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DEPARTMENT OF INFORMATION AND COMMUNICATION
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DOCTORAL DISSERTATION

CLOUD COMPUTING ADOPTION FACTORS AND BUSINESS VALUE DETERMINANTS

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Abstract

Cloud Computing (CC) emerges a new disruptive paradigm of sourcing the ICT services required by firms in order to support their processes and activities, quite different from the dominant one. In the existing 'on-premises' ICT services provision paradigm these services are produced primarily internally, based on assets (hardware and software) owned by the firm, installed in its premises, and administered and supported by its own ICT personnel. In contrast, in the new CC paradigm these ICT services are produced externally, at the CC services providers' premises, using assets owned, administered and supported by them, and are delivered to the client firm over the Internet. The US National Institute for Standards and Technology (NIST) defines CC as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources (e.g., networks, servers, storage, applications) that can be rapidly provisioned and released with minimal management effort or service provider interaction".

Most of the research that has been conducted on the CC is dealing with its technological aspects, while much less research has been conducted on its organizational aspects. Most of this latter research focuses on CC adoption factors, based mainly on the 'Technology, Organization and Environment' (TOE) theory of technological innovation adoption. However, this CC adoption factors research has focused on the first and the third perspective of the TOE framework: the technological and environmental factors affecting CC adoption. On the contrary limited research has been conducted concerning the second perspective of the TOE framework: the organizational factors; the effects of only a small number of firm's characteristics on CC adoption have been investigated.

Furthermore, there has been considerable literature concerning the potential of CC to offer important business benefits to firms, which are associated mainly with ICT support costs reduction, provision of flexible cost-effective computing capacity for supporting firm's growth, reduction of required ICT investment and conversion of them to operational costs, ubiquitous access capabilities using various types of devices, scalability, and also rapid and low cost ICT support of firm's innovation activity (of both product/service and process innovations). However, there has been limited empirical research on the 'real-life' benefits firms gain from CC, in order to understand to what extent, the above benefits are realized by firms, and which factors determine the magnitude of them.

This Ph.D. Dissertation aims to contribute towards filling the aforementioned important research gaps. Its main research objectives are:

- To identify firms' characteristics that positively or negatively influence the adoption of CC.

- To identify factors that affect the magnitude of the benefits and in general the business value that firms obtain from CC.

The present Ph.D. Dissertation makes the following contributions:

- It empirically investigates and compares the effects of a set of firms' strategies (ICT investment reduction, product/service innovation, process innovation), personnel characteristics (employment of ICT personnel, sufficiency of ICT skills of firm's employees, previous experience of ICT outsourcing), and technological characteristics (sophistication of firm's ICT infrastructure), which had not been dealt with in previous relevant literature, on firm's CC adoption propensity.
- It contributes to the research on the European North-South division, by comparing the effects of the factors mentioned previously on firms' CC adoption propensity between the European North and the European South.
- It empirically investigates the effects of open innovation (meant as collaboration with other firms for the design and implementation of innovations), which is a major trend of modern economy, on firms' propensity to adopt CC.
- It empirically investigates the effects of firms' hard and soft ICT capital on the benefits they gain from CC.
- It empirically investigates the effects of CC adoption management actions (contractual and relational governance of the relationships between firms and CC service providers, as well as adaptations in firm's ICT skills and organization) on the benefits firms gain from CC

The research presented in this Ph.D. Dissertation has provided interesting and practically relevant conclusions about the effects of different kinds of firm's characteristics on the propensity to adopt CC. In particular, the sophistication of firm's ICT infrastructure has been found to have a strong positive effect on firms' propensity to adopt CC, Similarly, strategies of ICT investment reduction increase firms' CC adoption propensity; however, this does not hold for innovation strategies, which do not affect CC adoption propensity. These indicate that firms (at least of the glass, ceramic and cement sectors, from which the data for this part of our research have been collected) view CC as a means of reducing ICT investment, but not as a means of supporting innovation.

Furthermore, the employment of specialized ICT personnel and previous experience of ICT outsourcing were found to positively affect firm's propensity to adopt CC. Despite the expectations that CC would be more beneficial for smaller than larger firms, we could not find any significant effect of size on the propensity of CC adoption in the sectors investigated in this study. Finally, the ICT skills of firm's employees and the price and quality competition it faces do not affect the propensity to adopt CC.

Also, our results indicate that different national contexts may have a significant effect on CC adoption determinants. In particular, we have found that in Southern European firms the adoption of a CC investment reduction strategy and the interest in new ICT (such as data warehousing, data mining, mobile services) affect positively CC adoption propensity. In contrast, for Northern European firms, it is the adoption of innovation strategy, as well as the electronic cooperation with other firms that affect CC adoption propensity positively; this reveals a quite different perception of CC in comparison with the Southern European firms.

Finally, our results provide evidence about a relationship between two important trends of modern economy, the open innovation and the CC. In particular, the inter-organizational collaboration with other firms for the design of innovations impacts positively the propensity for CC adoption; also, the use of ICT in order to support such collaborations has an even stronger positive effect on firm's propensity to adopt CC.

Highly interesting and practically relevant are the conclusions of the second part of the research presented in this Ph.D. Dissertation, concerning the determinants of the benefits/business value that firms obtain from CC. In particular, four out of the six examined types of firm's ICT hard and soft capital have been found to contribute to generating higher benefits from CC model: ICT strategic alignment, ICT infrastructure sophistication, internal ICT relationship, and internal capability for rapid implementation of various interconnections/integrations of existing firm's IS.

Finally, all examined four CC adoption management actions impact positively the benefits firms obtain from CC usage. The adaptation of firm's ICT skills has the strongest positive impact on CC benefits, followed by the relational governance of firm's relationships with its CC services providers. This result indicates that though CC services are a simple form of ICT outsourcing, based on the remote provision of highly standardized and minimally customizable ICT services, which are easily accessible in a self-service mode, with minimal interaction with their service provider, the development of a relationship with CC service providers continues to be important. Lower and of similar magnitude are the positive effects of the contractual governance of firm's relationships with its CC services providers, and the adaptation of ICT organization within the firm, on CC benefits. Therefore, having detailed and comprehensive contracts with the CC service providers, has a positive impact on the benefits obtained from CC, though this impact is lower than the one of the relational governance (at least in the Greek national context, from which the firm level data for this second part of our research have been collected). Also, positive impact on CC benefits has the adaptation of the organization of ICT in the firm as well, however lower than the one of the adaptation of its ICT skills. In particular, the development of a strategic approach to CC exploitation, as well as specific processes for managing it, the adaptation of the role of firm's ICT unit to the needs of the CC paradigm, and the

decentralization of CC related decisions to some extent from the ICT unit to firm's business units, lead to more benefits from CC.

Ευρεία Περίληψη στα Ελληνικά

Το Cloud Computing (CC) αναδύεται ως ένα νέο μοντέλο απόκτησης των υπηρεσιών ICT που χρειάζονται οι επιχειρήσεις για την υποστήριξη των διαδικασιών και των δραστηριοτήτων τους, το οποίο είναι πολύ διαφορετικό από το υπάρχον μοντέλο. Στο υπάρχον μοντέλο παροχής υπηρεσιών ICT αυτές παράγονται κυρίως εσωτερικά στην επιχείρηση, με βάση εξοπλισμό (υλικό και λογισμικό) που κατέχει η επιχείρηση, είναι εγκατεστημένο σε χώρους της, και διαχειρίζεται - υποστηρίζεται από το δικό της ανθρώπινο δυναμικό ICT. Αντίθετα στο νέο μοντέλο CC αυτές οι υπηρεσίες ICT παράγονται εξωτερικά, στους χώρους των παροχών υπηρεσιών CC, χρησιμοποιώντας εξοπλισμούς που αυτοί κατέχουν, διαχειρίζονται και υποστηρίζουν, και παρέχονται στην επιχείρηση πελάτη μέσω του Internet. Το Εθνικό Ινστιτούτο Προτύπων και Τεχνολογίας (National Institute for Standards and Technology) ορίζει το CC ως 'ένα μοντέλο εύκολης, ανάλογα με την ζήτηση και από οπουδήποτε πρόσβασης μέσω δικτύου σε ένα κοινόχρηστο σύνολο υπολογιστικών πόρων (π.χ. εξυπηρετητές, αποθηκευτικοί χώροι, εφαρμογές, δίκτυα), η οποία μπορεί να ενεργοποιηθεί και να απενεργοποιηθεί ταχέως, και με ελάχιστη διαχειριστική προσπάθεια ή διεπαφή με τον πάροχο των υπηρεσιών'.

Το μεγαλύτερο μέρος της επιστημονικής έρευνας που έχει πραγματοποιηθεί σχετικά με το CC ασχολείται με τις τεχνολογικές του διαστάσεις, ενώ πολύ λιγότερη έρευνα έχει πραγματοποιηθεί σχετικά με τις επιχειρησιακές του διαστάσεις. Η τελευταία εστιάζεται κυρίως στους παράγοντες υιοθέτησης του CC από τις επιχειρήσεις, και είναι βασισμένη στην θεωρία υιοθέτησης τεχνολογικής καινοτομίας 'Technology, Organization and Environment' (TOE). Όμως η έρευνα αυτή ασχολείται κυρίως με την πρώτη και την τρίτη από τις διαστάσεις που προτείνει η θεωρία αυτή: με τους τεχνολογικούς και τους περιβαλλοντικούς παράγοντες υιοθέτησης του CC. Αντίθετα περιορισμένη έρευνα έχει πραγματοποιηθεί σχετικά με την δεύτερη διάσταση της θεωρίας TOE: τους επιχειρησιακούς παράγοντες; έχει διερευνηθεί η επίδραση μόνον ενός μικρού αριθμού χαρακτηριστικών της επιχείρησης στην υιοθέτηση του CC.

Επί πλέον, υπάρχει αρκετή βιβλιογραφία σχετικά με τις μεγάλες δυνατότητες του CC να προσφέρει σημαντικά πλεονεκτήματα στις επιχειρήσεις, τα οποία συνδέονται κυρίως με την μείωση των κοστών ηλεκτρονικής υποστήριξης των διαδικασιών και των δραστηριοτήτων τους, την μείωση των σχετικών επενδύσεων και την μετατροπή σε λειτουργικά κόστη, την δυνατότητα πρόσβασης από οπουδήποτε και με χρήση διάφορων συσκευών, την επεκτασιμότητα, και την ταχεία και χαμηλού κόστους ηλεκτρονική υποστήριξη καινοτομίας (προϊόντων, υπηρεσιών και διαδικασιών). Όμως περιορισμένη έρευνα έχει πραγματοποιηθεί σχετικά με τα 'πραγματικά' οφέλη που οι επιχειρήσεις αποκομίζουν από την

χρήση CC, ώστε να κατανοήσουμε καλύτερα σε ποιό βαθμό τα παραπάνω προσδοκώμενα οφέλη υλοποιούνται (= πραγματικά αποκομίζονται), και ποιοι παράγοντες καθορίζουν το μέγεθός τους.

Η Διδακτορική αυτή Διατριβή στόχο έχει να συμβάλλει στην κάλυψη των παραπάνω ερευνητικών κενών. Οι κύριοι ερευνητικοί της στόχοι είναι:

- Ο εντοπισμός χαρακτηριστικών της επιχείρησης που επηρεάζουν θετικά ή αρνητικά την υιοθέτηση του CC
- Ο εντοπισμός παραγόντων που επηρεάζουν το μέγεθος των οφελών που οι επιχειρήσεις αποκομίζουν από την χρήση του CC.

Οι κύριες συμβολές που πραγματοποιεί η Διδακτορική αυτή Διατριβή είναι:

- Εμπειρική διερεύνηση και σύγκριση των επιδράσεων ενός συνόλου επιχειρησιακών στρατηγικών (μείωσης επενδύσεων ICT, καινοτομίας προϊόν-των/υπηρεσιών, καινοτομίας διαδικασιών), χαρακτηριστικών ανθρώπινου δυναμικού (απασχόληση προσωπικού ICT, επάρκεια δεξιοτήτων ICT του προσωπικού της επιχείρησης, προηγούμενη εμπειρία ICT outsourcing), και τεχνολογικών χαρακτηριστικών (βαθμός ανάπτυξης υποδομής ICT), τα οποία δεν έχουν εξετασθεί από την προηγούμενη σχετική εμπειρική βιβλιογραφία, στην τάση υιοθέτησης CC.
- Συμβολή στην έρευνα σχετικά με την διαίρεση Ευρωπαϊκού Βορρά-Νότου, μέσω σύγκρισης των επιδράσεων των προαναφερθέντων παραγόντων στην τάση υιοθέτησης CC από τις επιχειρήσεις μεταξύ Ευρωπαϊκού Βορρά και Ευρωπαϊκού Νότου.
- Εμπειρική διερεύνηση των επιδράσεων της 'ανοικτής καινοτομίας' (open innovation) (νοούμενης ως συνεργασίας με άλλες επιχειρήσεις για τον σχεδιασμό και την υλοποίηση καινοτομιών) στην τάση υιοθέτησης CC από τις επιχειρήσεις.
- Εμπειρική διερεύνηση των επιδράσεων του 'σκληρού' και του 'εύκαμπτου' κεφαλαίου ICT (hard and soft ICT capital) των επιχειρήσεων στο μέγεθος των οφελών που αποκομίζουν από την χρήση του CC.
- Εμπειρική διερεύνηση των επιδράσεων ενεργειών επιχειρησιακής διαχείρισης της υιοθέτησης CC (συμβασιακής και σχεσιακής διακυβέρνησης της συνεργασίας με τους παρόχους υπηρεσιών CC, προσαρμογή των δεξιοτήτων ICT και της οργάνωσης των ICT στην επιχείρηση) στο μέγεθος των οφελών που προκύπτουν από την χρήση του CC.

Από την έρευνα η οποία περιγράφεται στην παρούσα Διδακτορική Διατριβή προκύπτουν μία σειρά από ενδιαφέροντα και πρακτικά χρήσιμα συμπεράσματα σχετικά με τις επιδράσεις διάφορων χαρακτηριστικών της επιχείρησης στην τάση υιοθέτησης CC. Συγκεκριμένα, ο βαθμός ανάπτυξης της υποδομής ICT έχει ισχυρή θετική επίδραση στην τάση υιοθέτησης CC. Ομοίως στρατηγικές μείωσης των επενδύσεων ICT αυξάνουν την τάση υιοθέτησης CC, όμως αυτό δεν ισχύει και

για τις στρατηγικές καινοτομίας, οι οποίες δεν επηρεάζουν την τάση υιοθέτησης CC. Τα παραπάνω υποδηλώνουν ότι οι επιχειρήσεις (τουλάχιστον των κλάδων γυαλιού, κεραμικών και τσιμέντων, από τους οποίους συλλέχθηκαν τα δεδομένα αυτού του τμήματος της έρευνάς μας) βλέπουν το CC ως ένα μέσο μείωσης των επενδύσεων ICT, αλλά όχι ως ένα μέσο υποστήριξης καινοτομίας.

Επίσης, η απασχόληση προσωπικού ICT καθώς επίσης και προηγούμενη εμπειρία ICT outsourcing (= εξωτερικής ανάθεσης εργασιών ICT) επηρεάζουν θετικά την τάση υιοθέτησης CC. Παρά τις προσδοκίες ότι το CC θα ήταν περισσότερο επωφελές για τις μικρότερες από ότι για τις μεγαλύτερες επιχειρήσεις, από την έρευνά μας δεν προέκυψε στατιστικά σημαντική επίδραση του μεγέθους της επιχείρησης στην τάση υιοθέτησης CC στους παραπάνω κλάδους. Τέλος οι δεξιότητες ICT του προσωπικού της επιχείρησης, καθώς επίσης και το επίπεδο του ανταγωνισμού ως προς την τιμή και την ποιότητα που η επιχείρηση αντιμετωπίζει δεν επηρεάζουν την τάση υιοθέτησης CC.

Από τα αποτελέσματά μας προκύπτει ότι το εθνικό περιβάλλον (national context) μπορεί να επηρεάσει σημαντικά τους καθοριστικούς παράγοντες υιοθέτησης του CC. Συγκεκριμένα, στην Νότια Ευρώπη τα βασικά επιχειρησιακά χαρακτηριστικά που επηρεάζουν θετικά την τάση υιοθέτησης CC από τις επιχειρήσεις είναι οι στρατηγικές μείωσης των επενδύσεων ICT και επίσης το ενδιαφέρον για νέες ICT (όπως είναι data warehousing, data mining, mobile services). Αντίθετα, στην Βόρεια Ευρώπη είναι οι στρατηγικές καινοτομίας και η ηλεκτρονική συνεργασία με άλλες επιχειρήσεις που επηρεάζουν θετικά την τάση υιοθέτησης CC από τις επιχειρήσεις. Τα παραπάνω υποδηλώνουν μία πολύ διαφορετική προσέγγιση και αντίληψη για το CC από τις επιχειρήσεις της Βόρειας Ευρώπης συγκριτικά με τις επιχειρήσεις της Νότιας Ευρώπης.

Τέλος, από τα αποτελέσματά μας προκύπτει επίσης μία συσχέτιση μεταξύ δύο κεντρικών τάσεων της σύγχρονης οικονομίας, της ανοικτής καινοτομίας και του CC. Συγκεκριμένα η συνεργασία με άλλες επιχειρήσεις για τον σχεδιασμό καινοτομιών έχει θετική επίδραση στην τάση υιοθέτησης CC. Ακόμη θετικότερη επίδραση στην τάση υιοθέτησης CC έχει η χρήση ICT για τον σκοπό αυτό (επιχειρήσεις που ήδη χρησιμοποιούν ηλεκτρονικά εργαλεία για την υποστήριξη συνεργασίας με άλλες επιχειρήσεις για τον σχεδιασμό καινοτομιών έχουν ακόμη μεγαλύτερη τάση υιοθέτησης CC).

Ιδιαίτερα ενδιαφέροντα και πρακτικά χρήσιμα είναι και τα συμπεράσματα του δεύτερου μέρους της έρευνας που περιγράφεται σε αυτήν Διδακτορική Διατριβή, η οποία επικεντρώνεται στους καθοριστικούς παράγοντες του μεγέθους των οφελών και γενικότερα της επιχειρησιακής αξίας που οι επιχειρήσεις αποκομίζουν από την χρήση του CC. Συγκεκριμένα, τέσσερεις από τις έξι μορφές 'σκληρού' και του 'εύκαμπτου' κεφαλαίου ICT που εξετάσθηκαν συμβάλλουν στην αύξηση των οφελών που οι επιχειρήσεις αποκομίζουν από το CC: η στρατηγική ευθυγράμμιση της ICT (ICT strategic alignment), ο βαθμός ανάπτυξης

της υποδομής ICT, η ικανότητα δημιουργίας εσωτερικών σχέσεων μεταξύ της μονάδας ICT και των λοιπών μονάδων της επιχείρησης, και η ικανότητα ταχείας υλοποίησης διασυνδέσεων/ολοκληρώσεων μεταξύ πληροφοριακών συστημάτων. Τέλος, οι τέσσερεις ενέργειες επιχειρησιακής διαχείρισης της υιοθέτησης CC που εξετάσθηκαν έχουν όλες θετικές επιπτώσεις στα οφέλη που προκύπτουν από την χρήση του CC. Ο βαθμός προσαρμογής των δεξιοτήτων ICT έχει τις ισχυρότερες θετικές επιπτώσεις, ακολουθούμενη από τον βαθμό σχεσιακής διακυβέρνησης της συνεργασίας με τους παρόχους υπηρεσιών CC. Το συμπέρασμα αυτό υποδηλώνει ότι αν και η χρήση υπηρεσιών CC είναι μία απλή μορφή ICT outsourcing, βασισμένη στην απομακρυσμένη παροχή τυποποιημένων και ελάχιστα προσαρμόσιμων υπηρεσιών ICT, η ανάπτυξη σχέσεων με τους παρόχους τους συνεχίζει να είναι σημαντική. Χαμηλότερες, και παρομοίου μεγέθους, είναι οι επιπτώσεις του βαθμού συμβασιακής διακυβέρνησης της συνεργασίας με τους παρόχους υπηρεσιών CC, καθώς επίσης και του βαθμού προσαρμογή της οργάνωσης των ICT στην επιχείρηση, στο μέγεθος των οφελών από το CC. Συνεπώς η ύπαρξη λεπτομερών και περιεκτικών συμβάσεων με τους παρόχους υπηρεσιών CC έχει θετική επίδραση στα οφέλη που προκύπτουν από το CC, η οποία όμως είναι χαμηλότερη από αυτήν της σχεσιακής διακυβέρνησης των συνεργασιών αυτών (τουλάχιστον στο Ελληνικό εθνικό περιβάλλον, από το οποίο συλλέχθηκαν τα δεδομένα για αυτό το τμήμα της έρευνάς μας). Επίσης θετική επίδραση στα οφέλη του CC έχει η προσαρμογή της οργάνωσης των ICT στην επιχείρηση, η οποία όμως είναι χαμηλότερη από αυτήν της προσαρμογής στο CC των δεξιοτήτων ICT της επιχείρησης. Συγκεκριμένα, η ανάπτυξη μίας στρατηγικής προσέγγισης στην αξιοποίηση του CC, καθώς επίσης και εξειδικευμένων διαδικασιών διαχείρισής του, η προσαρμογή του ρόλου της μονάδας ICT της επιχείρησης στις ανάγκες του μοντέλου CC, και η αποκέντρωση σε κάποιο βαθμό της λήψης αποφάσεων που αφορούν την χρήση CC από την μονάδα ICT προς τις άλλες μονάδες-χρήστες, οδηγούν σε υψηλότερα οφέλη από το CC.

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Chapter 1: Introduction

1.1 The Problem

Cloud Computing (CC) emerges a new paradigm that will dramatically change the ways of sourcing the ICT services required by firms in order to support their processes and activities. In the dominant 'on-premises' ICT services provision paradigm these services are produced primarily internally, based on assets (hardware and software) owned by the firm, installed in its premises, and administered and supported by its own ICT personnel. In contrast, in the CC paradigm these ICT services are produced externally, at the CC providers' premises, using assets owned, administered and supported by them, and are delivered to the firm over the Internet. The cost of these external services for a firm usually depends on the levels of use of these services (e.g. usage time, number of users, range of the services offered, etc.).

According to Sultan (2013), even though the term CC emerged in 2007, there is no clear definition of it yet. Several different definitions have been proposed, each of them focusing on different aspects of CC. Marston et al. (2011) propose a synthesis of these definitions: "It is an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of-service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks". The US National Institute for Standards and Technology (NIST) defines CC as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources (e.g., networks, servers, storage, applications) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance, 2011).

