,079	0,078
Innovation<- e-Business	0,096	0,096
ICT Benefits<- e-Procurement	NS	NS
Innovation<- e- Procurement	0,099	0,100
ICT Benefits<- Internal IS	0,461	0,465
Innovation<- Internal IS	0,311	0,312
ICT Benefits<- Innovation	0,303	0,304
Business Performance<- Innovation	0,300	0,302
Business Performance<- ICT Benefits	0,265	0,267

Table 10.Percentages of firms having the examined internal and e-business IS and innovation types

Item	Percentage
Int1-Intranet	36,4%
Int2-ERP	21,0%
Int3-Account. SW	73,6%
Int4-Share Doc.	26,8%
Int5-Track Hours	18,0%
Int6- Invent. Man	20,6%
Eb1-Publish Offers	10,5%
Eb2-Answer Calls	9,3%
Eb3-Receive Ord.	10,5%
Eb4-Payment	5,2%
Inv1-Prod/Serv. Innov.	40,2%
Inv2 – ICT based Pr/Serv. Inn.	21,0%
Inv3-Process Innovation	32,7%
Inv4– ICT based Process Inn.	23,1%
Epro1- Find suppl.	7,7%
Epro2-Inv. suppl. To submit prop.	8,2%
Epro3- Order goods or services	9,6%

Table 11. Relative frequencies of ICT benefits' and business performance variables

Item	Negative Influence	No Influence	Positive Influence
Ict1-Rev. Growth	1,3%	45,4%	53,4%
Ict2-Proc. Effic.	1,3%	32,7%	66%
Ict3-Int.Work Or.	1,7%	36,1%	62,2%
Ict4-Pr/Ser. Qual.	1,9%	53.3%	44,7%
Ict5 –Cust. Qual.	1,8%	38,4%	59,8%
Ict6-Productivity	1,6%	38%	60,4%
	Decrease	Stability	Increase
Bp1- Market Share	8,8%	43,2%	48%
Bp2- Turnover	11,8%	30,0%	7,1%
Bp3-Productivity	7,3%	36,7%	56,0%

Table 1. Principal Components Analysis (PCA) with Varimax rotation

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Int1	0.119	0.141	0.081	0.185	**0.545**	0.062
Int2	0.048	0.078	0.041	0.049	**0.675**	0.034
Int3	0.074	0.111	0.098	0.050	**0.648**	0.036
Int4	0.146	0.091	0.044	0.197	**0.484**	0.058
Int5	0.082	0.044	0.052	0.076	**0.596**	0.007
Int6	0.122	0.023	0.026	0.015	**0.531**	0.052
Eb1	0.093	**0.862**	0.103	0.102	0.143	0.035
Eb2	0.084	**0.840**	0.122	0.096	0.139	0.037
Eb3	0.095	**0.874**	0.121	0.103	0.152	0.041
Eb4	0.075	**0.734**	0.084	0.095	0.071	0.030
Epro1	0.061	0.120	**0.884**	0.064	0.087	0.032
Epro2	0.063	0.142	**0.901**	0.076	0.118	0.027
Epro3	0.065	0.150	**0.888**	0.090	0.139	0.029
Inv1	0.134	0.097	0.041	**0.710**	0.055	0.101
Inv2	0.200	0.135	0.065	**0.731**	0.053	0.066
Inv3	0.111	0.063	0.060	**0.756**	0.235	0.091
Inv4	0.151	0.093	0.077	**0.772**	0.223	0.066
Ict1	**0.690**	0.102	0.054	0.122	0.062	0.125
Ict2	**0.739**	0.042	0.030	0.072	0.179	0.088
Ict3	**0.675**	0.021	0.025	0.070	0.213	0.035
Ict4	**0.680**	0.063	0.052	0.150	0.035	0.018
Ict5	**0.727**	0.093	0.011	0.122	0.083	0.040
Ict6	**0.765**	0.052	0.050	0.101	0.124	0.074
Bp1	0.089	0.049	0.023	0.106	0.049	**0.809**
Bp2	0.095	0.033	0.029	0.066	0.079	**0.869**
Bp3	0.119	0.038	0.028	0.114	0.096	**0.810**

Table 2. Principal Components Analysis (PCA) with Varimax rotation

	Factor1	Factor2	Factor3	Factor4	Factor5
Int1	**0.447**	0.065	0.212	0.129	0.129
Int2	**0.598**	-0.083	0.120	0.034	0.009
Int3	**0.509**	0.080	0.042	0.158	0.140
Int4	**0.531**	0.123	0.136	0.133	0.041
Int5	**0.615**	0.071	0.001	0.031	0.004
Int6	**0.732**	0.073	0.099	0.034	-0.038
Eb1	0.130	**0.924**	0.088	0.066	0.034
Eb2	0.065	**0.870**	0.130	0.088	0.136
Eb3	0.112	**0.892**	0.075	0.090	0.056
Eb4	0.030	**0.781**	0.090	0.081	0.000
Inv1	0.145	0.014	**0.780**	0.072	0.019
Inv2	0.121	0.107	**0.809**	0.119	0.014
Inv3	0.181	0.137	**0.722**	0.203	0.189
Inv4	0.162	0.172	**0.753**	0.213	0.175
Ict1	0.168	0.105	0.025	**0.664**	0.126
Ict2	0.112	0.133	0.074	**0.794**	0.075
Ict3	-0.009	0.034	0.149	**0.690**	0.017
Ict4	0.148	0.015	0.245	**0.641**	0.024
Ict5	0.060	0.043	0.108	**0.808**	0.022
Ict6	0.115	0.044	0.050	**0.789**	0.104
Bp1	0.060	0.005	0.111	0.066	**0.816**
Bp2	0.081	0.079	0.033	0.089	**0.833**
Bp3	0.0182	0.107	0.154	0.126	**0.850**

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