Most of the research that has been conducted on the CC is dealing with its technological aspects (e.g. Liu and Orban, 2008; Rockwerger et al., 2009; Assuncao et al., 2009; Xiao et al., 2013; Zhan et al., 2015), while much less research has been conducted on its organizational aspects. Most of the latter focuses on CC adoption factors. CC can provide significant benefits to firms, but at the same time it can also pose significant risks; this has resulted in lower adoption of CC than initial expectations (Low and Chen, 2011; Oliveira et al, 2014; Kung et al., 2015; Yigitbasioglu, 2015; Siepermann et al., 2016). These lower adoption rates have motivated considerable empirical research on factors affecting the adoption of CC. Most of this research has been based on the Technology, Organization and Environment (TOE) theory of technological innovation adoption (Tornatzky and Fleischer, 1990; Baker,

2011). However, most of this previous CC adoption factors research has focused on the first and the third perspective of the TOE framework: the technological and environmental factors affecting CC adoption. On the contrary limited research has been conducted concerning the second perspective of the TOE framework: the organizational factors; the effects of only a small number of firm's characteristics on CC adoption have been investigated. This is a serious deficiency, as knowledge on firm's characteristics affecting positively or negatively CC adoption leads to valuable insights as to the kinds of firms for which CC is more or less beneficial, which are quite useful for both CC user (or potential user) firms and CC services provider ones.

Furthermore, there has been considerable literature concerning the potential of CC to offer important business benefits to firms, which are associated mainly with ICT support costs reduction, provision of flexible cost-effective computing capacity for supporting firm's growth, reduction of required ICT investment and conversion of them to operational costs, ubiquitous access capabilities using various types of devices, scalability, and also rapid and low cost ICT support of firm's innovation activity (of both product/service and process innovations) (Etro, 2009; Brynjolfsson et al., 2010; Benlian and Hess, 2011; Marston et al., 2011; Venders and Whitley, 2012; Bernman et al., 2012; Hoberg et al., 2012; Willcocks et al., 2013; Willcocks et al., 2014; Müller et al., 2015). However, there has been limited empirical research on the 'real-life' benefits firms gain from CC, in order to understand to what extent the above benefits are realized by firms, and which factors determine the magnitude of them. This latter would be quite beneficial for CC user (or potential user) firms, as it can provide to them guidance and direction for increasing the benefits and business value they obtain from CC.

1.2 Research Objectives

This Ph.D. Dissertation aims to contribute towards filling the aforementioned important research gaps. Its main research objectives are:

- To identify firms' characteristics that positively or negatively influence the adoption of CC.
- To identify factors that affect the magnitude of the benefits and in general the business value that firms obtain from CC.

1.3 Contribution

The present Ph.D. Dissertation makes the following contributions to the existing literature:

- It empirically investigates and compares the effects of a set of firms' strategies (ICT investment reduction, product/service innovation, process innovation), personnel characteristics (employment of ICT personnel, sufficiency of ICT

skills of firm's employees, previous experience of ICT outsourcing), and technological characteristics (sophistication of firm's ICT infrastructure), which had not been dealt with in previous literature, on firms' propensity to adopt CC.

- It contributes to the research on the European North-South division, by comparing the effects of the factors mentioned previously on firms' CC adoption propensity between the European North and the European South.
- It empirically investigates the effects of open innovation (meant as collaboration with other firms for the design and implementation of innovations), which is a major trend of modern economy, on firms' propensity to adopt CC.
- It empirically investigates the effects of firms' hard and soft ICT capital on the benefits they gain from CC.
- It empirically investigates the effects of CC adoption management actions (contractual and relational governance of the relationships between firms and CC service providers, as well as adaptations in firm's ICT skills and organization) on the benefits firms gain from CC.

Based on the work and results of this Dissertation the following publications have been made:

Journal papers:

1. Loukis, E., **Kyriakou, N.,** Pazalos, K. and Popa, S. (2017). Inter-organizational innovation and cloud computing. Electronic Commerce Research, 17(3), pp. 379-401.
2. Arvanitis, S., **Kyriakou, N.** and Loukis, E. (2017). Why do firms adopt cloud computing? A comparative analysis based on South and North Europe firm data. Telematics and Informatics, 34(7), pp. 1322-1332.
3. Loukis, E., Arvanitis, S. and **Kyriakou, N.** (2016). An empirical investigation of the effects of firm characteristics on the propensity to adopt cloud computing. Information Systems and e-Business Management, 15(4), pp. 963–988
4. **Kyriakou, N**. and Loukis, E. (2018). Do Strategy, Processes, Personnel and Technology Affect Firm's Propensity to Adopt Cloud Computing? – An Empirical Investigation. Journal of Enterprise Information Management (accepted with revision).

Conference papers:

1. Loukis, E., **Kyriakou, N.** (2018). Contractual and Relational Governance, ICT Skills and Organization Adaptations, and Cloud Computing Benefits,

Proceedings of Hawaii International Conference on System Sciences (HICSS), January 2018, Hawaii, Big Island.

2. **Kyriakou, N.,** Loukis, E. (2017). Hard and Soft ICT Capital and Cloud Computing Benefits, 11th Mediterranean Conference on Information Systems (MCIS 2017), September 2017, Genova, Italy, AIS.
3. **Kyriakou**, **N.,** Loukis, E. (2017). Cloud Computing Business Value and Human Determinants – An Empirical Investigation, 21st Panhellenic Conference on Informatics (PCI 2017), September 2017, Larisa, Greece.
4. **Kyriakou, N**., Maragoudakis, M., Loukis, E. and Themistocleous, M. (2017). Prediction of Propensity for Enterprise Cloud Computing Adoption. In Proceedings of the 50th Hawaii International Conference on System Sciences (HICSS), January 2017, Hawai, Big Island.
5. Loukis, E., Arvanitis, S., **Kyriakou, N**., Famelou, A., Chatzianastasiadis, M. and Michailidou, F. (2016). ERP, e-Commerce, Social Media and Absorptive Capacity of Greek Firms: An Empirical Investigation. In Proceedings of 20th Panhellenic Conference on Informatics (PCI 2016), 10-12 November, 2016, Patra, Greece.
6. Loukis, E.N., Arvanitis, S., **Kyriakou, N**., Famelou, A., Chatzianastasiadis, M.M. and Michailidou, F. (2016). The Effects of Enterprise Systems on the Absorptive Capacity of Greek Firms. In Proceedings of 10th Mediterranean Conference on Information Systems (MCIS), 4-6 September 2016, Paphos, Cyprus.
7. **Kyriakou, N.**, Loukis, E. and Arvanitis, S. (2016). Enterprise Systems and Innovation-An Empirical Investigation. In Proceedings of the 49th Hawaii International Conference on System Sciences (HICSS), January 2016, Hawai, Kauai Island.
8. Loukis, E., **Kyriakou**, **N.** (2015). Cloud Computing Adoption Motivation in the European North and South. In Proceedings of 9th Mediterranean Conference on Information Systems (MCIS 2015), October 2015, Samos, Greece.
9. **Kyriakou**, **N.** Loukis, E. (2015). Firm Characteristics and Propensity for Cloud Computing Adoption. In proceedings of the Twenty-first Americas Conference on Information Systems (AMCIS), August 2015, Puerto Rico, USA.
10. Loukis, E., **Kyriakou, N.** and Pazalos, K. (2015). Operational and Innovation Collaboration and Cloud Computing. In European, Mediterranean & Middle Eastern Conference on Information Systems (EMCIS) 2015, 1-2 June 2015, Athens, Greece.
11. Loukis, E. and **Kyriakou, N**. (2015). Organizational factors affecting propensity to adopt cloud computing. In Proceedings of the 48th Hawaii International Conference on System Sciences (HICSS), January 2015, Hawai, Kauai Island.
12. **N. Kyriakou**, E. Loukis, (2014). The Effect of ICT Infrastructure Sophistication and Interconnection on the Propensity for Cloud Computing Adoption. In

Proceedings of European, Mediterranean & Middle Eastern Conference on Information Systems (EMCIS) 2014, October 2014, Doha, Qatar.

1.4 Structure of the Dissertation

The Dissertation consists of seven chapters. This introductory chapter is followed by *Chapter 2*, reviewing the existing relevant empirical literature, concerning on one hand CC adoption factors and on the other hand the determinant factors that affect the benefits firms gain from CC adoption. In *Chapter 3* are described the theoretical foundations we have used as basis of our research. In *Chapter 4* the research method is presented, as well as the data collection process of our empirical studies, and the definitions of their variables.

In *Chapter 5* initially in 5.1 are presented our results concerning the effects of a wide range of firms' characteristics on CC adoption. In particular, our study focuses on a wide set of firm characteristics referring to technological infrastructure, strategy, and personnel skills as well as size and external environment on the propensity to adopt CC. Then in 5.2 is presented a comparison of the effects of the organizational factors – firm characteristics examined in 5.1 on CC adoption propensity between the European North and the European South firms. Additionally, in 5.3 is investigated the effect of firm's inter-organizational collaboration for the design and implementation of innovation (= open innovation), as well of the use of ICT for this purpose, on firms' CC adoption propensity.

In *Chapter 6*, are presented our results concerning the effects of a wide range of factors on the benefits firms gain from CC usage. Initially in 6.1 is presented our empirical study of the effects of firm's hard ICT capital (firm's ICT infrastructure) and soft ICT capital (focusing on firm's ICT personnel, as well as its IS interconnection/integration capability, ICT strategic planning and alignment, internal ICT relationship and external ICT relationship capabilities) on the magnitude of the benefits gained from CC use. Then in 6.2 is presented our empirical study of the effect of firm's CC adoption managements actions (contractual and relational governance of the relationships between the firm and its CC service providers, as well as adaptations in firm's ICT skills and organization) on the benefits gained from CC adoption.

Finally, *Chapter 7* summarizes the conclusions drawn in this Dissertation.

Chapter 2: Literature Review

2.1 Introduction

A significant trend of the modern economy in the area of information and communication technologies (ICT) is the emergence of cloud computing (CC). Cloud computing (CC) has emerged as a convergence of advancements in the areas of grid computing, virtualization, utility computing, data-center automation, multi-tenancy and Web services, which can radically change the way firms access and use Information and Communication Technologies (ICT) for supporting their operations and activities, converting the former gradually to a 'fifth utility' (along with water, electricity, gas, and telephone) externally provided (Marston et al., 2011; Venters and Whitley, 2012; Willcocks et al., 2013; Müller et al., 2015). Marston et al (2011) define CC as "an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location." The US National Institute for Standards and Technology (NIST) defined CC as 'a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources (e.g., networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction' (Mell and Grance, 2010). There are three main categories of CC services (also termed as 'service models') currently offered: infrastructure as a service (IaaS) (= remote use of provider's storage and computing facilities), platform as a service (PaaS) (= remote use of provider's platform, including also operating system support and software development environment, for the development and deployment of applications) and software as a service (SaaS) (= remote use of software applications running on provider's systems and supported/maintained by them).

There is a growing recognition that CC can offer significant benefits to firms: lower cost of ICT support (in comparison with 'in-house' ICT services provision, mainly due to economies of scale achieved by providers), decrease of required upfront ICT capital investments (and conversion of them to operational expenses), access to specialized ICT resources, rapid deployment of ICT services, scalability (dynamic adjustment of these services in order to meet changing needs), enablement, support and reduction of cost - and in general barriers - to innovation, and wide accessibility (from anywhere and with any kind of device) (Benlian and Hess, 2011; Marston et al., 2011; Venders and Whitley, 2012; Bernman et al., 2012; Hoberg et al., 2012; Muller et al., 2015); it is widely recognized that these benefits will be higher for the small and medium enterprises (SME). According to Venders and Whitley (2012), the CC is expected to offer three main types of benefits to firms, associated with efficiency (reduction of ICT and in general operational costs), creativity and innovation (reduction of the time and

cost required for their ICT support), and simplicity (provision of ICT services that are simple to set-up, understand and use). Muller et al. (2015) distinguish between three levels of benefits that CC can offer to firms: the first one is associated with costs reduction and business efficiency improvements; the second one with business effectiveness improvements through internal business process innovation and integration; the third level of benefits is associated with business transformation through innovations in products, services and business models. However, it is widely recognized that CC can pose some risks as well: service availability and in general performance related risks, data security risks (associated with firm's data integrity and confidentiality) and also economic risks (associated with 'hidden costs' and also CC services provider 'lock-in') (Benlian and Hess, 2011; Venters and Whitley, 2012; Ackermann et al., 2012); for the above reasons, the adoption of CC by firms has been lower than the initial expectations (Low and Chen, 2011; Oliveira et al, 2014; Kung et al., 2015; Yigitbasioglu, 2015; Siepermann et al., 2016).

This has motivated considerable empirical research in order to identify factors that positively or negatively affect the adoption of CC by firms (reviewed in 2.2.1). Most of this empirical research use the Technology, Organization and Environment (TOE) theory of technological innovation adoption (Tornatzky and Fleischer, 1990; Baker, 2011) as their 'first-level' theoretical foundation; according to this theory the adoption of technological innovations by firms is influenced by three types of factors: technological, organizational and environmental ones. However, as the TOE theory is rather generic, it is necessary to elaborate its abovementioned three dimensions (in order to provide guidance and direction for the selection of specific variables for each dimension to be used as independent variables in CC adoption studies), and for this purpose some "second level" theoretical foundations have been used; in particular, for elaborating the technological dimension of the TOE theory many empirical CC adoption studies have used the Diffusion of Innovation (DOI) theory (Rogers, 2003); also, for elaborating the environmental dimension of the TOE theory several empirical CC adoption studies have used the institutional theory (DiMaggio and Powell, 1983 and 1991). On the contrary, such an elaboration has not been attempted for the organizational dimension of the TOE theory, and this has led to the empirical investigation of the effects of only a small number of firm's characteristics on CC adoption (mainly firm's size, top management support and general technological/ organizational readiness). The research gaps are highly important, since firm's characteristics are expected to shape to a significant extent both the benefits that CC can generate, and the risks it can pose, and therefore finally firm's propensity to adopt CC.

Furthermore, the abovementioned benefits of CC are not straightforward and automatically generated. There has been some previous research arguing that in order to exploit the full business value potential of CC and gain significant benefits from it, it is necessary to make some changes/adaptations of the skills of firm's ICT personnel

to this new CC paradigm of sourcing ICT services, and also in its internal organization of ICT exploitation (e.g. decentralization of ICT related decision making from the ICT unit towards the business units) (Ragowsky et al., 2014; Schneider and Sunyaev, 2016; Willcocks et al., 2013; Willcocks et al., 2014). Also, previous literature on ICT outsourcing has concluded that its outcomes and benefits are shaped by a variety of factors, which concern the contractual and relational governance of firm's relationships with its external ICT services providers, the characteristics and capabilities of the provider and the client firm, etc. (see literature review in (Lacity et al., 2010; Lacity et al., 2017)); since the use of CC services by firms is a specific form of ICT outsourcing, these factors might influence the benefits generated by CC as well.
Nevertheless, limited empirical research has been conducted concerning the "real" benefits obtained by firms from the use of CC, as well the factors affecting them. Though there is extensive empirical research on the factors affecting the adoption of CC (e.g. see (Loukis et al., 2017; Schneider and Sunyaev, 2016)), quite limited is the empirical research that has been conducted on the factors affecting the benefits from CC (reviewed in 2.2.2). This research is quite necessary, because CC is a new paradigm of sourcing the ICT services required by firms for supporting their processes and activities, based on external providers, which is quite different from the previous on-premises paradigm, based on internal ICT services provision. So, firms still do not know how to exploit this new CC paradigm, and what actions they have to take, in order to gain more benefits from it. Therefore, it is of critical importance to conduct research in order to identify and understand the factors and preconditions that affect the level of benefits that CC generates, and develop a knowledge base concerning the maximization of CC business value.

2.2 Empirical Literature

2.2.1 Cloud Computing Adoption Factors Literature

A review of previous empirical literature on factors affecting CC adoption has been conducted using the 'Systematic Literature Review' (SLR) methodology proposed by Okoli (2015), which it is focused on the information systems domain. Initially a search for relevant papers was made in Google Scholar, Elsevier, Springer, Emerald, as well as in the Association of Information Systems (AIS) journals and conferences; then we proceeded to the relevant references of the papers we initially found, etc. From this literature review it has been concluded that the first stream of CC adoption factors research has been based on the Technology Acceptance Model (TAM) and its extensions (Davis, 1986; King and He, 2006; Turner et al., 2010), making various types of adaptions of it to the particular characteristics of CC. The most important and representative studies of this first generation are briefly outlined next. Wu (2011) has developed an explorative model of SaaS adoption factors, which includes factors based on the TAM (perceived usefulness, perceived benefits, perceived ease of use,

attitude, behavioral intention of future use) as well as its extensions (social influence, marketing efforts), and additionally some CC specific factors (security and trust). Using data collected from 42 Taiwanese managers a structural equation model was estimated connecting the above factors, leading to the conclusion that the main factors affecting intention to use CC in the future is perceived ease of use, followed by perceived usefulness, which are both affected by social influences (such as mass media, expert opinions and word-of-mouth) and marketing efforts. Opitz et a. (2012) developed a model of CC adoption factors based on an extension of the TAM developed in Venkatesh and Davis (2000), which includes perceived usefulness and perceived ease of use in a first level, as well as subjective norm, image enhancement, job relevance, output quality and results demonstrability as antecedents of perceived usefulness in a second level. This model was estimated using data collected from 100 CIOs and ICT managers from stock indexed German firms. It has been concluded that firm's intention to use CC is affected mainly by its perceived usefulness, and much less by its perceived ease of use; furthermore, perceived usefulness is affected by output quality, which is influenced mainly by job relevance and results demonstrability, and less by image enhancement. Gupta et al. (2013) extend the TAM and develop a five factors model of the inclination of small and medium firms to use CC, which includes perceived ease of use, cost savings, support of collaboration and data sharing, security and privacy, and reliability as independent variables. Using data from 211 small and medium firms a structural equation model has been estimated, which lead to the conclusion that the perceived ease of use has the strongest effect, followed by security and privacy, and cost reduction; on the contrary, the perceived reliability and support of collaboration and data sharing did not have statistically significant effects.

As this first stream of CC adoption factors research had a narrow perspective, examining mainly the effects of firms' perceptions about various properties of CC (e.g. its ease of use, usefulness, security, etc.) on its adoption, gradually a second stream of CC adoption factors research was developed with a wider perspective; it was based on the TOE theory (Tornatzky and Fleischer, 1990; Baker, 2011), so it examined the effects of a wider range of technological, organizational and environmental factors on CC adoption. Since, as mentioned in the Introduction, the TOE theory is rather generic (Zhu and Kraemer, 2005; Baker, 2011), a significant part of these studies, in order to elaborate the technological perspective of the TOE theory and define the technological factors to be examined as independent variables, use the DOI theory (Rogers, 2003). In particular, they make use of the five critical characteristics of an innovation proposed by this theory as main determinants of the degree of innovation's adoption: relative advantage, compatibility, complexity, trialability, and observability. In this direction, Low et al. (2011) examine the effects of a set of technological factors (CC relative advantage, complexity and compatibility), organizational factors (top management support, firm size and technological readiness) and environmental factors

(competitive pressure and trading partner pressure) on CC adoption. They conclude that perceived CC relative advantage, top management support, firm size, competitive pressure and trading partner pressure have positive statistically significant effects on CC adoption. Also, Mangula et al. (2014) investigate the effects of a set of technological factors (relative advantage, compatibility, complexity, trialability, observability), organizational factors (organizational readiness, top management support) and environmental context (market pressure, market competition, vendor marketing, trust in vendor, government support) on the adoption of Software as a Service (SaaS) services. They conclude that compatibility, observability, market competition and government support have statistically significant positive correlations, and complexity has a negative one, with SaaS adoption. Oliveira et al. (2014) examine the effects of three CC innovation characteristics (relative advantage, complexity, and compatibility), three organizational context characteristics (top management support, firm size, and technological readiness) and two environmental context characteristics (competitive pressure, regulatory support). They conclude that relative advantage, technological readiness, top management support and firm size have statistically significant positive effects on CC adoption, while complexity has a negative one. Gutierrez et al. (2015) investigate the effects of a similar set of technological factors (relative advantage, complexity, and compatibility), organizational factors (top management support, firm size, and technological readiness) and environmental factors (competitive pressure, trading partners pressure) on CC adoption; they conclude that competitive pressure, complexity, technology readiness, and trading partner pressure have a significant positive influence on the adoption of CC services. Gangwar et al. (2015), combined the TOE theory with the TAM, and found that CC relative advantage, compatibility and complexity, as well as organizational readiness, top management commitment and CC training/education, affect CC adoption intention, through perceived ease of use and perceived usefulness acting as mediating variables; furthermore, competitive pressure and CC services providers' support were found directly affecting CC adoption intentions. Hsu and Lin (2016) investigate the effects of six technological factors (CC relative advantage, ease of use, compatibility, trialability, observability, and security), four organizational factors (firm size, global scope, satisfaction with existing IS, and cost reduction potential of CC) and two environmental factors (competition intensity and regulatory environment) on CC adoption intensity. They conclude that relative advantage, observability, security, cost reduction potential, satisfaction with existing IS and competition intensity affect firms' intention to adopt CC. Senyo et al. (2016), in a quite different national context from the abovementioned studies (Ghana), examine the effects of three technological factors (CC relative advantage, security concern, compatibility), four organizational factors (firm size, firm scope, top management support, technological readiness) and three environmental factors (competitive pressure, trading partners' pressure, regulatory support) on CC adoption. Their findings indicate that relative advantage, security

concern, top management support, technology readiness, competitive pressure and trading partners' pressure affect CC adoption. Recently Kumar et al. (2017) use the TOE theory in combination with the TAM and as theoretical foundations, and examine the effects of the two main TAM factors (CC perceived usefulness and ease of use), as well as three technological factors (relative advantage, compatibility, security concerns), three organizational factors (firm size, top management support, technological readiness) and two environmental factors (external pressure, service providers' support) on CC adoption intention by Indian SMEs. Their analysis reveals that relative advantage, security concerns, top management support, external pressure and service providers' support are the factors that influence intention to adopt CC.

A third stream of CC adoption factors research focuses on the environmental perspective of the TOE theory, and examines the effects of a wide range of factors concerning firm's external environment on CC adoption. Many of these studies in order to elaborate this environmental perspective, and define external environment related factors to be examined as independent variables, use the institutional theory (DiMaggio and Powell, 1983 and 1991). The institutional theory posits that organizations' decisions and practices are driven not only by efficiency concerns, but also by external legitimacy concerns as well, which lead to mimetic behavior and 'institutional isomorphism'; furthermore, it defines three types of external institutional forces that often influence the decisions and practices of organizations: mimetic, normative, and coercive ones. In this direction, Saya et al. (2010), based on the institutional theory, in combination with the real options theory, formulated and estimated a four layers' CC adoption model, leading to the conclusion that institutional influences (e.g. from government, customers, suppliers, competitors, strategic partners, industry and trade organizations, professional bodies) affect organizations perceptions about the technological characteristics of CC (perceived accessibility, scalability, cost-effectiveness, and lack of security), and through them affect the perceptions of the provided real options by CC adoption (concerning ICT applications growth, abandonment and deferral) and finally the intention to adopt CC. Kung et al. (2015) examine the effects of institutional pressures (mimetic, coercive, and normative ones), as well as the perceived complexity of CC, on firm's intention to adopt SaaS. Their study concludes that mimetic and normative pressures affect positively firm's intention to adopt SaaS, and at the same time it also finds interesting interaction effects between mimetic pressures and perceived CC complexity. Yigitbasioglu (2015) investigates the effects of the above institutional forces on top management beliefs concerning CC and their involvement in CC related decisions, and through them on CC adoption. He concludes that mimetic and coercive pressures influence the beliefs of the top management team concerning the benefits of CC, as well as their active participation, which in turn affect firm's intention to increase the adoption of CC services. A recent CC adoption study by Martins et al. (2016) combines the use of the DOI theory for the elaboration of the technological perspective of the

TOE theory, with the use of the institutional theory for the elaboration of its environmental perspective. It investigates the effects of three technological factors (CC relative advantage, compatibility and complexity), two organizational factors (technology competence and top management support) and three environmental factors (coercive, normative, and mimetic pressures) on SaaS diffusion in firms. They conclude that relative advantage, complexity, technology competence, top management support, and normative pressures influence the intention to adopt SaaS; relative advantage, technology competence, top management support, coercive pressures, and normative pressures influence the adoption of SaaS; finally, top management support and normative pressures influence the routinization of SaaS in the firm. Another recent study by Maqueira-Marín et al. (2017) on the environmental determinants of CC adoption analyze the influence of CC services providers, public administrations and R&D institutions, as well as killer applications' and success cases' awareness. It has been concluded that the influence of CC services providers and the awareness of success cases are important determinants of the adoption of CC.

From the review of previous empirical research on CC adoption factors it has been concluded that most of it uses the TOE theory as 'first-level' theoretical foundation. However, the technological and the environmental perspective of it have received much more research attention, and much less the organizational one; the impact of a wide range of technological and environmental factors, but only a small number of organizational factors (mainly size, top management support, and general technological/ organizational readiness), on CC adoption have been empirically investigated. This results in a limited understanding of firm's characteristics/internal conditions that favor and promote the adoption of CC, which would be quite useful for both CC user and service provider firms, allowing interesting and practically useful insights concerning the main aspects of CC usefulness and value potential perceived by firms, as well as the particular ways and forms of CC utilization they envision.

2.2.2 Cloud Computing Impact Literature

The potential of CC to offer significant business benefits to firms has been extensively analyzed in previous literature (Etro, 2009; Armbrust et al., 2010; Brynjolfsson et al., 2010; Iyer and Henderson, 2010; Iyer and Henderson, 2012; Marston et al., 2011; Venters and Whitley, 2012; Willcocks et al., 2013; Berman et al., 2012; Müller et al., 2015). The most important of these potential benefits are cost reduction, conversion of related capital investments to operating costs, rapid and low-cost development of technological support required for process, product and service innovations, scalability, ubiquitous access, provision of flexible cost-effective computing capacity for supporting firm's growth, and rapid and low-cost access to new technologies (e.g. business analytics, mobile) and high level ICT-related skills. Venters and Whitley

(2012) distinguish between three main types of business benefits offered by CC: efficiency, simplicity (of use and understanding) and creativity/innovation. More recently Muller et al. (2015) propose a similar but more detailed typology of the benefits that CC can offer to firms, which includes three main types of benefits, with each of them being elaborated into several sub-types: the first type of benefits is termed 'business efficiency support' (including costs reduction and business efficiency improvements); the second is termed 'business effectiveness improvements' (including enhanced intra-enterprise collaboration, business integration and common ICT infrastructure, and focus on core competencies); the third type of CC benefits is termed 'innovation - business transformation' (including business growth through innovation, agility, business partner collaboration).

However, limited empirical research has been conducted concerning the benefits that firms really obtain from CC, in order to understand to what extent the above potential benefits are realized by firms, and also which factors determine the magnitude of the obtained benefits from CC. Malladi and Krishnan (2012) investigate empirically the impact of SaaS on firms' ICT-enabled innovation, as well as the role of organizational complementarities in augmenting this impact, using data collected through a survey from 243 USA firms. They found that the use of SaaS has a positive impact on ICT-enabled innovation, which increases if there is previous ICT outsourcing experience, flexibility of firm's ICT infrastructure (= level of use of Service-Oriented Architecture (SOA) and Web Services) and process formalization and management maturity. Garrison et al. (2015) examine the effect of firm's ICT technical capability, managerial capability and relational capability (with the latter focusing on the relationship with the CC provider) on CC success and finally on firm performance, using data collected from 302 Korean firms. They conclude that all these three capabilities affect positively the degree of CC success, with the effect of the ICT relational capabilities being the strongest, followed by the effects of the ICT technical capabilities, and then the ICT managerial capabilities. Furthermore, the degree of CC success affects positively firm performance. Schniederjans and Hales (2016), using survey data collected from 247 ICT and supply chain professionals, examine the effects of CC use by firms on their economic performance (return on assets, return on investments, and operating earnings) as well as their environmental performance (extent and level of compliance in terms of reducing solid wastes, decreasing consumption of hazardous materials, reducing resource consumption and improvement in environmental reputation); also, they examine to what extent these effects are mediated by the support and the positive effects of CC on collaboration with supply chain partners. They reach the conclusion that the use of CC has positive impact on both economic and environmental performance, with the impact on economic performance being partially mediated by the collaboration with supply chain partners enabled by CC (while this does not hold for the impact of CC on environmental performance). So only a small number of empirical studies have been conducted concerning factors affecting CC benefits, which

has examined the effects of a limited number of factors on CC benefits. Hence, there is limited understanding of the factors and preconditions that determine the magnitude of the benefits firms obtain from CC.

Chapter 3: Theoretical Foundations

3.1 Technology Adoption Models

The Technology Acceptance Model (TAM) is the most widely theoretical foundation in empirical studies of adoption factors (= factors affecting positively or negatively the adoption) of various ICTs. It was developed by Davis et al. (1989) and is based on two theories borrowed from the psychology research; namely the expectancy-value theory (Fishbein and Ajzen, 1975) and the Theory of Reasoned Action (TRA) (Ajzen and Fishbein 1980). According to TAM the main determinants of the acceptance of a new technology by users are its Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), with behavioral intent being a key element that leads to the actual use of the system. The observation that "people tend to use or not use the application to the extent they believe it will help them perform their job better" (Davis 1989, p. 320) is the basis of PU. PU directly influences the attitude towards the use of a system and indirectly influences the behavioral intent to use it. An application, irrespective of its perception of usefulness, will only be used if it is also perceived as easy to use. When the benefits of using the application outweigh the cost or effort of using it, then it has a higher probability of being used. Similarly, PEOU influences the attitude towards the use of the system. Both PU and PEOU directly influence the attitude towards using new information technologies and lead the users' behavioral Intent to use them. It is worth noting that PEOU influences PU and PU has a direct impact on behavioral intent. The actual use of a system depends on the behavioral intent of the users to use it. PU is defined by the point of view of prospective users and depends on the improvement an application will provide to a user's performance in an organization. PU influences the attitude and the behavioral intention towards using a system. Similarly, PEOU describes how users perceive the easiness to use a system and it influences PU and the attitude towards the use of the system. A scale and validation for these variables has been developed by Davis (1989).

Since the adoption of a new technology usually constitutes an important innovation in the way some specific tasks are performed (at an individual person or firm level), the Diffusion of Innovation (DOI) theory (Rogers, 2003) has also been extensively used as theoretical foundation of empirical studies concerning adoption factors of various ICTs. According to this theory, there are five critical characteristics of an innovation that determine the degree of its adoption:

i) Relative Advantage, defined as the degree to which an innovation is perceived as better than the idea, work practice or object it supersedes;

ii) Compatibility, defined as the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters;

iii) Complexity, defined as the degree to which an innovation is perceived as difficult to understand, implement and use;
iv) Trialability, defined as the degree to which an innovation may be experimented with on a limited scale basis;
v) Observability, defined as the degree to which the results of an innovation are visible by the external environment.

We remark that the DOI theory includes a larger number of characteristics (the abovementioned 5 ones) affecting adoption in comparison with the TAM (including only 2 characteristics): two of these characteristics proposed by DOI are similar with the ones of the TAM (the relative advantage of the DOI is similar with the usefulness of the TAM, and also the complexity of the DOI is similar with the ease of use of the TAM), while DOI proposes three additional characteristics (compatibility, trialability and observability).

Furthermore, another theory widely used as theoretical foundation of empirical adoption studies of various ICTs is the 'Technology, Organization and Environment' (TOE) theory of technological innovation adoption. It has a wider perspective than the TAM and the DOI, proposing three types of factors that determine the degree of adoption of technological innovations: technological, organizational and environmental ones. The TOE theory has been used to explain the adoption of inter-organizational systems (Grover, 1993; Mishra et al. 2007), e-business (Zhu et al., 2003; Zhu and Kraemer, 2005; Zhu et al. 2006; Zhu et al., 2004), electronic data interchange (EDI) (Kuan and Chau, 2001), open systems (Chau and Tam, 1997), enterprise systems (Ramdani et al., 2009), and a broad spectrum of general IS applications (Thong, 1999). The TOE model has been utilized to explain the adoption of innovations in many industries, including manufacturing (Mishra et al., 2007; Zhu et al. 2006), health care (Lee and Shim, 2007), retail, wholesale, and financial services (Zhu et al., 2006). Since the TOE theory is rather generic (Zhu and Kraemer, 2005; Baker, 2011) a significant number of studies, in order to elaborate the technological perspective of the TOE theory and define the technological factors to be examined as independent variables, use the DOI theory (Rogers, 2003) as theoretical foundation (= they make use of the abovementioned five critical characteristics of an innovation proposed by DOI as main determinants of the degree of its adoption: relative advantage, compatibility, complexity, trialability and observability).

Finally, another interesting technology adoption model has been proposed by Battisti et al. (2009). According to this model the first use of a new technology is determined by five categories of variables: firstly, a vector of characteristics of a firm and its environment reflecting so-called "rank effects", i.e. relative advantages that might make the technology adoption beneficial for the firm; secondly, factors that reflect motives for adopting a certain technology, i.e., "inducement effects"; thirdly, the extent of usage of a technology to capture inter-firm "stock and order effects" (i.e., market-intermediated externalities); fourthly, "epidemic effects" (i.e., learning and

non-market intermediated externalities) reflecting either a firm's own earlier experience of similar technologies or experience gained through the observation of other firms that use the new technology; fifthly, the expected adoption costs that have to be lower than the expected benefits in order to adopt the new technology.

3.2 Contractual and Relational Governance

Firms have various types of relationships with other firms, and as part of them they have exchanges of products, services and financial resources; the effective management and governance of these relationships and exchanges are of critical importance for firms, in order to ensure the delivery of the desired products' and services' quantities, prices, and quality, as well as to be safeguarded against the inherent hazards of inter-organizational relationships. There are two main mechanisms of governance of these inter-organizational relation-ships: the 'contractual governance' and the 'relational governance' (Goo et al., 2009; Hoetker and Mellewigt, 2009; Huber et al., 2013; Lioliou et al., 2014; Mellewigt et al., 2007; Poppo and Zenger, 2002).

The contractual governance is based on comprehensive formal written contracts, which are binding legal agreements that specify the obligations of all parties to perform particular actions in the future, the outcomes/outputs to be delivered, as well as procedures of communication, dispute resolution and handling changes and contingencies (both foreseeable and unforeseeable ones) (Brown et al., 2006; Goo et al., 2009; Lioliou et al., 2014; Poppo and Zenger, 2002). Contracts aim to coordinate activities between parties, and to prevent opportunistic behavior of them, through the creation of a mutually agreed and legally binding set of obligations and non-compliance. In particular, contracts include the detailed products and services that have to be provided by the supplier, their quality levels and the ways/procedures of their measurement, as well as the prices to be paid for them by the client; also, they include specific sanctions/penalties for the case that the required quantity/quality levels are not achieved, or there are delays in deliveries. Furthermore, contracts usually define detailed descriptions of forms of communication between client and supplier, and procedures for handling problems and contingencies that might appear, as well as for resolution of disputes. Sometimes there are also clauses describing procedures and terms for meeting additional needs of the client in the future, as well as for addressing changes of the initial needs (e.g. needs for higher volumes of products and services, or for new ones, new technologies, etc.).

On the contrary, the relational governance is based on the development of informal unwritten norms, attitudes and social processes between the supplier and the client, which promote information exchange, trust, collaborative problem solving, flexibility, mutual adaptation, and aim at better and smoother cooperation, higher level of satisfaction for both parties, and finally long term business relationship (Dyer and

Singh, 1998; Goo et al., 2009; Lioliou et al., 2014; Poppo and Zenger, 2002). In particular, the most important element of relational governance is the extensive bi-directional information exchange between the client and the supplier: on one hand the client provides extensive information to the supplier concerning their needs, activities, internal business processes, problems, strategic goals, etc.; on the other hand the supplier provides extensive information to the client concerning the whole range of their products and services, their technological capabilities, ways of better exploitation of them by the client, etc. Another important element of relational governance is the establishment of a positive attitude in both parties for solving problems and resolving disputes in close co-operation, and abstaining from opportunism, aiming to achieve mutual benefit and satisfaction; and also, a positive attitude and flexibility in both parties for responding positively to requests for changes required by the other party. The above are reinforced by a shared interest and commitment in having a long-term business relationship and co-operation.

Previous research in the area of ICT outsourcing has shown that both contractual and relational governance of firm's relationships with its external ICT services providers are important and influence positively the outcomes and resulting benefits (Goo et al., 2009; Huber et al., 2013; Lacity et al., 2010; Lacity et al., 2017; Lioliou et al., 2014; Oshri et al., 2015).

3.3 Open Innovation

3.3.1 Open Inter-Organizational Innovation

A major trend in the modern economy is the shift of firms from the 'closed' innovation paradigm, in which their innovation design and implementation activities were based on their internal knowledge resources, skills and production capabilities, towards the inter-organizational 'open' innovation paradigm, which is based to a significant degree on collaboration with other organizations, aiming at the exploitation of external knowledge resources, skills and production facilities as well (Chesbrough, 2003a, 2003b and 2006; Huizingh, 2011; West et al., 2014). Chesbrough (2003a) defines open innovation as 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively' (Chesbrough, 2006). The globalization, the strong competition, the continuous emergence of new technologies, the fast changes that characterize the modern business environment, as well as the high expectations and demands of consumers for high value-added products and services, and also for continuous renewal and improvement of them, make it difficult for individual firms to design and implement the continuous stream of innovations required for their survival on their own, relying only on their internal resources, skills and production facilities. So firms are increasingly looking for knowledge, skills and production resources required for the development and implementation of innovations not only inside, but also outside

their boundaries as well, and this has given rise to a gradual shift from the closed internal innovation paradigms to increasingly open inter-organizational ones (Chesbrough, 2003a, 2003b and 2006; Huizingh, 2011; West et al., 2014). For this purpose firms are creating various types of business collaboration structures, such as business networks, clusters, ecosystems, innovation hubs, keiretsu, and triple-helix (Zeng et al., 2010; Busquets, 2010; Salavisa et al., 2012; Majava et al., 2013; Xie et al., 2013; Lyytinen et al., 2016), which comprise different and heterogeneous organizations, having various types of relationships among them, and also economic and social exchanges, aiming at the collaborative design and implementation of complex and demanding product, service and process innovations. This also results in an increase of firms' outsourcing of some parts' production or services provision to other specialized firms all over the world, in order to take advantage of their resources and economies of scale (Gusmano et al., 2009; Navghavi and Ottaviano, 2010; Arvanitis and Loukis, 2013).

The participation of a firm in such collaboration structures offers significant business benefits (Baraldi and Nadin, 2006; Huston and Sakkab, 2006; Mancinelli and Mazzanti, 2009; Kajikawa et al., 2010; Zeng et al., 2010; Cui et al., 2015): access to complementary resources and capabilities, new technologies and markets, diverse knowledge, and also opportunities to achieve economies of scale, to share the costs and risks of firm's activities, and to cope with market and technological complexities. However, the realization of these benefits is not straightforward, and relies critically on the organization of such complex collaborations. For this reason considerable research has been conducted for the identification and the development of effective open innovation methods and practices, usually based on the use of ICT, and also for their analysis and evaluation, as well as for discovering the contexts and types of problems for which each of them is more appropriate (Laursen and Salter, 2006; Pisano and Verganti, 2008; Bellantuono et al., 2013; Mina et al., 2014; Felin and Zenger, 2014).

3.3.2 Open Innovation and ICT/CC

An important condition for the efficiency and effectiveness of the open inter-organizational innovation, and the realization of its abovementioned potential benefits, is the use of appropriate ICT for supporting it (Hakansson and Snehota, 1995; Dodgson et al., 2006; Baraldi and Nadin, 2006; Cui et al., 2012; Cui et al., 2015). According to Hakansson and Snehota (1995) and Baraldi and Nadin (2006) among firms participating in such structures specific coordination actions are required at three layers: 'activity links' (i.e. mutual adaptations in their activities), 'resource ties' (i.e., technical connections and mutual orientations of their physical and organizational resources) and 'actor bonds' (i.e. social interactions between individuals and organizational units of collaborating firms). These coordination actions require extensive exchanges of information, both 'structured' and

'unstructured', which can be greatly supported through the use of appropriate ICT, and especially through the use of appropriate CC services, taking into account the strong potential of the latter to support and facilitate business collaboration at a low cost, as mentioned previously in the Introduction. ICT can provide digital spaces that allow the rapid, extensive and cost-effective exchange of knowledge required among the multiple organizations participating in an open innovation initiative (e.g. suppliers, customers, business partners, and even universities and government agencies) for the collaborative design of innovation; at the same time ICT can support and reduce the cost of the coordination required for the inter-organizational collaborative implementation of innovations (Meroño-Cerdan et al., 2008; Lopez-Nicolas and Soto-Acosta, 2010; Soto-Acosta et al., 2014; Lyytinen et al. 2016). These have led to a big growth of the business collaboration software market. Numerous ICT platforms have been recently developed in order to support such inter-organizational collaboration for the design of innovations, which enable firms to access and use a rich collaboration support functionalities (e.g. centralized content storage and sharing, forums, instant messaging and other interaction and productivity applications, support of groups, social media type applications, project management, etc.), that can be made available to both firm's employees and also external entities, rapidly (requiring only minimal initial settings and customizations) and at a low cost (Forbes, 2013; Tan and Kim, 2015; Ross and Blumenstein, 2015). Furthermore, various types of ICT platforms have been developed which can support substantially inter-organizational collaboration at the operational level for the implementation of innovations (e.g. for the production of innovative products, or the provision of innovative services), such as the supply chain management (SCM) systems (Wu and Chang, 2012; Laudon and Laudon, 2014; Rainer et al., 2015; Chopra and Meindl, 2016). The emergence of CC creates big opportunities for providing to firms the abovementioned ICT support of open innovation (both for the inter-organizational collaborative design and implementation of it) rapidly and at a low cost. According to Berman et al. (2012) CC can facilitate external collaboration with partners and customers, which will result in significant improvements of productivity and increased innovation performance; CC-based platforms can bring together disparate groups of people, both from inside and outside the firm, who can collaborate and share resources, information and processes. Sultan (2013) argues that CC can revolutionize both internal and external knowledge management of firms, as it allows overcoming the main technological, organizational and financial obstacles it traditionally faced, and this can promote both closed and open innovation. Clohessy and Acton (2013) argue that open innovation is a promising route to value generation from CC, and propose a framework for this, which aims to assist firms in order to create value from CC by combining appropriate characteristics of it (such as on-demand service, resource pooling, rapid elasticity, etc.), deployment models (public, private, hybrid and community) and service models (IaaS, PaaS, SaaS) with closed or open innovation

(with main emphasis on the latter). A study conducted by the London School of Economics (LSE), based on interviews with ICT and management practitioners, revealed that CC has a strong potential to provide extensive electronic support of design and operation-oriented collaboration among organizations at a low cost (Willcocks et al., 2014). It concludes that the existing organizational computing paradigm is based on firms' internal information systems (IS), which are usually are not designed to be systematically accessible by external entities, e.g. customers, suppliers, business partners, etc. (with the exception of some specific types of IS, such as the supply chain management (SCM) systems, or systems brokering hotel or airline reservations). On the contrary, the new organizational computing paradigm emerging through CC aims by design to enable systematic controlled (under strict security and authorizations) access to appropriate parts of firm's data or functionality by external entities (e.g. customers, suppliers, business partners, etc.) as well, anytime and from anywhere, as it happens with firm's employees; this supports and promotes collaboration with the external world, easily and at a low cost. The above study concludes that this will gradually blur the boundaries of organizations, and in general lead to structural changes of them, giving rise to the 'cloud corporation', which has much more 'amorphous' and less strict boundaries with the external world, is much more collaborative with external stakeholders, flexible and 'fluid'. Jede and Teuteberg (2015), based on an extensive review of relevant literature, conclude that many CC services have been developed, which can provide substantial support of the main SCM processes at a low cost, enabling real-time information sharing among all participating firms, quick decision making, and better coordination, and finally higher efficiency of the whole SC; such CC services can provide extensive support for rapid inter-organizational open innovation implementation at a low cost. Furthermore, in recent years a variety of cloud-based collaboration tools have been developed (Forbes, 2013; Tan and Kim, 2015; Ross and Blumenstein, 2015), with most of them being offered through the SaaS model as well. These cloud-based collaboration tools have a great potential to provide a cost effective electronic support of open innovation (inter-organizational design and implementation of innovation).

However, the above arguments and expectations have not been empirically investigated based on 'real-life' data; it has not been empirically examined to what extent firms perceive CC as a useful and cost-effective means of supporting open inter-organizational innovation. Furthermore, previous research on CC adoption factors has not examined empirically the equivalent question of whether the use of open innovation practices impacts positively CC adoption.

3.4 ICT Skills and Organization Adaptation

The CC constitutes a quite different paradigm of sourcing the ICT services required for supporting firms' activities and processes, in comparison with the 'on-premises'

paradigm. In the on-premises paradigm ICT services are produced mainly internally, based on assets (hardware and software) owned by the firm, installed in its premises, and administered and supported by its own ICT personnel. On the contrary, in the CC paradigm the ICT services are produced externally, at the CC providers' premises, using assets owned, administered and supported by them, and are delivered to the firm through the Internet. For the above reasons the CC paradigm requires different ICT personnel skills and ICT organization in the adopting firm from the on-premises paradigm. In this direction, recent qualitative research (based on interviews) has revealed that CC benefits are not straight-forward and automatically generated, but depend on the extent of making some adaptations in the skills of firm's ICT personnel, as well as its internal ICT organization (e.g. ICT processes, roles, etc.) (Ragowsky et al., 2014; Schneider and Sunyaev, 2016; Willcocks et al., 2013; Willcocks et al., 2014); since the existing ICT skills and internal organization are currently aligned with the 'on-premises' paradigm, they have to be changed and adapted to the needs of the new CC paradigm, in order to exploit the full potential of it, and gain significant benefits.

In particular, the adoption of CC changes significantly the set of tasks that have to be performed within a firm in order to obtain the required ICT support of its activities and processes. This new tasks' set includes less technology related tasks in comparison with the on-premises paradigm (e.g. less IS development, administration and support), with more focus on integration between on-premises systems and various external CC services (Ragowsky et al., 2014). At the same time, it includes more the business related: extensive external information about existing relevant CC services offered by multiple providers should be analyzed mainly from a business perspective, with respect to their capability and suitability for supporting firm's business activities and processes, in order to identify the ones that can be used by the firm and offer significant business benefits (Willcocks et al., 2014). Furthermore, for the selected CC services contracts should be negotiated with their providers, signed and then monitored and managed. Therefore, the set of tasks to be performed in the firm for obtaining ICT support in the CC paradigm is less technological and more business related than in the previous 'on-premises' paradigm. This results in a reinforcement of the role of firm's business units in the CC paradigm, and at the same time weakening of the role of the ICT unit. It is absolutely necessary that the non-ICT personnel of the business units is significantly involved in the exploration and processing of extensive external information about the existing (and continuously increasing and evolving) CC services; this information is mainly business oriented, concerning the capabilities and functionalities offered, and much less technical, as the technological details of the provision of the CC services concern mainly their providers and much less the user firms.

At the same time, the adoption of CC necessitates a change of the role of firm's ICT unit, in order to be adapted to the needs of the CC paradigm: from ICT services provision (through the development of applications, software packages acquisition,

systems administration and support, etc.), towards the central coordination and support of the selection and use in the firm of various external CC services, and also the interconnection – integration of them with firm's internal on-premises systems (Willcocks et al., 2013; Willcocks et al., 2014). At the same time part of ICT decision making should be decentralized to some extent from the ICT unit to the business units, increasing their involvement and the role in the CC related decisions. Furthermore, training should be provided to firm's ICT personnel about the technologies of CC, the capabilities they provide, its interconnection/integration with on-premises IS, as well as the monitoring and management of contracts and business relationships with CC services providers. Additionally, in the CC paradigm the ICT personnel should become more business oriented (as in this paradigm there are less technical tasks to be performed in the firm, as mentioned above, but more business-related ones) (Willcocks et al., 2013; Willcocks et al., 2014); for this reason the ICT personnel should receive also business training, in order to acquire more business knowledge and understanding concerning firm's operations, business processes and strategic goals.

Finally, in order to have higher level of benefits from CC it is important to adopt not a fragmentary and un-coordinated approach to the use of CC services by the firm, but a more coordinated and strategic one: a CC strategy should be developed concerning the types of CC services that will be used, the applications they will be used for, the business objectives of CC use, and also the applications that will remain 'on-premises' (Berman et al., 2012; Karpovich et al., 2017; Ragowsky et al., 2014). Important strategic advantages can be achieved by using CC services (e.g. SaaS) for 'commodity' applications, which do not provide any differentiation from competitors, and at the same time deploy on-premises unique applications that provide differentiation and competitive advantages, possibly interconnected with the above CC services we use; also, competitive advantages can be generated using CC services for the rapid and low-cost implementation of innovations. Beyond the strategic level, it is important to develop also new processes for CC exploitation at the operational level (Willcocks et al., 2014): for the cooperation between the ICT unit and the business units concerning the use of CC, for the cooperation with CC providers, for the quality control of the CC services, etc.

However, there is a lack of empirical research concerning the impact of the above adaptations of the skills of firm's ICT personnel, as well as its internal ICT organization, to the needs of the CC paradigm, on the magnitude of the benefits generated by CC.

Chapter 4: Data

4.1 Introduction

The main objective of this Ph.D. Dissertation is to investigate the factors that lead firms to adopt CC as well as the factors that determine the magnitude of the benefits that they have upon adoption. For this purpose, we adopt a quantitative approach, taking advantage of two datasets, which are used in order to estimate a series of regression models. In the following sections of this chapter our data and research methodology are described in detail.

4.2 Datasets

4.2.1 European Dataset

The data used in the first part of this Dissertation (our CC adoption factors research) have been collected through the "e-Business Survey", which has been conducted as part of the e-Business Market W@tch (www.ebusiness-watch.org) initiative of the European Commission, from a sample of 676 firms, from the Glass, Ceramic, and Cement manufacturing sectors of six European countries (Germany, France, Italy, Poland, Spain, UK). The composition of the sample by size, sector and country is shown in Table 1. For this survey a questionnaire was developed, which contained 90 questions structured into the following modules: Use of ICT systems; e-Commerce and automated data exchange; Innovation activity and the role of ICT; ICT skills requirements; ICT investments; ICT, energy efficiency and emissions; Background information about the company.

The data were collected through interviews using computer-aided telephone interview technology. The decision-maker in the enterprise targeted by the survey was normally the person responsible for ICT within the enterprise. Alternatively, particularly in small firms, the managing director was interviewed. The survey took into consideration only enterprises that used computers. The sample drawn was a random sample of enterprises from the respective sector population in each of the countries considered, with the objective of fulfilling minimum strata with respect to size class per country-sector cell. The response rate, i.e. the number of completed interviews divided by the net sample of contacts established with eligible enterprises, was typically about 15-20%.

Size		Sector		Country	
Small (10-49)	53.8%	**Glass**	23.5%	**Germany**	26.6%
Medium (50-249)	33.6%	**Ceramic**	22.9%	**Spain**	18.5%
Large (250+)	12.6%	**Cement**	53.6%	**France**	12.7%
				Italy	14.9%
				UK	9.5%
				Poland	17.8%

Table 1. Composition of the European Sample

4.2.2 Greek Dataset

The data used in the second part of this Dissertation (our CC benefits' determinants research) have been collected from Greek firms, through a survey which has been conducted in cooperation with ICAP S.A. (www.icap.gr), one of the largest business information and consulting companies in Greece. As our starting point, we used the original large sample of Greek firms of ICAP S.A., which to the best of our knowledge is the best and largest source of firm data in Greece. From it, we constructed an intermediate smaller sample, with about 50% of the firms of the initial sample, including 3308 firms, and the same composition by industry and size with the original sample. To these firms of the intermediate sample we sent a questionnaire developed by the researchers, which included a large number of questions concerning background information of the firm, ICT usage, and also cloud usage and benefits. The initial version of this questionnaire was developed by the researchers, was then reviewed by three questionnaire development experts from ICAP S.A. and based on their remarks the final version of it was formulated. Finally, we received completed questionnaires from 363 firms (188 small, 131 medium and 41 large ones), having a response rate of about 11%. The composition of the sample by size and industry is shown in Table 2 and by sector is shown in Table 2.

It should be noted that the original sample of ICAP is not representative of the composition of Greek firms by industry. The Greek economy contains thousands of small and very small enterprises in trade, particularly in retail trade, tourism, particularly in catering, and construction. The ICAP sample focuses on the most technologically developed part of the Greek economy: it concentrates on manufacturing (30.7% of sample firms) and some modern service industries (such as computer services, business services and transport/communication - 13.7% of sample firms), still keeping a high percentage of trade and tourism firms (49.5% of sample firms); the intermediate sample has a similar composition by industry. Therefore, our sample structure focuses on the most technologically developed part of the Greek economy.

Size		Industry	
Small (10-49)	52.2%	**Service**	50.4%
Medium (50-249)	36.4%	**Manufacturing**	49.6%
Large (250+)	11.4%		

Table 2. Composition of the Greek Sample

Chapter 5: Cloud Computing Adoption Factors

5.1 Firm Characteristics and Cloud Computing Adoption

5.1.1 Introduction

There is a growing recognition that CC can offer significant benefits to firms: lower cost of ICT support (in comparison with 'in-house' provision of ICT services, mainly due to economies of scale achieved by providers), decrease of required upfront ICT capital investments (and conversion of them to operational expenses), access to specialized ICT resources, rapid deployment of required ICT services, scalability (dynamic adjustment of these services in order to meet changing needs), enablement, support and reduction of cost – and in general barriers – to innovation, and wide accessibility (from anywhere and with any kind of device). It is widely recognized that these benefits will be higher for the small and medium enterprises (SME) (Benlian and Hess, 2011; Marston et al., 2011; Venders and Whitley, 2012; Bernman et al., 2012; Hoberg et al., 2012; Willcocks et al., 2013; Willcocks et al., 2014; Mueller et al., 2015). According to Venders and Whitley (2012), the CC is expected to offer three main types of benefits to firms, which are associated with efficiency (reduction of ICT and in general operational costs), creativity and innovation (reduction of the time and cost required for their ICT support), and simplicity (provision of ICT services that are simple to set-up, understand and use), respectively. Mueller et al. (2015) distinguish between three levels of benefits that CC can offer to firms: the first one is associated with costs reduction and business efficiency improvements; the second one with business effectiveness improvements through internal business process innovation and integration; the third level of benefits is associated with business transformation through innovations in products, services and business models. However, at the same time there is a growing recognition that CC can pose some risks as well, which act as barriers to its adoption, such as data security risks (concerning unauthorized access to or modification of firm's data resources), service availability and in general performance risks, lack of relevant standardization and vendor lock-in risks. Such barriers have resulted in lower adoption of CC by firms below initial expectations (Benlian and Hess, 2011; Low and Chen, 2011; Hsu et al., 2014; Kung et al., 2015; Siepermann et al., 2016).

It is therefore necessary to investigate and understand better the factors that affect positively or negatively the adoption of CC by firms. Considerable empirical research has been conducted in this direction. However, this research has examined the effects of only a limited number of firm's characteristics (mainly firm's size, readiness and top management support) on CC adoption decision but has neglected important firm's characteristics such as its technological infrastructure, strategy and human resources. These firm characteristics are expected to shape to a significant extent the magnitudes of both the benefits the firm can gain from CC and also the risks and problems that CC

poses to it, which are both affecting a firm's propensity to adopt CC. The findings of such research can shed light on the types of firms with respect to technological infrastructure, strategy and human resources, in which CC is perceived as more suitable and useful, and also those for which CC is perceived as less beneficial. At the same time, these findings could provide useful insights as to the types of technological infrastructures and strategies, for which CC is perceived more appropriate for, and the importance of various aspects of a firm's human resources for CC adoption. Therefore, this research can be quite useful, first, for CC services providers in order to optimize their marketing activities by focusing on firms' segments that have high levels of CC adoption propensity, and at the same time make the necessary improvements and enrichments of their services in order to expand into new firms' segments currently having limited propensity to use CC. Second, potential CC user firms could also benefit from this research for making better decisions with respect to CC adoption and use by taking into account useful relevant knowledge extracted from large numbers of other firms.

This research makes a contribution towards filling the abovementioned research gap. It presents an empirical investigation and comparison of the effects of a set of firm characteristics referring to technological infrastructure, strategy and personnel skills – characteristics that have not been examined in previous empirical research on CC adoption – as well as size and external environment on the propensity to adopt CC.

5.1.2 Research Hypotheses

As theoretical foundation of our study we have used the Technology, Organization and Environment (TOE) theory of technological innovation adoption (Tornatzky and Fleischer, 1990; Baker, 2011). It is a multi-dimensional approach, which defines three different types of factors affecting the adoption of technological innovations by firms: (a) technological factors concerning the perceived properties of the specific technological innovation, as well as the technologies currently used in the firm; (b) organizational factors concerning characteristics and resources of the firm; and (c) environmental factors concerning characteristics of firm's external environment. However, previous literature has emphasized that the TOE theory provides primarily a general framework in form of a typology of factors for studying the adoption of various technological innovations, that has to be elaborated and adapted to the specific technological innovation under study (see on this point Baker, 2011 for a review of previous studies on the adoption of various ICT using the TOE theory as theoretical foundation). This necessitates the identification – based on previous related literature – of factors for each of these three categories of adoption determinants that are appropriate to the specific technological innovation under investigation.

In this direction, for each of the three types of factors that according to TOE theory determine a firm's decision to adopt a technology (technological, organizational and

environmental) we reviewed previous CC literature in order to identify particular characteristics of a firm that might have an impact on CC adoption propensity and based on them we have developed our research model (shown in Fig.1) and our research hypotheses. With respect to the technological factors, though previous empirical CC adoption research focuses on firms' subjective perceptions concerning the five characteristics of CC proposed by the DOI theory (relative advantage, compatibility, complexity, trialability and observability), we have focused on objective technological factors that concern characteristics of the ICT currently used by firm (see previous paragraph). From previous CC literature we identified one such factor: the degree of sophistication of firm's ICT infrastructure; the effect of it on CC adoption has not been investigated in previous CC adoption empirical research. Furthermore, with respect to organizational factors, we identified the following six firm characteristics that are expected to affect positively the propensity for CC adoption: the existence of an ICT investment reduction strategy, the existence of an innovation strategy, the employment of CC personnel, the ICT skills of firm's employees, the existence of previous experience of ICT outsourcing, and firm's size; the effects of the first five of them on CC adoption have not been investigated in previous CC adoption empirical research. Finally, we identified two characteristics of firm's external environment that we expect to affect its propensity for CC adoption: the intensity of the price competition and the intensity of quality competition the firm faces. The above thoughts led to the development of our research model shown in Fig. 1.

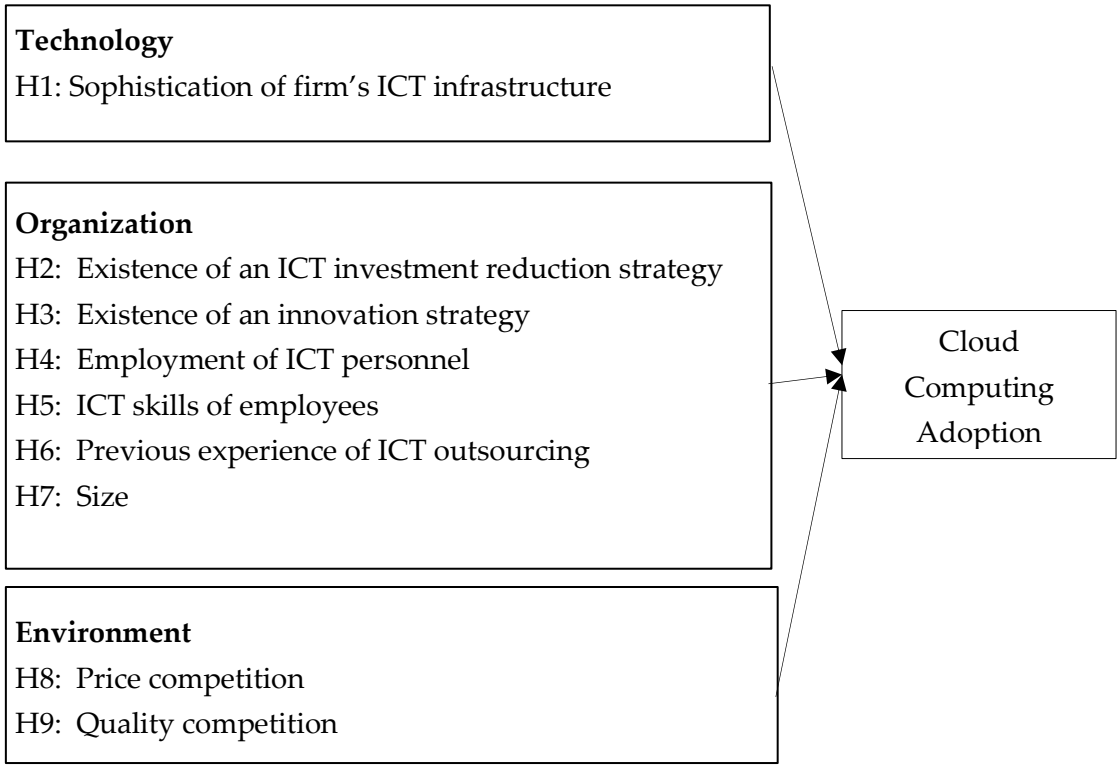

Figure 1. CC Adoption Factors Research Model

5.1.2.1 ICT Infrastructure Sophistication

Our first research hypothesis concerns the effect of firm's ICT infrastructure sophistication on its propensity to adopt CC. In previous CC literature (Marston et al., 2011; Venders and Whitley, 2012; Mueller et al., 2015) we find arguments concerning the high usefulness and value of CC for firms not having sophisticated ICT infrastructures, as it enables them to easily and rapidly gain access to more ICT capabilities and functionalities, at a low cost without the need for ICT investments. So, we would expect that firms having weak ICT infrastructures with limited capabilities and sophistication might have a stronger motivation to adopt CC than the ones having highly sophisticated ICT infrastructures. However, there exist also arguments pointing to the opposite direction: CC can be quite useful and valuable also for firms having highly sophisticated ICT infrastructures, as it enables them to reduce their high ICT operations, support and maintenance costs. For instance, it might be beneficial for them to use IaaS and PaaS services for hosting some of their applications, or even use SaaS for replacing some older applications with more modern standard software packages. So, based on these arguments we would expect that firms having more sophisticated – and therefore costlier – ICT infrastructures might have a stronger motivation to use an appropriate mix of CC services for reducing their ICT related costs than firms with less sophisticated (and therefore less costly) ICT infrastructures. For these reasons we have formulated two alternative research hypotheses on this, so the empirical analysis will show which of them is confirmed:

H1a: *The degree of sophistication of a firm's ICT infrastructure has a positive effect on its propensity to adopt CC.*
H1b: *The degree of sophistication of a firm's ICT infrastructure has a negative effect on its propensity to adopt CC.*

5.1.2.2 ICT Investment Reduction Strategy

Our second research hypothesis concerns the effect of having an ICT investment reduction strategy on firm's propensity to adopt CC. In many countries all over the world, mainly due to unfavorable economic conditions (e.g., overall recession or sectoral economic problems), firms have to adopt to a greater or lesser degree strategies of investment reduction, which usually include reduction of ICT investment. This can have a negative impact on firms' long-term competitiveness, as it does not allow them to make the required investments for upgrading and enhancing their ICT infrastructures (e.g., for increasing their computing power and/or their functionality) in order to meet new business needs or take advantage of emerging new ICT. CC can be very useful for coping with this problem, as it enables firms to transform the ICT capital investments (cap-ex) required for meeting the above needs into operating expenses (op-ex) (Marston et al., 2011; Venders and Whitley, 2012; Müller et al., 2015).

In particular, CC enables firms to upgrade the computing power of their ICT infrastructures (e.g., by using Infrastructure as a Service (IaaS)), upgrade their functionality (e.g. by using Software as a Service (SaaS)), and also to exploit new emerging ICT, without having to make additional upfront ICT investments, transforming them into operational expenses, which are based on the real use they make of these services (through a 'pay as you go' model). So, we expect that firms that have an ICT investment reduction strategy will have a good motivation to adopt CC. Hence our second research hypothesis is:

H2: *The existence of an ICT investment reduction strategy has a positive effect on firm's propensity to adopt CC.*

5.1.2.3 Innovation Strategy

Our third research hypothesis refers to the effect of having an innovation-oriented strategy on the propensity to adopt CC. Previous CC literature argues that this new paradigm of ICT services acquisition can provide benefits associated not only with ICT investment and in general costs reduction (which has been the initial 'value proposition' of CC), but also with the support and facilitation of innovation (Marston et al., 2011; Venders and Whitley, 2012; Berman et al., 2012; Willcocks et al., 2013; Willcocks et al., 2014; Müller et al., 2015). Innovation is becoming increasingly important in modern economy for the competitiveness of firms. However, innovations in firms' processes, products or services very often require the development of extensive ICT infrastructures, which can be quite expensive and also time consuming, when using the traditional 'in-house' ICT development and operation paradigm. The use of CC enables a reduction of costs and time required for these ICT developments, and therefore a reduction of the cost and time-to-market of these innovations. In this direction Brynjolfsson et al. (2010) argue that 'an overly simplistic reliance on the utility model risks blinding us to the real opportunities and challenges of cloud computing', concluding that 'the real strength of cloud computing is that it is a catalyst for more innovation'. According to Berman et al. (2012) the CC has a great potential to enable and support ICT-based transformations of firms' internal operations, customer relationships, products and services, and even business models and industry value chains at low cost and rapidly. They further argue that CC can digitally facilitate and support the creation of new products and services, and the utilization of new channels or payment methods, in order to attract existing or adjacent customer segments and finally generate significant new revenues. At the same time firms can also use CC in order to create new demand and potentially new markets, and finally attract new customer segments and generate entirely new revenue streams. Willcocks et al. (2013), based on a series of surveys and interviews, conclude that CC facilitates initially 'ICT-operational' innovations (i.e. changes in ICT operations and personnel that do not

impact firm-specific business processes), in a second step 'business process innovations' (changing substantially the way the business operates), and in a third step 'market (product/service) innovations' (enhancing significantly a firm's product/service offerings for existing customers, or enabling entry into new markets). All the above arguments indicate that CC can be not only a means of ICT investment and cost reduction, but also a strong and cost-efficient support and facilitator of innovation. Therefore, we expect that the existence of an innovation-oriented strategy would increase firm's motivation for CC adoption. Thus, our third research hypothesis is:

H3: *The existence of an innovation-oriented strategy has positive effect on firm's propensity to adopt CC.*

5.1.2.4 Employment of ICT Personnel – ICT Skills of Employees

Our fourth and fifth research hypotheses refer to the effects of the employment of ICT personnel and the ICT skills of a firm's (non-ICT) employees (ICT users or potential users) on its propensity for CC adoption. The human capital of firms has been widely recognized as being of critical importance for innovation, as it is the main determinant of firms' knowledge 'absorptive capacity', which enables them to identify and absorb useful knowledge and technology from their external environment, to assimilate it and use it for the enrichment of firm's knowledge base, and finally to exploit it for innovations in a firm's processes, products and services (Vandenbussche et al., 2006; Lopez-Garcia and Montero, 2012). The adoption of CC by a firm is an important innovation in the way it acquires and sources ICT services for supporting its activities, so of critical importance for it is the 'relevant' human capital of the firm: on one hand its ICT personnel (i.e. employees having specialized studies in ICT, being responsible for the provision of the required ICT services throughout the firm), and on the other hand its non-ICT personnel (i.e. employees being responsible for executing parts of any other function of the firm, except ICT services provision, such as sales, procurement, production, financial management, etc.), who use ICT – or might potentially use ICT – for their work.

Previous literature (e.g., see Fink and Neumann, 2007; Arvanitis et al., 2013) has emphasized the importance of the employment of specialized ICT personnel for ICT-related innovation. It has a critical role in the acquisition of external knowledge on new ICT, the transfer of it to firm's employees of various business units, the combination of it with domain specific knowledge (e.g., concerning firm's business processes, customer needs, competition), and finally the exploitation of it for the design and implementation of relevant innovations. In this vein, ICT personnel through their technical and business knowledge and skills can be quite useful for the effective and beneficial introduction of this innovative CC-based paradigm of

acquisition/sourcing and management of ICT resources (Willcocks et al., 2013; Willcocks et al., 2014). In particular, the ICT personnel is important for identifying the existing CC services and providers in the market, and for analyzing them in relation to the relevant needs of the firm. Further, it is important for transferring this knowledge to the business units of the firm, and – in cooperation with them – for the selection of the most appropriate CC services and providers, for the formulation of the contacts, and for monitoring and managing these relations. Finally, ICT personnel is quite important for the integration of various CC services from different providers with existing in-house ICT infrastructures, which is a critical success factor of CC deployment (Garrison et al., 2012). On the contrary, weaknesses in the above activities can give rise to uncertainties concerning CC, the existing CC offerings in the market, the benefits they can provide to the firm, and also the risks they really pose, which might have negative impact on firm's propensity to adopt CC.

At the same time, according to a recent study conducted by the London School of Economics (LSE) based on numerous interviews with practitioners all over the CC supply chain (Willcocks et al., 2014), the non-ICT personnel of firms (ICT users or potential users) has a much stronger role and involvement in the adoption and exploitation of CC than in the 'on-premises' ICT paradigm. For example, quite important is their contribution for filtering large amounts of information concerning existing CC offerings in the market and capabilities provided by them, and finally for selecting the most appropriate ones for meeting the particular needs of the firm. Therefore, for the rational selection and the full exploitation of the benefits of CC it is necessary that non-ICT employees have sufficient ICT skills, and this can enhance a firm's CC adoption propensity. For all the above reasons our fourth and fifth research hypotheses are:

H4: *The employment of specialized ICT personnel has a positive effect on a firm's propensity to adopt CC.*

H5: *Sufficient ICT skills of a firm's employees have a positive effect on its propensity to adopt CC.*

5.1.2.5 ICT Outsourcing

The sixth research hypothesis concerns the effect of having previous experience of ICT outsourcing on firm's propensity to adopt CC. As CC is a type of ICT outsourcing (Benlian and Hess, 2011), if a firm's personnel has previous experience and skills concerning any type of ICT outsourcing, this can be useful for the effective adoption and use of CC. In particular, previous experience of other types of ICT outsourcing creates awareness and trust concerning external ICT services provision, and also knowledge of how to monitor and manage such relations, as well as respective internal processes and practices, which can be quite useful for the effective and beneficial

introduction and use of CC. Previous ICT outsourcing literature (Lacity et al., 2009; Lacity et al., 2010) has revealed that critical for its success is the 'supplier management capability' of the client firm, defined as the extent to which the client firm is able to effectively manage ICT outsourcing suppliers. If this capability has been developed in the past through experience gained from any type of ICT outsourcing, it can also be useful in the future for managing other types of ICT outsourcing, such as the use of CC. This past experience will increase a firm's confidence and motivation to move in this direction and also reduce relevant uncertainties. For the above reasons we expect that if the firm has previous experience of ICT outsourcing, this would increase the propensity for CC adoption. Therefore, our sixth research hypothesis is:

H6: *Previous experience of ICT outsourcing has a positive effect on a firm's propensity to adopt CC.*

5.1.2.6 Size

We also investigated the effects of size on CC adoption propensity, a question on which there has been extensive debate and opposing arguments. There is extensive CC literature arguing that the benefits that CC can offer are higher for the smaller firms (Gupta et al., 2013; Marston et al., 2011; Venders and Whitley, 2012; Mueller et al., 2015; Johansson et al., 2015). Due to economies of scale that CC providers can achieve through the development and highly professional operation of big data centers that serve numerous user firms, this technology can offer to CC-users ICT cost reductions (in comparison with the traditional 'in-house' ICT services provision paradigm), and access to specialized ICT resources, personnel and applications, which would be too costly otherwise. However, some large firms due to their size might already have – or can have – such big data centers, specialized ICT resources, personnel and applications (even if at a little higher cost than the CC provider) and can achieve significant economies of scale in their ICT operations. Therefore, smaller firms are expected to have higher benefits from the adoption of CC than the larger ones. Also, the reduction of the need for upfront ICT investments that CC offers is much more important for the smaller firms in comparison with the larger ones, as it is much more difficult for the former to raise capital (e.g., from banks or investors) than for the latter (Saedi and Iahad, 2013; Alshamaila and Papagiannidis, 2014). However, there exist also previous studies providing arguments and also empirical evidence pointing to the opposite direction (Low and Chen, 2011; Oliveira et al., 2014). According to them large firms have an advantage with respect to CC adoption (and innovation in general) over the small ones, because they have more resources for this, can take greater risks, and have more skills, experience, and also resources in order to survive any potential failures than small firms. For these reasons we have formulated two alternative research hypotheses on this, so the empirical analysis will show which of them is confirmed:

H7a: *Firm size has a positive effect on the propensity to adopt CC.*
H7b: *Firm size has a negative effect on the propensity to adopt CC.*

5.1.2.7 Competition

Our final research hypotheses concern the effect of the competition a firm faces on its propensity to adopt CC. Previous research in economics has concluded that competition fosters innovation (though too high competition might lead to opposite effects). Since firms' incentives for innovation depend mainly on the profitability increment that can be achieved through innovation, i.e. the difference of 'post-innovation' profitability from 'pre-innovation' profitability, competition reduces the pre-innovation profitability by more than it reduces the post-innovation one, so it increases the above profitability increment, and therefore incentives for innovation (see, e.g., Aghion et al., 2005). As the adoption of CC is a kind of innovation in the way a firm acquires and sources ICT services for supporting its activities, we expect that it will be fostered by higher levels of competition. Also, previous ICT literature has concluded that competition is an important driver for the adoption of various ICT (Zhu et al., 2003; Zhu et al., 2004; Oliveira and Martins, 2010; Arvanitis et al., 2016). Economic literature distinguishes two main types of competition: price competition (in which a firm tries to distinguish its product/service from those of its competitors on the basis of low price) and non-price (or quality) competition (in which a firm tries to distinguish its product/service from those of its competitors on the basis of attributes such as design, materials, workmanship, customer-focus, etc., in general offering higher product/service quality) (e.g. McConnell et al., 2011). Firms facing intense price competition have a strong pressure to reduce their operating costs, so they have a strong motivation to use CC in order to reduce the operational, support and maintenance costs of their existing ICT infrastructures, and also to extend them at a low cost with new applications that automate manually executed tasks, and therefore reduce their cost. Also, firms facing intense quality competition have a strong pressure to increase the quality of their products/services, and this very often requires additional ICT support; the use of CC might be a very good solution for achieving this at a low cost and rapidly. For all these reasons, we expect that facing high price or quality competition will increase a firm's motivation and therefore propensity to adopt CC. So our final two research hypotheses are:

H8: *Price competition has a positive effect on a firm's propensity to adopt CC.*
H9: *Quality competition has a positive effect on a firm's propensity to adopt CC.*

5.1.3 Model Specification

Our study is based on data collected through the "e-Business Survey". The objectives of this survey were to collect data on the use of various types of ICT, the ICT skills, the

ICT investment and the innovation activity of firms in the European glass, ceramic and cement manufacturing sectors. As mentioned these are important long-established and mature manufacturing sectors in the European Union, which are rather conservative in terms of adoption of new ICT, and innovative business practices in general (Empirica GmbH, 2009), and therefore more representative of 'traditional' manufacturing than the high-tech and highly innovative services and manufacturing sectors in which most previous empirical research on the adoption of various ICT has been conducted.

In order to test the abovementioned research hypotheses H1 – H9, we estimated the following multivariate model:

$$Prop\_Cloud = b_o + b_1*ICT\_Infr\_Soph + b_2*ICT\_Invest\_Red + b_3*Innov + b_4*ICT\_Pers + b_5*Empl\_ICT + b_6*ICT\_Outs + b_7*Pr\_Comp + b_8*Qual\_Comp + b_9*D\_Large + b_{10}*D\_Medium + e_i \quad (1)$$

where Innov = (Prodserv_Inn; Proc_Inn); b_o to b_{1o}: parameters that have to be estimated

In the Appendix A are shown the exact definitions of all these variables, which correspond to the e-Business Survey questions we have used. The dependent variable Prop_Cloud is a measure of the propensity to adopt CC, which initially was a three-level variable assessing how relevant the respondent firm finds CC, having as possible values: very relevant, partly relevant, or not relevant. So, the Prop_Cloud variable we use in the model estimations is a binary one, which takes the value 1 if a firm reports relevance (even partial) of CC for their activities, and 0 if it replies that CC is not relevant for them.

As independent variables we have included six binary ones (1/0): existence of ICT investment reduction strategy (ICT_Invest_Red); two innovation strategy variables, one concerning the existence of product/service innovation strategy (Prodserv_Inn), and another one concerning the existence of process innovation strategy (Proc_Inn);[1] ICT personnel employment (ICT_Pers); sufficiency of firm employees' ICT skills (Empl_ICT); and previous experience of ICT outsourcing (ICT_Outs).

Also, we have constructed and inserted as independent variable a measure of a firm's ICT infrastructure sophistication (ICT_Infr_Soph), which is calculated as the average of four binary variables concerning the use of four important types of enterprise systems: ERP (enterprise resource planning) system, SCM (supply chain management) system, CRM (customers relationships management) system and SRM (suppliers' relationships management) system.

[1] As there is high level of correlation between them and in order to avoid multi-collinearity problems (Greene, 2011; Sreejesh et al., 2014) we did not include both of them in the same model, but we estimated the above model separately for product and for process innovation.

Finally, we have used two competition variables (Pr_Comp and Qual_Comp), which measure the intensity of the price competition and the quality competition respectively that the respondent firm faces; both of them are three-level ordinal variables, having as possible values: 'not so important', 'important', or 'very important'.
We have also included two dummy variables for firm size: D_Large and D_Medium; these variables are set according to the number of employees of the firm: variable D_Large takes the value of 1 for large firms with more than 250 employees and value 0 for all other firms, while variable D_Medium takes the value of 1 for medium-sized firms with 50-249 employees and value 0 for all others (so small firms with 10-49 employees are our reference group). Furthermore, our model contains controls for sector and country, as the survey covered three sectors and six countries: two sectoral dummy variables (reference sector: cement industry) and five country dummy variables (reference country: Poland).
Since the dependent variable is binary, for estimating the above multivariate model (1) we used binary logistic regression, which is the most appropriate estimation method when the dependent variable is binary according to relevant econometric literature (Gujarati, 2009; Greene, 2011; Sreejesh et al., 2014). For validation purposes we calculated for each estimated model the value of the 'pseudo' R2 of Nagelkerke (Scott Long, 1997), which are analogous to the R2 calculated in the Ordinary Least Squares (OLS) estimation. Given the cross-section character of our model we do not raise any claims for causality of our estimates, which from the econometric point of view are primarily conditional correlations; however, they might yield useful insights for possible causality effects in the sense of our hypotheses.

5.1.4 Results

In Table 3 are shown the estimates of model (1). The second column contains the estimates of equation (1) with the product/service innovation strategy variable (model version 1), while the third column contains the estimates with the process innovation variable (model version 2). For each independent variable is shown the exp(b_i), which in the binary logistic regression estimation is equal to the increase of the odds of CC adoption propensity (= probability of having CC adoption propensity/probability of not having CC adoption propensity) if the independent variable increases by one unit (Gujarati, 2009; Greene, 2011; Sreejesh et al., 2014) (in bold statistically significant b_i).

	Model Version 1	Model Version 2
ICT_Infr_Soph	**2.854****	**2.995****
ICT_Invest_Red	**1.638***	**1.651***
Prodserv_Inn	1.381	
Proc_Inn		1.122
ICT_Pers	**1.544***	**1.546***

Empl_ICT	1.171	**1.660***
ICT_Outs	**1.616***	1.183
Pr_Comp	1.035	1.048
Qual_Comp	0.998	0.992
D_Large	1.168	1.171
D_Medium	1.074	1.062
Sector_Glass	**1.808****	**1.827****
Sector_Ceramic	1.470	1.515
Country_Germany	**0.312*****	**0.304****
Country_Spain	1.124	1.084
Country_France	1.165	1.102
Country_Italy	1.670	1.655
Country_UK	**0.343***	**0.335***
N	676	676
Nagelkerke R^2	0.178	0.175
Chi-square	**66.989*****	**65.339*****

(*, **, and * denote statistical significance at the 10%, 5% and 1% test level respectively)**

Table 3. Estimated Models of Propensity to Adopt Cloud Computing

From these estimates we can see that four out of our totally ten independent variables (without the control variables) have positive (as all exp(bi)>1) and statistically significant effects on the propensity to adopt CC. The variable measuring the degree of sophistication of firm's ICT infrastructure (ICT_Infr_Soph) shows the strongest positive and statistically significant effect on CC adoption propensity[2], and this provides support for research hypothesis H1a.

Also, the ICT investment reduction strategy variable (ICT_Invest_Red) has a positive and statistically significant effect, and this provides support for research hypothesis H2. Both innovation variables (Prodserv_Inn and Proc_Inn) show positive but statistically insignificant (at the 10%-test level) effects, but their respective standard errors (not shown here) indicate nearness to statistical significance at the 10% test-level. So, research hypothesis H3 is not confirmed according to standard statistical criteria, but it is not far away from confirmation.

The variables for ICT-personnel (ICT_Pers) and for ICT outsourcing (ICT_Outs) also have positive and statistically significant coefficients. On the contrary, the variable for ICT skills and – rather unexpectedly – the variables for firm size show no statistically significant effect on the CC adoption propensity. Therefore, hypotheses H4 and H6 receive empirical support, contrary to the Hypotheses H5 and H7, which are not confirmed by our estimates.

[2] We estimated also these two versions of our model using instead of the ICT infrastructure sophistication independent variable each of its component variables (use of ERP, CRM, SCM, SRM systems), and found positive statistically significant effects of all four on CC adoption propensity

Finally, the external environment seems to exercise no influence on the propensity to adopt CC; both competition variables (Pr_Comp and Qual_Comp) have positive but statistically insignificant coefficients. So, research hypotheses H8 and H9 are not supported. Our findings are summarized in Table 4.

Research hypothesis	Independent Variable	Support	Sign
H1	Degree of sophistication of firm's ICT infrastructure	√	+
H2	Adoption of ICT investment reduction strategy	√	+
H3	Adoption of an innovation-oriented strategy		
H4	Employment of specialized ICT personnel	√	+
H5	Sufficiency of ICT skills of firm's employees		
H6	Previous experience of ICT outsourcing	√	+
H7	Size		
H8	Price competition		
H9	Quality Competition		

Table 4. Summary of Findings

The comparison of the coefficients of the independent variables indicates that the strongest effect on CC adoption propensity among all the examined firm characteristics has the sophistication of firm's ICT infrastructure. Therefore, in the examined sectors firms with highly sophisticated ICT infrastructures have a stronger propensity to use CC services, probably in order to reduce their high ICT operations, support and maintenance costs. Then follow the effects of the adoption of ICT investment strategy, the employment of ICT personnel and the existence in the firm of previous experience of ICT outsourcing, which are of similar magnitude and can be compared to each other because the underlying variables are binary.[3] These results indicate that firms of these three manufacturing sectors (glass, ceramics and cement) view CC as a means mainly to reduce the operations, support and maintenance costs of their ICT infrastructures, and to a lower extent as a means to reduce ICT investment (and to an even lower extent as a means to support and facilitate innovation, if we allow the weak effects of the innovation variables to be worthy to be taken into consideration). These sectors, being rather conservative in terms of adoption of new ICT, and innovative business practices in general are oriented more towards lower risk uses of CC (such as hosting existing applications in order to reduce their operations, support and maintenance costs), and less towards higher risk uses of CC (e.g., for accessing new applications through CC SaaS services or for supporting innovations). Also, our results provide evidence that a firm's ICT personnel is important for the adoption of CC, as it has a critical role, initially for the development of awareness in

[3] For this reason, we do not need to estimate marginal effects.

the business units of the firm concerning possible benefits and risks of CC for the particular firm, and also for the identification of CC services and providers in the market that can be useful for the firm, and the final the selection among them, as well as for monitoring and managing relevant contracts and relations. On the contrary, in these sectors the (non-ICT) employees (ICT users or potential users) and their ICT skills do not seem to play an important role for CC adoption. Furthermore, our results reveal the importance of a firm's previous experience of ICT outsourcing for the adoption of CC. This experience creates on one hand awareness and trust in the firm concerning external ICT services provision and on the other hand knowledge, skills and processes concerning the effective monitoring and management of such external services. Finally, high intensity of price and quality competition is not drivers of CC adoption in these sectors.

As mentioned in section 2 most previous empirical studies examining effects of firm characteristics (internal and environment related ones) on CC adoption have found that competition has a positive impact on the adoption of CC by firms (Low and Chen, 2011; Mangula et al., 2014; Gutierrez et al., 2015; Gangwar et al., 2015; Hsu and Lin, 2015), while some other studies have not found statistically significant effects of competition on CC adoption (Hsu et al., 2014; Oliveira et al., 2015). So, our findings are in agreement with the second group of studies. A possible explanation for this finding is that these three traditional manufacturing sectors, being rather conservative in terms of ICT adoption and also due to the nature of their production processes, which are energy intensive and lead to significant carbon dioxide emissions (see Empirica GmbH (2000) for more details), do not find CC adoption as a major and effective response to high competition. They may focus instead on increasing the efficiency of their production processes through a reduction of energy consumption and carbon dioxide emission, thus avoiding the costs of fluctuating energy prices and pollution taxation. In general, the influence of competition on CC adoption propensity seems to be to a significant extent shaped by the sectoral context.

We have also found that firm size shows no statistically significant effect on firm's propensity to adopt CC. Our findings concerning the effects of size on the propensity for CC adoption in the three examined sectors are not in agreement with the arguments and the empirical evidence provided by the empirical studies of Low and Chen (2011) and Oliveira et al. (2014) that have found positive effects of size on CC adoption. However, our findings are in agreement with the ones of the empirical studies of Gutierrez et al. (2015) and also Hsu and Lin (2015), which found that size has not a significant influence on the adoption of CC services. So, our findings do not confirm the initial expectations that CC would be adopted primarily by the SMEs (Marston et al., 2011; Venders and Whitley, 2012; Saedi and Iahad, 2013; Alshamaila and Papagiannidis, 2014), enabling them to reduce their distance from the larger firms with respect to ICT capabilities, and therefore to become more competitive. Therefore

the influence of size on CC adoption propensity also seems to be dependent to a significant extent on the sectoral context.

5.1.5 Conclusions

Cloud computing is an emerging new paradigm of ICT resource acquisition and management by firms, which on one hand can offer significant benefits and on the other poses some risks that act as barriers to its adoption. Therefore, it is important to identify the factors that affect the adoption of CC positively or negatively. In the previous sections we presented an empirical investigation of the effects on the adoption of CC of a set of firm characteristics referring to technological infrastructure, strategy, and personnel skills that have not been examined in previous empirical CC adoption research. The study's conceptual foundation is the Technology, Organization and Environment (TOE) theory of technological innovation adoption. Our study contributes to filling an important research gap, as the impact of a firm's characteristics on CC adoption has been only to a very limited extent investigated in previous empirical literature. The study is based on a large dataset from 676 European firms from the glass, ceramics and cement industries, which has been collected through the e-Business Watch Survey of the European Commission. It focuses on three important manufacturing sectors, which are rather conservative in terms of adoption of new ICT, and innovative business practices in general.

This study has identified an interesting set of firm's characteristics that increase its propensity to adopt CC in these sectors. The most effective of them with respect to CC adoption is the sophistication of a firm's ICT infrastructure: due to the high operating and maintenance costs of sophisticated ICT infrastructures the use of CC services (such as IaaS and SaaS services) can be quite beneficial for reducing these costs. The second most effective characteristic is the adoption of ICT investment reduction strategy: if a firm follows such a strategy, then the use of CC can be a good option for upgrading and enhancing its ICT infrastructure in order to meet new business needs, and also for accessing and using new emerging ICT and novel types of applications (e.g., CRM or business analytics), without having to make additional ICT investments. Furthermore, the employment of specialized ICT personnel and also previous experience of ICT outsourcing have been found to affect positively the propensity to adopt CC. Another interesting finding of our study concerns the effect of a firm's size on CC adoption propensity: despite the expectations that CC would be more beneficial for smaller than larger firms, we could not find any significant effect of size on the propensity of CC adoption in the sectors investigated in this study. Finally, the ICT skills of firm's employees and the price and quality competition do not appear to affect the CC adoption propensity as well.

Our study has interesting implications for both research and practice. With respect to research it makes a contribution to the empirical research literature on factors affecting

the adoption of CC by investigating and comparing the effects of an important set of firm's characteristics not dealt with previously, which refer to a firm's strategic orientations, technological and human resources. Therefore, it deepens our understanding of firm-level conditions that promote CC adoption. Furthermore, our study opens up new directions of research on the effects of wider sets of firm characteristics on CC adoption, which can leverage various relevant concepts and frameworks developed in previous management science research, examining their impact on CC adoption and exploitation.

With respect to practice, our findings offer useful guidance to firms' management having to make decisions about the adoption of CC as to the types of firms from a technological infrastructure, strategy, human resources perspective to be viewed as more appropriate for adopting CC. Our results also indicate that firms can start with uses of CC of lower risk (e.g., use CC for hosting existing applications in order to reduce their operations, support and maintenance costs), and then, leveraging the experience gained from them, proceed to higher risk (and at the same time higher business value) uses of CC (e.g., use CC for accessing new applications, and then for supporting innovations in processes, products and services). Also, firms should not underestimate the importance of ICT personnel for the rational and beneficial adoption of CC (believing that CC makes ICT personnel unnecessary), but they should increase the involvement of their (non-ICT) personnel (ICT users or potential users), leveraging their ICT and business operations related knowledge. Furthermore, our findings offer useful guidance to CC provider firms, as to: i) which types of firms find CC more beneficial and have stronger propensity to adopt it, in order to focus their marketing and sales activity on them; and ii) which firms find CC as less beneficial, in order to improve and enrich their CC services for expanding into these firms' segments. An interesting lesson learnt from our study is that though initially the main target groups of CC were the smaller firms and also the firms with limited and deficient ICT infrastructure, our findings indicate that (at least in the three examined manufacturing sectors) (a) firm size is not a relevant characteristic for CC adoption and (b) firms with highly sophisticated ICT infrastructures show more interest in adopting and using CC. Therefore, CC services providers should rethink their offerings and probably transform so as to attract more interest from its initially targeted groups (e.g., through making their offerings more appropriate and easy to use by SMEs).

The main limitation of this study is that it is based on data from only three manufacturing sectors (glass, ceramics and cement), which are rather conservative in terms of adoption of new ICT, and innovative business practices in general, so that findings may have been influenced to some extent by this particular sectoral context. So, further research is required concerning the effect of wider sets of firm characteristics on the propensity to adopt CC in various sectoral contexts. However, it remains an advantage of our study that it deals with European firms, for which few

studies are available. A second limitation is that, due to the use of an existing dataset (on the collection of which we have not control), our variables have been measured mainly as ordinal or binary variables. So further relevant research is needed, which should be based on more detailed measurements of these variables (using ordinal scales with more levels or interval scales). Also, it would be useful to distinguish between different categories of CC services (IaaS, PaaS, SaaS), as they might differ as to the factors affecting their adoption. Finally, it would be interesting and useful to identify and examine mediating factors of the investigated effects (such as various types of benefits and risks) using structural equations modeling techniques. A third limitation refers as already mentioned to the cross-section character of our data. Thus, data for more points of time are needed for further research.

5.2 Cloud Computing Adoption Factors in Southern and Northern Europe

5.2.1 Introduction

The European North-South divide has been one of the most important and widely debated problems of Europe for long time (Aiginger, 2013a, 2013b; Landesmann, 2013). The countries of the European South (often referred to as the 'European Periphery') have for decades lower levels of economic and technological development, productivity and performance, and also higher levels of unemployment, than the countries of the European North. The Southern European counties are characterized by some fundamental weaknesses associated with the size and structure of manufacturing, deficits in innovation and education, deficits with respect to the exploitation of economy globalization and the restructuring of the public sector. They have a larger share of low-skill and a small share of high-skill industries; hence, the technology-driven industries are much smaller in comparison with the Northern European counties, and also declining. European periphery countries did not use the advantage of globalization despite being located by the sea and despite a history of global trade connections. It is because of these weaknesses (besides institutional problems) that economic performance differed across European countries, particularly between Northern and Southern countries, in the recent crisis (Aiginger, 2011). Though there has been a convergence between the European North and South for some time, recently, due to the economic crisis, this trend has stopped, and on the contrary a divergence is observed (Aiginger, 2013a; Aiginger, 2003). It is widely recognized that in order to overcome this negative situation, and achieve a gradual convergence between these two regions, it is important not only to cut wages and public expenditure in the European South (which has been the dominant approach so far), but also to make wider and better use of new technologies and boost innovation, aiming at the increase of productivity and growth.

In this study, we empirically investigate and compare Northern and Southern European firms with respect not to the 'quantity' of CC use, but to its 'quality': their CC adoption motivations and orientations. In particular, we investigate and compare to what extent Northern and Southern European firms view CC as a means of: (a) ICT investment reduction; (b) supporting and facilitating product/service innovation and process innovation; (c) experimenting with and exploiting new ICT; and (d) supporting and facilitating electronic innovation collaboration. Furthermore, this investigation is not based on the descriptive analysis of firms' managers' subjective perceptions concerning the usefulness of CC along the abovementioned four dimensions; it adopts a more "objective" approach, based on the estimation of a probit model the propensity for CC adoption, which is explained by the four main motives mentioned above (ICT investment reduction; product/service innovation and/or process innovation; interest in some new emerging ICT (data warehousing and data mining, mobile services); and having external collaborations for the development of innovations) separately for these two geographic regions and the pooled data of both regions. The estimated model contains further variables that are associated with technology adoption and a series of controls for firm size, sector and country affiliation.

5.2.2 Research Hypotheses

Our general theoretical framework builds on the adoption model of Battisti et al. (2009). According to this model the first use of a new technology is determined by five categories of variables: firstly, a vector of characteristics of a firm and its environment reflecting so-called "rank effects", i.e. relative advantages that might make the technology adoption beneficial for the firm; secondly, factors that reflect motives for adopting a certain technology, i.e., "inducement effects"; thirdly, the extent of usage of a technology to capture inter-firm "stock and order effects" (i.e., market-intermediated externalities); fourthly, "epidemic effects" (i.e., learning and non-market intermediated externalities) reflecting either a firm's own earlier experience of similar technologies or experience gained through the observation of other firms that use the new technology; fifthly, the expected adoption costs that have to be lower than the expected benefits in order to adopt the new technology.

This general framework is specified in the present paper in the context of the adoption of CC. Particularly, (a) we concentrate on ICT-relevant firm characteristics for rank effects; (b) due to the cross-sectional character of our data order and stock effects cannot be separated from epidemic effects, hence we can measure only a net effect of all three external effects; (c) we assume that adoption costs are approximately the same for all firms and can be captured by sector and country controls; and (d) we emphasize based on existing literature four important motives to adopt CC that refer to specific characteristics of this technology. The empirical investigation of the relevance of these

motives or inducement factors build the main contribution of this paper, hence our hypotheses refer exactly to these motives.

CC can provide significant benefits to firms. Initially the ICT cost reduction was regarded as the most significant of them, and especially the reduction of the required ICT investments, by converting related capital investments (cap-ex) to operating costs (op-ex). However, it was soon realized that CC could provide, beyond these 'first-level' cost reduction-oriented benefits, some additional 'second-level' significant transformation-oriented benefits: it can enable the rapid and low cost experimentation with and exploitation of new emerging technologies, and also support and facilitate innovation collaboration with external partners (Etro, 2009; Brynjolfsson et al., 2010; Marston et al., 2011; Venders and Whitley, 2012). According to Armbrust et al. (2010), CC enables the quick implementation of new ICT-based ideas, as "developers with innovative ideas for new Internet services no longer require the large capital outlays in hardware to deploy their service or the human expense to operate it" (p. 50).

Our first research hypothesis concerns the association between the adoption of an ICT investment reduction strategy and the propensity for CC adoption. Due to the economic crisis that exists in many countries firms have to adopt to a greater or lesser degree strategies of IT investment reduction. This does not allow them to upgrade and enhance their ICT infrastructures in order to meet new business needs, or to take advantage of new emerging technologies (such as data warehousing/mining, mobile technologies, etc.). This can have negative impact on firms' long-term competitiveness. CC can be quite useful for such firms as it enables them to upgrade the computing power of their ICT infrastructures (e.g., by using Infrastructure as a Service (IaaS)) and also their functionality (e.g., by using Software as a Service (SaaS)), without having to make additional upfront ICT investments (Marston et al., 2011; Venders and Whitley, 2012), transforming them to operational expenses based on the real use they make of these services (a 'pay as you go' model), and also without having to incur the corresponding operation, support and maintenance costs. Therefore, we expect that firms adopting an ICT investment reduction strategy will have a strong propensity to adopt CC. So, our first research hypothesis is:

H1. *The adoption of an ICT investment reduction strategy is positively associated with the propensity for CC adoption.*

Our second research hypothesis concerns the association between the adoption of an innovation-oriented strategy and the propensity for CC adoption. Changes in customers' needs and preferences, emergence of new technologies and strong competition make it necessary for firms to make innovations in their products and services, and also in their internal production and administrative processes, which have become today highly important for the competitiveness and even for the survival of firms. However, these innovations (both product/service and process ones) usually

necessitate the development of complex supporting ICT infrastructures. This can be costly (requiring considerable capital investments), risky (since if the innovation is not successful its supporting ICT infrastructure will become to a large extent useless, leading to waste of significant financial resources), and also can take too much time (which is quite negative in the rapidly changing and highly competitive modern economy). CC can alleviate the above problems: it can reduce the cost of the required ICT infrastructure for supporting an innovation (and make it an operational expense, without having to make ICT investments), reduce the implementation time (as the required CC services can be rapidly activated and customized), and also reduce the risk (since if the innovation is not successful the CC services used for supporting it can be simply terminated). Extant CC literature has emphasized that it can provide benefits associated not only with the ICT cost reduction, but also with the support and facilitation of innovations as well, as CC enables the rapid development of their required supporting ICT infrastructures, at a low cost, without requiring ICT capital investments (Brynjolfsson et al., 2010; Marston et al., 2011; Venders and Whitley, 2012; Berman et al., 2012). So, we expect that firms adopting an innovation-oriented strategy will have a strong propensity to adopt CC. Thus, our second hypothesis is:

H2. *The adoption of an innovation-oriented strategy is positively associated with the propensity for CC adoption.*

Our third research hypothesis concerns the association between the interest in the adoption of new ICT and the propensity for CC adoption. A major trend of the modern economy is the continuous emergence of new ICT; each firm has to decide which of the multiple new emerging ICT are appropriate and beneficial for its particular activities, processes, products and services, and also sufficiently mature, so they should be adopted, and which of these emerging ICT are not, so they should not be adopted. However, the adoption of a new emerging ICT poses two important problems: on one hand, it can be costly and require some capital investment, and on the other hand it carries some uncertainty and risk (as to whether it is really applicable, appropriate and beneficial). If it is not finally successful there will be a loss of valuable financial resources that have been used for the relevant investment. CC can alleviate both these problems: it can reduce the abovementioned required costs, making them operational expenses and eliminating the need for investment; also, it can eliminate the inherent risk (since if the adoption is not successful the CC services used can be simply terminated). Existing literature argues that one of the most important advantages of CC is that it enables enhancing firm's ICT infrastructure by incorporating new emerging ICT, rapidly, at a low cost and without having to make additional investments, with the most widely mentioned of them being data warehousing/mining and mobile services (Marston et al., 2011; Venters and Whitley, 2012; Bhagyashree and Borkar, 2012; Verma, 2013). Therefore, we expect that firms

interested in experimentation with and exploitation of new ICT will have a strong propensity to adopt CC. So, our third hypothesis is:

H3. *Interest in adopting new ICT is positively associated with the propensity for CC adoption.*

Finally, our fourth research hypothesis concerns the association of the collaboration with other firms with the propensity to adopt CC. The globalization, the strong competition, the continuous emergence of new technologies, the fast changes that characterize the modern business environment, as well as the high expectations and demands of consumers for high value-added products and services, and also for continuous renewal and improvement of them, make it difficult for individual firms to survive on their own, relying only on their internal resources, and this results in increasing collaboration among firms having complementary resources, both at the operational and the product/service and process innovation level (Rycroft, 2007; Zeng et al., 2010; Xie et al., 2013; Majava et al., 2013). However, this necessitates extensive exchange of both structured and unstructured information, which can be significantly supported and facilitated through the use of appropriate ICT. The use of CC services enables the development, operation and maintenance of this ICT support of collaboration rapidly, at a low cost, without having to make additional investments. A recent study based on interviews with business and ICT practitioners in the UK revealed that CC has a strong potential to support and facilitate business collaboration at a low cost (Willcocks et al., 2014). For the above reasons, we expect that firms using online software applications (other than E-mail) to collaborate in the development of new products and processes with other firms will have a strong propensity to adopt CC. So, our fourth research hypothesis is:

H4. *Collaboration with other firms is positively associated with the propensity for CC adoption.*

5.2.3 Model Specification

In this study, we used firm level data collected through the "e-Business Survey 2009" survey. Appendix B presents the composition of the dataset used in the present study by country and sector. 59.4% of all firms come from Northern Europe, 40.6% of them from Southern Europe; about 50% of all enterprises come from the cement sub-sector. Appendix B contains standard descriptive statistics (mean; standard deviation) for all variables in our model and also the correlations among model variables for all firms, and separately for the sub-sample of firms from Northern Europe and Southern Europe, respectively. A short inspection of these tables demonstrates that none of the correlation coefficients is larger than 0.26, thus practically excluding problems of multicollinearity in our estimates.

As dependent variable, we used the propensity for CC adoption, which is constructed as a binary variable with the value 1, if firms report relevance of CC for their activities and 0, if they report that CC is not relevant for them. As independent variables we used, first, four binary variables referring to the four different motivations for adopting CC (ICT investment reduction; product/service innovation and/or process innovation; interest in new emerging ICT – data warehousing, data mining, and mobile services; and electronic (i.e., supported by ICT) external innovation collaboration). These four variables measure inducement effects that are specific for CC. Further, we control for other factors that could influence the CC propensity: (a) some firm characteristics (firm size, firm being part of an international enterprise group, exporting, earlier experience with other ICT outsourcing activities); (b) environmental factors (intensity of price competition at the main market), both groups of variables reflecting rank effects; and (c) experience with CC of other firms in the firm-specific market environment (net effect of stock, order and epidemic effects; see section 5.2.2). Finally, we control for sector and country affiliation in order to reduce the possibility of omitted variable bias (and control for adoption costs; section 5.2.2). Appendix B shows in detail how the model variables were constructed. Our model can be formally expressed as follows:

$$CC_i = b_0 + b1\ ICT\_INVEST\_RED_i + b_2\ INNO_i\ (INNOPC_i) + b_3\ NEW\_ICT\_TECH_i + b_4\ COLLAB\_ELC_i + b_5\ OUTS_i + b_6\ EXPORT_i + b_7\ INTERi + b_8\ PCOMP_i + b_9\ Medium\text{-}sized_i + b_{10}\ Large_i + b_{11}\ EP_i + sector\ dummies + country\ dummies + e_i$$

We tested the research hypotheses H1 – H4 separately for the European North (firms from Germany, France and United Kingdom) sub-sample, the European South (firms from Italy and Spain) sub-sample and the pooled firm data for both regions by estimating probit models for the CC propensity.

5.2.4 Results

5.2.4.1 Descriptive Analysis

In Table 5 we show the share of firms reporting that CC is "very relevant" or "partly relevant" for their activities for each of the five countries examined in this study. We remark that in the glass, ceramic and cement sectors of the examined Southern Europe countries there is a higher share of firms considering CC as very relevant or partly relevant than in the examined Northern Europe countries. A possible explanation of this might be that the economic problems of the European South limit the financial resources of firms, and this increases their propensity to use CC for reducing the ICT costs and especially ICT investments; however, a clearer picture on this can be formed by examining the model estimates, which are discussed in the following paragraphs of this section.

Cloud Computing Propensity		Very or Partly Relevant (%)	Not Relevant (%)
South (N=226)	Italy	21.8	78.2
	Spain	16.0	84.0
North (N=327)	UK	4.7	95.3
	France	12.8	87.2
	Germany	4.4	95.6

Table 5. Cloud Computing Propensity by Country

In Table 6 we present the share of firms reporting that the various motivations for using CC are "very relevant" or "partly relevant" for each of the five countries examined in this study. We remark that in the European South the percentage of firms of these sectors adopting an ICT investment reduction strategy is much higher than in the European North, due to the existing economic problems that reduce demand and sales. Further, we find in Southern Europe higher percentages of firms introducing innovations, having electronic external innovation collaboration and being interested in data warehousing/mining.

		ICT Investment Reduction	Product Innovation	Process Innovation	Interest in Data Mining, Warehouse	Interest in Mobile Services	Electronic Collaboration
South (N=226)	Italy	30.7	39.6	38.6	32.7	13.9	13.9
	Spain	30.4	36.0	44.0	26.4	13.6	13.6
North (N=327)	UK	14.1	34.4	40.6	9.4	26.5	7.8
	France	20.9	20.9	24.4	22.1	41.9	11.6
	Germany	16.7	36.1	39.4	17.2	33.9	9.4

Table 6. Motives for Adopting Cloud Computing; percentage of firms

5.2.4.2 Econometric Analysis

Table 7 shows the probit estimates for the sub-samples of the firms in Southern Europe (column 1) and in Northern Europe (column 2) as well as for the entire sample (all firms; column 3). The main focus is on the variables for the four different motivations related to our research hypotheses. For the firms from Southern Europe seem to be relevant the motive of ICT invests reduction and the motive of the interest for emerging technologies, but not the innovation and the collaboration motives. The respective findings for the Northern European countries are quite opposite to those for South Europe: relevant are in this case the innovation motive, particularly for process innovation, and the collaboration motive, which is related to the innovation motive. So, we find two different patterns of motives for the two European regions. With respect to our hypotheses the results are in a way complementary to each other: H1 and H3 appear to be valid for Southern Europe but not for Northern Europe and H2 and H4 seem to be valid only for Northern but not for Southern Europe. For three

of the four motives examined in this study we find positive and statistically significant coefficients in the estimates for all firms. As we have seen, behind this overall finding hides much heterogeneity with respect to the southern and northern part of the European Union.

Indep. Variables	Southern Europe	Northern Europe	All firms
Inducement effects			
ICT_invest_red	**0.582*** **	0.245	**0.412*** **
	(0.230)	(0.246)	(0.164)
INNOPC		**0.507***	
		(0.298)	
INNO	0.197		0.208
	(0.228)		(0.172)
NEW_ICT_TECH	**0.941*** **	0.249	**0.683*** **
	(0.274)	(0.282)	(0.191)
COLLAB_ELC	0.121	**0.967*** **	**0.468** **
	(0.292)	(0.315)	(0.218)
Rank effects			
OUTS	0.340	**0.514***	**0.340***
	(0.272)	(0.303)	(0.196)
EXPORT	**-0.649***	-0.103	**-0.425***
	(0.362)	(0.312)	(0.234)
INTER	0.400	0.300	0.304
	(0.383)	(0.328)	(0.239)
PCOMP	-0.033	0.302	0.066
	(0.187)	(0.206)	(0.134)
Medium-sized	-0.256	0.324	-0.059
	(0.248)	(0.271)	(0.185)
Large	0.262	-0.185	0.151
	(0.380)	(0.410)	(0.270)
Stock, order, epidemic effects			
EP	**0.040***	0.033	**0.024** **
	(0.023)	(0.023)	(0.012)
Controls			
Sector dummies	Yes (2)	Yes (2)	Yes (2)
Country dummies	Yes (1)	Yes (2)	Yes (4)
Const.	**-2.763*** **	**-3.802*** **	**-2.899*** **
	(0.755)	(0.804)	(0.458)
N	226	327	553
Pseudo R^2	0.188	0.267	0.218
Chi^2	**42.2*** **	**58.5*** **	**71.2*** **

Table 7. Probit Estimates for the Binary Variable CLOUD_PROP

(Note: Heteroskedasticity-robust standard errors in brackets; *, ** and *** denote statistical significance at the 10%, 5% and 1% test level, respectively; reference firm size: small firms).

The findings show that for Southern European firms the main motives for adopting CC are (a) the possibility of reducing for ICT and (b), rather unexpectedly, the interest for emerging ICT such as data mining, data warehouses and mobile services. One possible explanation for this second effect might be that Southern firms that have to handle in a rather unfavorable economic environment expect to be able to experiment and/or exploit emerging ICT at low cost and risk when using CC. The situation is different in the northern part of Europe, where more favorable current economic conditions and a different tradition of investing heavily in innovation might explain the dominance of the innovation and collaboration motives.

In sum, the above results indicate that the Southern European firms of the above sectors view CC as a means of reducing ICT investment; CC enables them to upgrade and enhance their ICT infrastructures in order to meet new business needs, without having to make new investments, which would difficult to finance in the problematic economic context of the European South. On the contrary, the Northern European firms of the above sectors view CC mainly as a means of supporting and facilitating innovation, particularly process innovation, and innovation collaboration via online software applications.

Further, we find that for Northern European firms having experience with ICT outsourcing is the likelihood to adopt CC higher than in firms without such experience. This is not the case for Southern European firms. An epidemic effect, i.e. the awareness of competitors assessing CC to be relevant for their activities seems to enhance a firm's own propensity to CC. Exporting is not enhancing CC propensity. On the contrary, being disposed to international competition is associated with a lower CC propensity. All other factors that could influence CC adoption appear to have no significant effects on CC propensity in both regions.

5.2.5 Conclusions

A first contribution of our research refers to the conceptual background that was used in the present study. We use a theoretical approach for technology diffusion, which is widely used in economics, as unifying theoretical framework that can be also utilized in the literature on information systems management. This general framework was specified in the context of the adoption of CC.

However, the main contribution refers to the empirical findings. One of the most important problems of Europe for long time has been the gap in economic and technological development and performance between the European North and the European South, referred to as the 'European North-South divide'. Though for some time a gradual convergence between these two regions was in progress, recently, due to the economic crisis, this has stopped, and on the contrary a new divergence has started. It is widely recognized that in order to reverse this negative trend and achieve

a gradual convergence between these two regions, it is of critical important to make wider and better use of new technologies and boost innovation in the European South in order to improve its productivity. This study makes a contribution to this 'European North-South divide' debate, by empirically investigating and comparing European North and South with respect to the one of the most important, innovative and disruptive new ICT, the CC. This technology changes radically the way firms access and use ICT for supporting their activities, and also the economics of business computing as it enables the conversion of relevant capital investments (cap-ex) to operating costs (op-ex). In particular, we investigate and compare the "quality" (instead of the "quantity" usually examined by similar studies) of CC use (or planned use) by the Northern and Southern European firms. To its end, we examine to what extent they view CC as a means of: (a) ICT investment reduction; (b) supporting and facilitating product/service innovation and process innovation; (c) experimenting with and exploiting new ICT; and d) supporting and facilitating external collaboration.

It has been concluded that in the European South firms of the above sectors have in general a higher interest in and propensity for the adoption of CC than in the European North. However, the motivations and orientations with respect to CC adoption show important differences between the two regions. Southern European firms of the examined sectors view CC as a possibility for reducing ICT investment expenditure as well as a means of low cost and risk means of experimentation with and exploitation of new emerging ICT. The economic problems and the lower market demand in the European South put pressure on firms to exploit the extensive capabilities for low cost and risk use of new emerging ICT offered by CC. On the contrary, Northern European firms view CC as a means of supporting and facilitating product/service innovation, and also of reducing cost and increasing capabilities of their existing external electronic collaboration (with business partners and experts) for the development of innovations.

These findings are indicated that Southern European firms are mainly oriented towards 'first-level' cost (and especially investment) reduction related benefits from CC as well as from new emerging ICT, while on the contrary Northern European firms are mainly oriented towards 'second-level' transformation related benefits from CC, which are associated with support and facilitation of innovation and external collaboration. The difficulty of financing investments in the problematic economic context of the European South, in combination with the longer and stronger tradition of the European North concerning the use and advanced exploitation of complex new technologies, are a possible explanation for these findings.

The results of this empirical study have interesting implications both for research and practice. With respect to research it makes a contribution to the existing body of knowledge concerning the impact of the national context of ICT adoption, focusing on a very important and disruptive ICT (the CC), particularly on motivations and orientations of CC adoption. With respect to practice, our conclusions can be useful

for government agencies, both at national level and at European level, in order to formulate effective technology adoption and transfer policies, and also for CC services providers, in order to optimize their offerings in taking into account the specific characteristics and needs of each national market. Our study has two main limitations: its limited sectoral and national scope, and also the use of a rather broad dependent variable (propensity for CC adoption in general). So, further research is required concerning the motivations/orientations of the adoption of various types of CC services (e.g. IaaS, PaaS, SaaS), in various sectorial and national contexts.

5.3 Inter-Organizational Open Innovation and Cloud Computing

5.3.1 Introduction

It has been argued that there is an association between two major trends of the modern economy (the shift of firms from the 'closed' innovation paradigm and the emergence of CC): a highly important condition for the efficiency and effectiveness of inter-organizational open innovation is appropriate ICT support, and CC can provide at a low cost extensive capabilities for this, and especially for the electronic support of inter-organizational collaboration for the design and implementation of innovations. However, the above arguments and expectations have not been empirically investigated: it has not been empirically examined to what extent firms perceive CC as a useful and cost-effective means of supporting open inter-organizational innovation; or (equivalently) to what extent there is positive association between these two important trends of modern economy, the inter-organizational open innovation and the adoption (or propensity for adoption) of CC.

This study contributes to filling this research gap. It investigates empirically the effects of firm's inter-organizational collaboration for the design and implementation of innovations, and also the use of ICT for supporting such collaborations, on firm's propensity to adopt CC; in this way, it examines in an 'objective manner' (without resorting to subjective perceptions of firms' managers) to what extent firms regard CC as a cost-effective means of supporting inter-organizational collaborative design and implementation of innovation. So, the main research question our study attempts to address is:

'Do firms perceive CC as a cost-effective means of supporting inter-organizational collaboration for the design and implementation of innovations?'

Furthermore, since some firms already use some ICT for the electronic support of such inter-organizational innovation collaborations, our second research question is:

'Do firms perceive CC as a means of reducing the cost and increasing the capabilities and flexibility of already existing ICT support of inter-organizational collaboration for the design and implementation of innovations?'

This research aims to create useful knowledge on an important aspect of the potential of CC, which concerns the support and promotion of open innovation. We expect that

its findings will be interesting and useful for researchers (making a contribution to the existing CC adoption research, and opening up new directions of CC adoption and business value research), CC services providers (in order to improve and enrich their offerings and value propositions towards the electronic support of inter-organizational collaboration for the design and implementation of innovations), consulting firms (interested in finding new ways of CC organizational exploitation), and also CC user (or potential user) firms' management (providing guidance to them in order to make advanced and multi-dimensional exploitation of CC).

5.3.2 Research Hypotheses

Our first research hypothesis concerns the effect of inter-organizational collaboration with other firms for the design of innovations on firm's propensity to adopt CC. The modern economy innovation becomes increasingly collaborative: firms are increasingly collaborating with other firms, which possess complementary resources (e.g. knowledge, human skills and equipment and production facilities), in order to design, produce and promote innovative products, services, and also to design and implement their innovations in their processes (Rycroft, 2007; Salavisa et al., 2012; Zeng et al., 2010; Huizingh, 2011; West et al., 2014). This requires extensive exchange of information (both structured and unstructured) between the firms involved in inter-organizational collaborative innovation design, in order to exchange the different knowledge elements that each of them contributes, combine/synthesize them and create the new knowledge required for the design of the innovation; this can be significantly supported and facilitated through the use of appropriate ICT (Meroño-Cerdan et al., 2008; Lopez-Nicolas and Soto-Acosta, 2010; Soto-Acosta et al., 2014; Lyytinen et al. 2016). The use of CC services enables the development, operation and maintenance of this ICT support required for the inter-organizational collaborative innovation design at a low cost, and without having to make additional investments, since a big variety of cloud-based collaboration tools have been developed and offered through the SaaS model (Forbes, 2013; Tan and Kim, 2015; Ross and Blumenstein, 2015). According to Lai et al. (2012) and Sultan (2013) CC can substantially support internal and external knowledge management processes of firms, and this has led to the development of 'knowledge as a service (KaaS)', which can greatly facilitate the interactions and knowledge exchanges among members of a 'knowledge network' at low cost. For the above reasons, we expect that firms having inter-organizational innovation design collaboration with other firms will have a high motivation and propensity to adopt CC. So, our first research hypothesis is:

H1: *Inter-organizational collaboration with other firms for the design of innovations has positive effect on firm's propensity for cloud computing adoption.*

Furthermore, there are firms already using ICT for the electronic support of collaborations they have with other firms for the design of various kinds of innovations in their products, services and processes. These firms can substantially reduce the operation, support, maintenance and upgrade cost of this ICT support, and also gain access to better and more extensive collaboration support functionality, by using appropriate CC services (e.g. by replacing existing on-premises collaboration support systems with modern cloud-based collaboration tools offered through a SaaS model). Quite useful for this can be a variety of cloud-based collaboration tools that as mentioned above have been developed (Forbes, 2013; Tan and Kim, 2015; Ross and Blumenstein, 2015), which provide a wide range of remote collaboration support functionalities. Sultan (2013) argues that most leader ICT firms (such as Microsoft, Google, Salesforce, etc.) are developing applications with rich functionalities that support both internal and external knowledge management, which are offered through the classical 'on-premises' model as well as the SaaS model, and this creates big opportunities for firms (and especially SMEs) to obtain high quality ICT support of both their closed and open innovation design activities. For the above reasons, we expect that firms using ICT for supporting innovation design collaborations with other firms will have a high motivation and propensity to replace some of their existing external collaboration support systems and adopt CC in order to take advantage of the abovementioned highly attractive offerings. So, our second research hypothesis is:

H2: *The use of ICT for supporting inter-organizational collaboration with other firms for the design of innovations has positive effect on the propensity for cloud computing adoption.*

Today firms tend to open not only their innovation design activities, but also their innovation implementation ones as well, taking advantage of production equipment and facilities, human skills and relevant knowledge of other firms. This leads to outsourcing some parts of innovative products, or some parts of innovative services, to other specialized firms all over the world (Gusmano et al., 2009; Navghavi and Ottaviano, 2010; Arvanitis and Loukis, 2013), increasing significantly the quantity and value of their external procurement, and also its geographical scope, moving from local suppliers, to country level and even international ones. However, this increases significantly firm's operational complexity and workload, especially in cases of international procurement: having suppliers beyond firm's country necessitates the management of much different legislation, regulations, taxation systems, payment systems and currencies, etc. The above lead to high requirements for storage, processing and exchange of relevant information, and finally to high costs for the development, maintenance and operation of the necessary ICT support, which can increase considerably firm's operating costs. The use of existing cloud-based SCM systems (Demirkan et al., 2010; Demirkan and Goul, 2013; Jede and Teuteberg, 2015) is a good option in such cases, as it can provide extensive and high-quality ICT support

of the above complex inter-organizational operations, at a low cost, which is mainly an 'operating expense', without having to make big ICT investment. For the above reasons, we expect that firms having wider geographical scope of procurement will have a high motivation and propensity to adopt CC. So, our third research hypothesis is:

H3: *Increase of the geographical scope of firm's procurement has positive effect on the propensity for cloud computing adoption.*

Furthermore, there are firms already using ICT for supporting and increasing the efficiency of the operational collaborations they have with other firms for the implementation of various kinds of innovations, such as SCM systems (Wu and Chang, 2012; Laudon and Laudon, 2014; Rainer et al., 2015; Chopra and Meindl, 2016). This ICT support can have high operation, support, maintenance and upgrade costs, so it can be highly beneficial for these firms to use CC services in order to reduce these costs; this can be achieved by using IaaS and PaaS services for hosting such existing applications, or even by using SaaS for replacing some older and/or bespoke applications with more modern standard software packages, such as cloud-based SCM systems (Demirkan et al., 2010; Demirkan and Goul, 2013; Jede and Teuteberg, 2015). The electronic exchange of orders, invoices, inventory levels and other data required in these operational collaborations can be conducted much easier and at a lower cost if the firms we are collaborating with are given access to appropriate parts of such cloud-based SCM systems (e.g. to some of their data or/and functionality) we are using. This can provide an efficient support of operational collaboration with other firms, which has also high flexibility for addressing changes in our business collaboration networks (new firms can be easily given such access if required, and this will activate immediately electronic collaboration with them). For the above reasons, we expect that firms using ICT for supporting their operational collaboration with other firms will have a high motivation and propensity to adopt CC. So, our fourth research hypothesis is:

H4: *The use of ICT for supporting firm's operational collaboration with other firms has positive effect on the propensity for cloud computing adoption.*

5.3.3 Model Specification

The definitions of all the variables that we have used from the European survey are shown in the Appendix C. As dependent variable has been used the propensity for CC adoption (CLOUD_PROP), which initially has been measured in a three levels scale (very relevant, partly relevant or not relevant for the firm), but as the relative frequency of the first value was very small we merged the first two values, so this

variable has been finally recoded as binary (with very relevant or partly relevant coded as 'yes', and not relevant coded as 'no'). We have used five independent variables, with three of them concerning inter-organizational design of innovations, and the other two concerning inter-organizational implementation of innovations. In particular, the first two independent variables are binary (yes/no) variables assessing whether or not the firm has external collaborations with other firms for the design of product/service innovations and process innovations respectively (i.e. in the development of new products or services are involved other firms or external experts) (COLL_PRODSER_INN and COLL_PROC_INN). The third independent variable is a binary (yes/no) variable assessing whether or not the firm is using ICT for the electronic support of innovation design collaborations with other firms (i.e. uses software applications in order to collaborate with other firms in the development of product/service innovations or process innovations) (EL_COLL_INN). Our fourth independent variable concerns the geographic scope of firm's procurement (GSC_PROC), which is measured in a three levels scale (regional, country or international). The fifth one is a binary (yes/no) variable assessing whether or not the firm is using an advanced ICT application for supporting its operational collaboration with other firms: a supply chain management (SCM) system (E_SCM). Also, we used for comparison purposes an additional independent variable, which corresponds to the most important CC adoption factor/motivation according to the relevant literature (Marston et al., 2011; Venders and Whitley, 2012; Müller et al., 2015): ICT capital investment reduction. In particular, we used an additionally binary (yes/no) variable assessing whether or not the firm has an ICT investment adoption strategy (ICT_INV_RED), in order to compare the effects of this widely recognized central CC adoption factor/motivation with the effects of the abovementioned five independent factors of our study.

In order to test our research hypotheses H1 – H4 initially we estimated the association between the dependent variable and each of the abovementioned independent variables, by calculating: a) two widely used measures of association between ordinal variables, Somers' d and Kendall's tau-b (they both range from -1 to 1, with the sign indicating the direction of the association, and the absolute value indicating its strength); b) the widely used Pearson's correlation (which is acceptable for ordinal variables); and c) the partial correlation, controlling for sector (using for this purpose two sectoral binary dummy variables D_SECT1 and D_SECT2) and size (using two binary size dummies: one taking value 1 for large firms having 250 or more employees (D_LARGE), and 0 for all other firms, and another one taking value 1 for medium size firms having between 50 and 249 employees, and 0 for all other firms (D_MEDIUM)). The calculation of these partial correlations allows the identification of spurious correlations, which are due to similar influences of sector or/and size to both variables (e.g. due to positive effects of size to both variables), by calculating these correlations after the extraction of the influences of sector and size from both variables.

Then we estimated the following regression model:

$$CLOUD\_PROP_i = b_0 + b_1\ ICT\_INV\_REDi + b_2\ COLL\_PRODSER\_INNi\ (COLL\_PROC\_INN_i,\ EL\_COLL\_INN_i) + b_3\ GSC\_PROC_i\ (E\_SCM_i) + b_4\ D\_MED_i + b_5\ D\_LARGE_i + b_6\ SECT1_i + b_6\ SECT2_i + e_i \quad (1)$$

having as dependent variable the abovementioned propensity for CC adoption one (CLOUD_PROP), and as independent variables the adoption of an ICT investment adoption strategy (ICT_INV_RED), one variable concerning inter-organizational collaboration for the design of innovations (initially we entered the COLL_PRODSER_INN variable, then the COLL_PROC_INN and finally the EL_COLL_INN; due to high levels of correlation among these three variables it was not possible to include all of them in the same regression model, as this caused multi-collinearity problems) and one variable concerning inter-organizational collaboration for the implementation of innovations (initially we entered the GSC_PROC variable and then the E_SCM; again due to high levels of correlation among these two variables it was not possible to include both of them in the same regression model, as this caused multi-collinearity problems). Also, we included the abovementioned two size dummy variables D_MEDIUM, and D_LARGE (having as reference group the small firms), and also two sector dummy variables SECT1 and SECT2 (having as reference group SECT3 = cement sector). So, we estimated six regression models in total. Since the dependent variable (CLOUD_PROP) has been recoded as binary, for these estimations we used logistic regression, which is according to the relevant econometric literature (Greene, 2011; Sreejesh et al., 2014) the most appropriate estimation method when the dependent variable is binary.

5.3.4 Results

In Table 8 are shown for all independent variables the calculated Sommer's D coefficient, Kendall tau-b coefficient, correlation and partial correlation (controlling for sector and size) values with respect to the dependent variable (propensity for CC adoption) (statistically significant values having significance lower than 10% are shown in bold).

Independent Variable	Sommers' D	Kendall tau-b	Correlation	Partial Correlation
COLL_PRODSER_INN	**0.129*** **	**0.130*** **	**0.130*** **	**0.108*** **
COLL_PROC_INN	**0.160*** **	**0.164*** **	**0.164*** **	**0.136*** **
EL_COLL_INN	**0.152*** **	**0.152*** **	**0.152*** **	**0.137*** **
ICT_INV_RED	**0.160*** **	**0.165*** **	**0.165*** **	**0.141*** **
E_SCM	**0.193*** **	**0.193*** **	**0.193*** **	**0.170*** **
GSC_PROC	0.015	0.017	0.029	-0.009

(*, **, and * denote statistical significance at the 10%, 5% and 1% test level respectively)**

Table 8. Sommer's D, Kendall tau-b, correlation, and partial correlations of independent variables with the dependent variable

Also, in Table 9 are shown the six estimated regression models of CC adoption propensity with the specification of the equation (1). For each independent variable is shown the exp(b), which is the increase of the odds of CC adoption propensity (= probability of having CC adoption propensity/ probability of not having CC adoption propensity) if the independent variable increases by one unit (in bold are shown the statistically significant ones having significance lower than 10% are shown in bold). We remark that the R^2 values of these five models are low to medium (between 0.148 and 0.173), but this is not a problem, as the main objective of their estimation is not to include as many factors affecting CC benefits as possible, in order to achieve the best possible prediction of CC benefits, but to examine the effects of the specific independent variables (= open innovation design and implementation related variables) on CC adoption propensity.

Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
ICT_INV_RED	**2.011*** **	**1.900*** **	**2.089*** **	**1.859** **	**1.743** **	**1.938*** **
E_SCM				**2.383*** **	**2.388*** **	**2.250*** **
GSC_PROC	1.014	0.994	0.942			
COLL_PRODSER_INN	**1.958** **			**1.877** **		
COLL_PROC_INN		**2.093*** **			**2.023*** **	
EL_COLL_INN			**2.525*** **			**2.216** **
D_MEDIUM	1.354	1.272	1.271	1.296	1.218	1.212
D_LARGE	**1.888** *	1.747	**1.975** *	1.644	1.504	1.688
SECT1	**1.879** **	**1.915** **	**1.774** *	1.719	**1.732** *	1.606
SECT2	1.482	1.512	1.402	1.480	1.523	1.417
COUNTRY_SPAIN	**4.374*** **	**3.918*** **	**3.764*** **	**3.372*** **	**3.071** **	**3.073** **
COUNTRY_FRANCE	**3.704*** **	**3.636*** **	**3.159** **	**3.570*** **	**3.495** **	**3.060** **
COUNTRY_ITALY	**5.426*** **	**5.548*** **	**5.322*** **	**5.145*** **	**5.247*** **	**5.149*** **
COUNTRY_UK	1.133	1.103	1.119	1.137	1.106	1.144
COUNTRY_POLAND	**3.517*** **	**3.379*** **	**3.650*** **	**3.448*** **	**3.324*** **	**3.562*** **
N	676	676	676	676	676	676
Nagelkerke R^2	0.148	0.153	0.154	0.168	0.173	0.171
Chi-square	**55.02*** **	**56.94*** **	**57.35*** **	**62.93*** **	**64.78*** **	**63.99*** **

Table 9. Estimated models of CC adoption propensity

From Tables 8 and 9, we can see that inter-organizational collaboration with other firms for the design of both product/service and process innovations have statistically significant positive effects on firm's propensity for CC adoption. Therefore, research hypothesis 1 is supported. Also, we can see the use of ICT for the support of inter-organizational collaboration with other firms for the design of innovations has statistically significant positive effect on the propensity for CC adoption. So, research

hypothesis 2 is supported as well. On the contrary, the geographical scope of firm's procurement does not have a statistically significant effect on the propensity for CC adoption, so research hypothesis 3 is not supported. Finally, the use of a SCM system for supporting firm's operational collaboration with other firms has positive effect on the propensity for CC adoption; therefore, research hypothesis 4 is supported.

The above results provide some interesting evidence concerning association between two major trends of the modern economy: open inter-organizational innovation and cloud computing. Our results indicate that firms of the three examined manufacturing sectors view CC as a cost-effective means of supporting inter-organizational collaboration with other firms for the design of innovations. The latter necessitates extensive exchange of knowledge among collaborating firms, new combinations of this knowledge, and based on it design of the innovation, initially at a conceptual level, and then more detailed; all these can be significantly supported and facilitated through the use of appropriate ICT (Meroño-Cerdan et al., 2008; Lopez-Nicolas and Soto-Acosta, 2010; Soto-Acosta et al., 2014; Lyytinen et al. 2016). CC is perceived as a cost efficient option for sourcing this ICT support at a low cost, which is an additional operational expense, without having to make additional investments, taking advantage of a big variety of cloud-based collaboration support tools have been developed, and can be offered through the SaaS model as well; these tools can offer a rich set of functionalities that can support both internal and external knowledge management, such as centralized content storage and sharing, forums, instant messaging and other interaction and productivity applications, support of groups, social media type applications, project management, etc., that can be made available to both firm's employees and also external entities (Forbes, 2013; Tan and Kim, 2015; Ross and Blumenstein, 2015). Furthermore, firms of these sectors view CC as a means of reducing the cost and increasing the capabilities and flexibility of already existing ICT support of inter-organizational collaboration they have with other firms for the design of innovations. The abovementioned of cloud-based collaboration support tools offered through the SaaS model are perceived by firms of these sectors as a good alternative to existing on-premises collaboration support systems currently used for the electronic support of open innovation design (i.e. inter-organizational collaboration with other firms for the design of innovations).

Furthermore, our results indicate that at least in the three examined sectors the wider geographic scope of procurement caused by inter-organizational implementation of innovations, which usually necessitates extensive operational collaboration with a big number and variety of firms, and therefore extensive ICT support for the storage, processing and exchange of big amounts of relevant information, is not a driver of CC adoption; firms of these sectors do not view CC as a cost - effective means of providing ICT support of their operational collaboration with multiple geographically dispersed suppliers. A possible reason for this might be that in these three manufacturing sectors the operational collaboration processes exhibit significant specificities and

complexities, leading to high levels of 'asset specificity' (e.g. need of highly specialized and customized software applications in the CC services provider side, and also extensive communication and cooperation between experienced and knowledgeable personnel of the CC services provider and the CC services user) and 'uncertainty' (as to whether the CC services provider can meet all the special needs with satisfactory service levels and price). This higher asset specificity and uncertainty, according to the transaction cost theory (Williamson, 1985 and 1989) make the outsourcing of the electronic support of this inter-organizational operational collaboration through the use of CC more difficult and costly to manage, and less attractive and beneficial, in comparison with the on-premises alternative. Another possible reason might also be that the adoption of CC for supporting critical everyday activities (such as the ones of these operational collaborations) is risky, and requires a certain level of 'cloud computing maturity' along various technological and organizational dimensions (Oracle, 2011); there is a chance that the three examined sectors, which as mentioned in the introduction are rather conservative in terms of adoption of new ICT, and innovative business practices in general, do not possess sufficient maturity for this. On the contrary, our results indicate that firms of the three examined sectors view CC as a means of reducing the cost and increasing the capabilities and flexibility of already existing on-premises ICT support of inter-organizational operational collaborations, such as SCM systems. These systems can be quite costly to operate and maintain, and also not provide all the required functionality; so, it might be quite attractive to use IaaS and PaaS services for hosting such existing on-premises applications, or even to use SaaS for replacing some older and/or bespoke applications with more modern standard software packages, such as cloud-based SCM systems (Demirkan et al., 2010; Demirkan and Goul, 2013; Jede and Teuteberg, 2015).

Finally, a comparison was made of the effects of the examined independent variables on the propensity for CC adoption, taking into account the calculated Sommer's D, Kendall tau-b, correlation and partial correlation coefficients shown in Table 8, as well as the b coefficients of the estimated regression models shown in Table 9. This comparison leads to the conclusion that the use of SCM systems has the strongest effect, which is stronger than the effect of having an ICT investment reduction strategy, that is regarded by the relevant literature (Marston et al., 2011; Venders and Whitley, 2012; Müller et al., 2015) as the most important CC adoption factor/motivation. This indicates that the reduction of the costs of complex on-premises applications, as well as the enrichment of provided functionality, can be a very strong motivation for using CC. Then follow the effects of the use of ICT for supporting inter-organizational collaboration with other firms for the design of innovations, and the existence of inter-organizational collaboration for the design of process innovations, and finally of product/service innovations.

In general, the results shown in Tables 8 and 9 indicate that the inter-organizational innovation design is much stronger associated with propensity to adopt CC than the

inter-organizational innovation implementation. A possible explanation for this is that the former has a much smaller scale and is less critical for the everyday operation of the firms (though quite important for their future performance, or even for their survival) in comparison with the latter; therefore, the business uncertainty generated from the use of CC services is lower for the former than for the latter. This lower uncertainty, according to the transaction cost theory (Williamson, 1985 and 1989), leads to higher propensity to adopt CC for supporting inter-organizational collaborative design of innovations than inter-organizational collaborative implementation of innovations.

5.3.5 Conclusions

Two important and widely debated trends in the modern economy are the gradual shift of firms from the 'closed' internal innovation paradigm towards the 'open' inter-organizational innovation paradigm, and also the emergence of cloud computing (CC) as a new more efficient paradigm of business computing. In the previous sections of this paper has been presented an empirical investigation of the association between these two trends. In particular, we investigated empirically the effects of firm's inter-organizational collaboration for the design and implementation of innovations, and also use of ICT for supporting these collaborations, on firm's propensity to adopt CC; in this way we actually examined in an 'objective' manner (without resorting to subjective perceptions of firms' managers) to what extent firms regard CC as a cost effective means of supporting open collaborative inter-organizational innovation design and collaboration.

Our results provide some first evidence concerning the existence of association between the above two important trends of modern economy. We have found that inter-organizational collaboration for the design of innovations has positive impact on the propensity for CC adoption; also, the use of ICT for supporting inter-organizational collaboration for the design and implementation of innovations, are drivers of CC adoption, aiming at the reduction of the costs and the increase of the capabilities and the flexibility of this ICT support. These results provide valuable insights concerning the perceptions of firms of three important European industrial sectors about the potential of CC to support and promote open inter-organizational innovation. They indicate that firms of these sectors regard CC as a cost-effective means of supporting open inter-organizational innovation design, but not open inter-organizational innovation implementation (i.e. for supporting relevant critical daily operations). This might be due to specificities and complexities of the processes and collaboration practices of the three examined manufacturing sectors, which result in limited supply of corresponding specialized SaaS applications by CC providers. Also, the importance of this operational collaboration with partners for the everyday activities of these firms makes them hesitant to use external providers of ICT support

of them. However, the firms of these sectors regard CC much more as a means of reducing the cost and increasing the capabilities and flexibility of already existing ICT support of open inter-organizational innovation design and implementation, probably by using IaaS and PaaS services for hosting some of these applications, or by using SaaS for replacing some older and/or bespoke ones with more modern standard software packages. Summarizing, our study provides some interesting evidence concerning the potential of CC to support and promote this emerging paradigm of open inter-organizational innovation.

Chapter 6: Determinants of Cloud Computing Benefits

6.1 Hard and Soft ICT Capital and Cloud Computing Benefits

6.1.1 Introduction

Cloud Computing (CC) is a relatively new innovative model of sourcing the information and communication technologies (ICT) services required by firms for supporting their activities, which is based on external CC services providers; it is quite different from the existing on-premises model, in which the ICT services needed for supporting firm's activities are sourced internally (Armbrust et al., 2010; Marston et al., 2011; Venders and Whitley, 2012; Hoberg et al., 2012; Bayramustaa and Nasirb, 2016). It has emerged from a convergence of technological innovations (such as virtualization, high performance networks and data-centre automation) as well as management innovations (concerning the 'servitization' of products and assets) (Venders and Whitley, 2012). A definition of CC has been given by the US National Institute for Standards and Technology (NIST), as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources (e.g., networks, servers, storage, applications) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell and Grance, 2011).

Marston et al. (2011) provide a more detailed definition of CC as follows: "It is an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks".

Relevant literature argues that CC has the potential to offer important advantages and benefits to firms, which are associated mainly with ICT costs reduction, as well as support and promotion of firm's innovation activity (Etro, 2009; Brynjolfsson et al., 2010; Benlian and Hess, 2011; Marston et al., 2011; Venders and Whitley, 2012; Bernman et al., 2012; Hoberg et al., 2012; Willcocks et al., 2013; Willcocks et al., 2014; Müller et al., 2015). However, there has been limited empirical research in this direction, in order to understand to what extent these benefits are realized by firms, and which factors determine the magnitude of them. As CC is a new innovative paradigm for the provision of the ICT services required by firms for supporting their activities, it is important to conduct empirical research on the real business value it generates, as well as its determinants; the findings of this research can be useful to CC service providers (in order to provide guidance to their clients for increasing the

business value they obtain from CC), as well as to management and ICT firms' practitioners and relevant consultants (in order to design appropriate actions for the maximization of the business value firms obtain from CC).

Our study contributes to filling this research gap. It formulates a set of research hypotheses concerning the effects of firm's 'hard ICT capital', as well as some types of firm's 'soft ICT capital', on the benefits offered by CC. Previous information systems (IS) literature has revealed the importance of different types of hard and soft ICT capital that firms develop (including both ICT resources and capabilities) in order to support their activities, as well as their business impacts, and their effects on various dimensions of firm's performance, in the 'classical' on-premises paradigm (Feeny and Willcocks, 1998; Bharadwaj, 2000; Wade and Hulland, 2004; Ravichandran and Lertwongsatien, 2005; Loukis et al., 2009; Liang et al., 2010; Gu and Jung, 2013; Arvanitis et al., 2013). So, we extend this literature for the new innovative CC paradigm of providing ICT support of firm's activities, by examining the impact of hard ICT capital as well as some types of soft ICT capital on the business benefits generated by CC. This is in line with the findings of previous ICT outsourcing research (see reviews in Lacity et al., 2010, 2016 and 2017) that client firm characteristics are important determinants of ICT outsourcing outcomes and benefits (since the use of CC is a specific form of ICT outsourcing). The research hypotheses we formulate are then tested using data collected through a survey from 363 Greek firms, from which CC benefits regression models are estimated, leading to interesting conclusions.

6.1.2 Research Hypotheses

In order to formulate our research hypotheses, we focused on some of the main types of hard and soft ICT capital (both ICT resources and capabilities), for which there are arguments or/and previous literature support concerning a possible impact on the magnitude of the benefits obtained from the use of CC services. The common theoretical foundation of our research hypotheses is the 'resource-based view' (RBV) of the firm (Wernerfelt, 1984; Barney, 1991; Barney and Clark, 2007): the CC services used by a firm are easily and rapidly available to other firms as well, so they are not rare and inimitable. However, some types of both hard as well as soft ICT capital that firms possess enable complex combinations and integrations of many different CC services (possibly from different providers), and also with elements of firm's 'on-premises' ICT infrastructure, which can be highly valuable, and at the same time more rare and difficult to imitate, leading to higher levels of CC benefits. For these types of hard and soft ICT capital we have developed the following research hypotheses.

Our first research hypothesis concerns the effect of firm's ICT infrastructure overall sophistication on the magnitude of CC benefits. Firms having highly sophisticated ICT infrastructures have extensive experience concerning the efficient and effective use of ICT for supporting their activities, which will enable them to select and exploit better

the most appropriate and cost effective CC services in order to: a) reduce the cost of the existing electronic support of their activities (e.g. by using IaaS and PaaS services for hosting some of the existing applications, or by using SaaS for replacing some older and/or bespoke applications with more modern standard software packages); b) also provide additional electronic support of their activities (e.g. by using SaaS for the electronic support of activities not currently supported, or minimally supported, providing for the latter more support functionalities); c) experiment with new technologies initially, and then exploit the most appropriate and valuable ones for the firm at a larger scale, without need for relevant investments; d) respond rapidly and at low cost to various changes/challenges in its external environment (i.e. enhance its 'agility'); and e) support the rapid and low cost introduction of products/services innovations (new products/services or significantly improved ones), as well method/process innovations (new methods/processes or significantly improved ones). The above will result in higher levels of benefits from CC for firms having higher ICT infrastructure sophistication and therefore more experience of electronically supporting their activities. Previous empirical research has found a positive effect of firm's ICT infrastructure sophistication on its propensity to adopt CC (Loukis et al., 2017).

From a RBV theory perspective, CC services per se, as mentioned above, are not rare and difficult to imitate, as they are available to all firms; however, a highly sophisticated ICT infrastructure provides many opportunities for complex combinations and integrations of various elements of it with external CC services (enabling extensive exchange of data and functionality combination) (Ragowsky et al., 2014; Willcocks et al., 2014), which can be quite valuable, and at the same time more rare and difficult to imitate, resulting in high levels of benefits, concerning both efficiency improvement, as well as agility enhancement and innovation support. For the above reasons our first research hypothesis is:

H1: *Firm's ICT infrastructure sophistication has a positive effect on the magnitude of CC benefits*

While our first research hypothesis H1 concerns the effect of firm's hard ICT capital on CC benefits, the next three research hypotheses H2 to H4 are dealing with the soft ICT capital: the effects of three different types of firm's 'ICT human capital' on CC benefits. The role and importance of firm's human capital for innovation has been extensively researched both theoretically and empirically in previous innovation literature (Vandenbussche et al., 2006; Lopez-Garcia and Montero, 2012; Arvanitis et al., 2016). This research has revealed that the human capital of a firm is its "engine of innovation", as it embeds firm's internal knowledge capital, which is critical for its innovation activity. Also, the human capital is a critical determinant of firm's 'Absorptive Capacity' (ACAP), defined as its ability to absorb, assimilate and exploit

external knowledge and technology, which is highly important for innovation (Cohen and Levinthal, 1989 and 1990; Camisón and Forés, 2010). As CC constitutes a radical innovation concerning the ICT support of firm's activities, we expect that firm's relevant ICT human capital will be important for its success.

Firm's ICT personnel, possessing extensive knowledge on one hand about firm's existing ICT infrastructure, its strengths and weaknesses, as well as the needs for extensions and improvements of it, and on the other hand about firm's business processes and activities, can play an important role in absorbing, assimilating and exploiting external knowledge about the existing CC services and providers; and also in selecting and exploiting better the most appropriate and cost effective CC services. The above enable achieving high quality electronic support of firm's existing activities and business processes, as well as agility enhancement and innovation (in processes, products and services), at a low cost. Therefore, if a firm has sufficient size of ICT personnel (so that, beyond fulfilling their everyday duties, they have time to deal systematically with CC), this can increase the benefits obtained from CC services usage. Previous empirical research has found a positive effect of firm's ICT personnel on its innovation activity (Arvanitis et al., 2013), as well as on its propensity to adopt CC (Loukis et al., 2017). From an RBV theory perspective, the existence of sufficient ICT personnel is necessary for the identification and implementation of the abovementioned (in research hypothesis 1) possible highly valuable combinations and integrations of appropriate CC services, and also with firm's 'on-premises' ICT infrastructure (since ICT personnel have a deep knowledge of it), which are rare and difficult to imitate, leading to higher levels of CC benefits. So, our second research hypothesis is:

H2: *The size of ICT personnel has a positive effect on the magnitude of CC benefits*

The following two research hypotheses, H3 and H4, focus on the effects of two types of ICT human capital, which concern specific ICT skills and resulting capabilities, on the benefits obtained from CC. So, our third research hypothesis H3 concerns the effect of firm's IS interconnection/integration capability on CC benefits. The adoption of CC by a firm changes significantly the composition of the tasks of its ICT unit: the systems development, administration and support related tasks decrease, while the systems interconnection/integration related tasks increase and become more significant (Willcocks et al. 2013; Willcocks et al., 2014; Ragowsky et al., 2014). Extensive interconnection/integration is required between the remaining on-premises IS and various external CC services used (usually from many different providers, and having different technological bases, data structures, security mechanisms), so that they can exchange data and functionality with the required security levels. Ragowsky et al. (2014), based on opinions expressed by Chief Information Officers (CIOs) of USA firms, conclude that the role of the CIO is evolving from providing and supporting

internal ICT services, toward a 'Chief Integration Officer' one, with main focus on the integration of externally acquired standardized hardware and software (used for developing their internal ICT infrastructure), and also external CC services, retaining quality and performance control. According to the above CIOs opinions, the main reason for this increasing importance of integration is that 'Firms that adopt public cloud infrastructure without significant integration to other systems will lose a potentially valuable source of organizational differentiation. It is only through integration to the rest of the organization that the firm can differentiate its internal routines and hope to gain advantage from these IT systems'.

So, firms having high capabilities of rapid internal implementation (by their own ICT staff personnel) of various interconnections/integrations of different IS, so that there is interoperability of them (i.e. one IS can use data and functionality of other IS), will be better prepared to cope with the above integration related challenges that CC poses, reap more benefits from it. From an RBV perspective, this IS interconnection/integration capability is particularly important for the rapid and reliable implementation of the abovementioned possible complex and highly valuable combinations and integrations of multiple external CC services, and also with firm's 'on-premises' ICT infrastructure, which are rare, difficult to imitate, and provide significant efficiency, as well as agility and innovation-oriented benefits. Therefore, our third research hypothesis is:

H3. *The IS interconnection/integration capability has a positive effect on the magnitude of CC benefits*

The fourth research hypothesis H4 concerns the effect of firm's ICT strategic planning and alignment capability on CC benefits. Previous IS research has extensively dealt with the importance and the impact of ICT strategic planning and alignment in the on premises paradigm of electronic support of firm's activities (Chen et al., 2010; Galliers, 2011; Leidner, et al., 2011). The development of an ICT strategic plan, which defines firm's directions and plans concerning the investment in, deployment, use, and management of ICT, is highly important for generating high business value from the use of ICT; if there are weaknesses in this area ICT investment might offer limited benefits, even lower than their cost.

Furthermore, extensive research on ICT strategic alignment has revealed that if firm's ICT strategic plans are connected and aligned with its overall strategies, then the business value it will obtain from ICT will be much higher (Chan and Reich, 2007; De Haes and Van Grembergen, 2009; Wu et al., 2015). We expect that a firm having high ICT strategic planning and alignment capability will have experience and skills, as well as a positive tradition, in this area, so it will adopt a similar strategic approach with respect both to selection and the use of CC services. In particular, firm's ICT strategic plan will include a strategy as to which IS will remain on-premises, and

which will be based on external CC services. The firm instead of making an uncoordinated and fragmented use of CC services, which address short terms problems and needs of specific business units (which very often happens – see Willcocks et al. 2013; Willcocks et al., 2014), with minimal integration between them, and also with the on-premises IS, will define in its ICT plan a complete set of CC services to be used in order to support firm's strategic directions, address its weaknesses, leverage its strengths, seize external opportunities and cope with external threats. Having the above higher-level business objectives as a guide for the selection and exploitation of CC services will lead to higher levels of benefits from CC, concerning the improvement of efficiency as well as flexibility (especially for firms experiencing highly dynamic external environment), exploitation of strategic new technologies and support of innovations.

From an RBV theory perspective a high ICT strategic planning and alignment capability constitutes a sound basis for the design of strategically founded combinations/integrations of CC services, appropriate combinations/integrations of them with elements of the internal on-premises IS, as well as unique internal resources and capabilities; such combinations/integrations can be highly valuable, and at the same time quite rare and difficult to imitate, leading to higher levels of benefits. So, our fourth research hypothesis is:

H4. *The ICT strategic planning and alignment capability has a positive effect on the magnitude of CC benefits.*

The final two research hypotheses, H5 and H6, concern the effects of another form of soft ICT capital, the ICT relational capital, internal and external, on the benefits obtained from CC. Previous IS literature has revealed the importance of the internal ICT relationship between the personnel of firm's ICT unit and the personnel of its business units (who use ICT for supporting their activities) for the effective exploitation of ICT in the firm, and the generation of high levels of business value from it, in the 'classical' on-premises paradigm (Feeny and Willcocks, 1998; Ravichandran and Lertwongsatien, 2005; Liang et al., 2010; Gu and Jung, 2013). We expect that this will hold to an even larger extent for the case of the exploitation of the CC, as it requires a quite different set of tasks to be performed by the firm, in which the weight of the business-related tasks is increased, while the weight of the technology related tasks is reduced, in comparison with the on-premises paradigm.

In particular, the business-oriented tasks include the evaluation of the numerous existing relevant CC services on offer in the market from a business perspective, the selection of the most appropriate ones from this perspective, and then their optimal business exploitation, possibly through interconnection/integration between different CC services, and also with the on-premises IS. The technology oriented tasks include the evaluation of the existing relevant CC services from a technological perspective

(e.g. concerning the specific technologies and platforms they are based on, their security mechanisms, their reliability, their availability, as well as their integration capabilities), the selection of the most appropriate ones from this perspective, and then the implementation of the required integrations of them, and their technological monitoring (e.g. with respect to their availability, response time, etc.). The above indicate that close co-ordination and co-operation is required, between firm's business units (responsible for performing the former business-oriented tasks) and the ICT unit (responsible for performing the latter technology oriented tasks), for a successfully exploitation of CC by the firm, and the realization of high levels of benefits from it. The existence of a good internal ICT relationship between the ICT unit of the firm and its business units creates high levels of mutual understanding, trust and inter-dependence between them, and in general a tradition of co-operation, and also establish (formal or informal) mechanisms and procedures for this; these are expected to lead to and facilitate a close and effective cooperation between them for the effective exploitation of CC in the firm as well, resulting in higher levels of CC benefits, concerning improvements of efficiency, agility and support of innovation.

From a RBV perspective this ICT internal relationship can be the best source of ideas for valuable, rare and difficult to imitate combinations and integrations of many different CC services (possibly from different providers), and also with elements of the internal on-premises IS, based on the combination of the business-related knowledge of the business units and the technological knowledge of the ICT unit; this can lead to the generation of more CC benefits. So, our fifth research hypothesis is:

H5: *The internal ICT relationship (between the ICT unit and the business units) has a positive effect on the magnitude of CC benefits*

Our last research hypothesis concerns the effect of the external ICT relationship between the firm and its ICT vendors on CC benefits. Previous IS literature has revealed the importance of this external ICT relationship, for the effective exploitation of ICT by the firm, and the generation of high levels of business value from it, in the 'classical' on-premises paradigm (Feeny and Willcocks, 1998; Ravichandran and Lertwongsatien, 2005; Liang et al., 2010; Gu and Jung, 2013). We expect that this will hold to an even larger extent with CC, as in this paradigm the CC providers have a much bigger role in the electronic support of firm's activities than the ICT providers in the on premises paradigm.

The development of a good and deep relationship with CC providers, characterized by extensive information and knowledge exchange, mutual understanding, trust and positive attitude to solving problems and resolving any disputes aiming at mutual benefit and satisfaction (towards 'win-win' directions), and avoiding opportunistic behaviors, will result to higher levels of CC benefits. The information and knowledge provided by CC providers allows a better selection and customization of CC services

for supporting the current needs of the firm, as well as the future ones (e.g. for responding to various changes and challenges in firm's external environment, enhancing its agility, and for supporting innovations in firm's processes, products and services); furthermore, the provision of extensive technological information and knowledge by the CC providers about their services will enable the design and implementation of valuable integrations between them, and also with appropriate elements of our on-premises IS. A recent empirical study by Garrison et al. (2015) found that firm's relationships with CC services providers have a strong positive impact on CC success and firm performance (see section 2.1 for more details).

The existence of good ICT external relationships between the firm and its ICT vendors creates on one hand a tradition of close and constructive co-operation with them, extensive exchange of information and knowledge, as well as a positive attitude towards solution of problems or resolution of possible disputes that might appear, and on the other hand a general capability and possibly specific mechanisms and procedures for effectively managing these relationships; these will facilitate a good and deep cooperation with CC providers as well, leading to the abovementioned increase of CC benefits.

From a RBV perspective, establishing a good and deep cooperation with CC providers leads to better supports by them, enabling deeper discovery and exploitation of the capabilities of their CC services, and effective solution of possible problems; also it enables better customization of the services, leading to better adaptation of them to firm's specific needs, processes and activities; and finally a better combination and integration of different CC services (possibly from different CC providers), and also with appropriate elements of our on-premises IS, as well as unique internal resources and capabilities. These will allow a more valuable exploitation of CC, which is rare and difficult to imitate, leading to higher levels of CC benefits. So, our sixth research hypothesis is:

H6: *The external ICT relationship (between the firm and its ICT vendors) has a positive effect on CC benefits*

6.1.3 Model Specification

For this study, we have used firm-level data collected from Greek firms through a survey – the definition of all our variables are shown in Appendix D. In order to test out research hypotheses H1 to H6, five linear regression models (model 1 to 5) were estimated using the aforementioned data, having the following specification:

$$CC\_BEN_i = b_0 + b_1*ICTI\_SO_i + b_2*SOFT\_ICTC + b_3*D\_SIZE_i + b_4*D\_SECT_i + ei \quad (for\ firm\ i)$$

In all these models, dependent variable is the CC benefits (CC_BEN), which assesses the magnitude of the benefits obtained by the firm from the use of CC (Appendix D). As it is the most multidimensional of all our variables it has been measured though a six items scale developed based on previous literature on the benefits offered by CC (Marston et al., 2011; Venders and Whitley, 2012; Müller et al., 2015); they assess to what extent the use of CC services by the firm has provided six main potential CC benefits mentioned by the above relevant literature (using a 5-levels Likert-type scale 1-5, where: 5 = to a very large extent, 4 = to a large extent, 3 = to a moderate extent, 2 = to a small extent, 1 = not at all or to a very small extent): reduction of cost of firm's electronic support, improvement of its quality, use and exploitation of new technologies, electronic support and facilitation of products/services innovations, electronic support and facilitation of methods/processes innovations, improvement of firm's agility/adaptability. A Principal Component Analysis was performed for the above six variables, which gave one factor that was used as our dependent variable.
Also, all five models included as an independent hard ICT capital variable the degree of sophistication of firms' ICT infrastructure (ICTI_SO), which has been calculated as the average of five 5-levels Likert–type variables (using the abovementioned scale), assessing the extent of using an Enterprise Resource Planning (ERP) system, a Customer Relationship Management (CRM) system, a Supply Chain Management (CRM) system, a Business Intelligence/Business Analytics (BI/BA) system and a Collaboration Support (CS) system. Also all models include as independent variables two dummy variables: one size dummy (D_SIZE), in order to capture the effects of firm size on CC benefits, which was based on firm's number of employees in full-time equivalents, taking value 1 for small-sized firms with less than 50 employees, 2 for medium-sized firms with 50 to 249 employees and 3 for large-sized firms with 250 or more employees; and another sector dummy (D_SECT), in order to capture the effects of firm sector on CC benefits, taking value 0 for service sectors firms and 1 for manufacturing or construction sectors firms.
Finally, each of the five models included as independent variable one soft ICT capital variable, corresponding to one of the relevant research hypotheses H2-H6. Because there were high levels of correlation among these soft ICT capital variables it was not possible to include all of them in one regression model, as this would lead to multi-collinearity problems, resulting in unreliable estimations of regression coefficients (Gujarati, 2009; Greene, 2011). The first of these variables is a measure of firm's ICT personnel (ICT_PERS), and is equal to the number of firm's ICT employees as a percentage of firm's total number of employees. The other four soft ICT capital variables assess in a 5-levels Likert-type scale firm's IS interconnection/integration capability (INTEGR_CAP), ICT strategic planning and alignment capability (ICT_STRAL_CAP), internal ICT relationship (between the ICT unit and the business units) (INT_REL) and external ICT relationship (between the firm and its ICT vendors) (EXT_REL).

6.1.4 Results

The estimates of the five models (model 1 to 5) described in the previous section are shown in Table 10. For each independent variable, the standardized regression coefficients are shown; statistically significant coefficients at the test levels of 1% and 5% are shown in bold. We can see that the effect of our overall measure of hard ICT capital, the ICT infrastructure sophistication, on CC benefits is positive and statistically significant; therefore, research hypothesis H1 is supported. With respect to our five soft ICT capital variables, three of them have positive and statistically significant effects on CC benefits: the IS interconnection/integration capability, the ICT strategic planning and alignment capability and the internal ICT relationship; so, research hypotheses H3, H4 and H5 are supported. On contrary, the size of ICT personnel and the external ICT relationship do not have statistically significant effects on CC benefits; so, research hypotheses H2 and H6 are not supported. We remark that from all examined types of ICT capital the capability for ICT strategic planning and alignment has the strongest positive impact on CC benefits (standardized coefficient 0.323); it is followed by the hard ICT capital (average standardized coefficient over all five models 0.229). Lower are the effects of the internal ICT relationship (standardized coefficient 0.201) and finally the IS interconnection/integration capability (standardized coefficient 0.177). Finally, with respect to our dummy variables we can see that the size dummy has a negative statistically effect on CC benefits, while the sector dummy does not have a statistically significant effect. We remark that the R^2 values of these five models are low to medium (between 0.125 and 0.206), but this is not a problem, as the main objective of their estimation is not to include as many factors affecting CC benefits as possible, in order to achieve the best possible prediction of CC benefits, but to examine the effects of the specific independent variables (=types of hard and soft ICT capital) on the benefits obtained from CC.

Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5
D_SIZE	**-0.168****	**-0.233*****	**-0.259*****	**-0.236****	**0.229****
D_SECT	-0.096	-0.113	-0.100	-0.117	-0.136
ICTI_SO	**0.261*****	**0.236*****	**0.148***	**0.237****	**0.262*****
ICT_PERS	0.116				
INTEGR_CAP		**0.177***			
ICT_STRAL_CAP			**0.323*****		
INT_REL				**0.201***	
EXT_REL					0.087
N	115	115	115	115	115
R-Square	0.125	0.154	0.206	0.163	0.133
F	**3.752*****	**4.815*****	**6.893*****	**5.173*****	**4.075*****

(*, **, and * denote statistical significance at the 10%, 5% and 1% test level respectively)**

Table 10. Cloud computing benefits regression models.

The above results indicate that four out of the six examined types of ICT capital that firms develop can contribute to generating higher benefits from this innovative CC model of sourcing ICT services. The capability for developing ICT strategies and plans, which are connected with the overall strategies and plans of the firm (ICT strategic alignment), seems to have the strongest positive effect on CC benefits among all types of ICT capital examined in this study. Previous IS literature has highlighted the importance of ICT strategic planning in the on premises model of electronic support of firm's activities and alignment, and its positive impact on the business benefits firms gain from ICT usage (Chen et al., 2010; Galliers, 2011; Leidner, et al., 2011), which increases significantly if it is strongly connected and aligned with firm's overall strategic directions (ICT strategic alignment - Chan and Reich, 2007; De Haes and Van Grembergen, 2009; Wu et al., 2015).

Our findings indicate ICT planning connected with business planning has a positive impact of the benefits gained from this new CC model as well. The existence of this important capability leads to a less fragmented and uncoordinated exploitation of CC, and more strategic one, aiming to support firm's strategic plans, address its weaknesses, leverage its strengths, as well as to facilitate and support seizing external opportunities and coping with external threats. This leads to a more strategically focused use of external CC services, and also a more sophisticated one, which makes highly valuable, and at the same time rare and difficult to imitate combinations and integrations of CC services from many different vendors, and also with elements of firm's internal on-premises IS, and in general with important or even unique resources and capabilities of the firm, leading to higher levels of benefits from CC.

The second strongest effect was the one of the ICT infrastructure sophistication. Our findings indicate that the development and operation of a sophisticated ICT infrastructure leads to the accumulation of valuable collective knowledge and experience concerning the efficient and effective use of ICT for supporting firm's activities and business processes, which can be useful for the rational selection, exploitation and combination of the most appropriate and cost-effective CC services, leading to the generation of higher levels of benefits from CC usage. Furthermore, a highly sophisticated ICT infrastructure provides many opportunities for using CC services in order to reduce the costs of some parts of it, or enhance the capabilities or/and the performance of some others (e.g. use SaaS for replacing some older and/or bespoke applications with more modern and less costly to operate and maintain standard software packages with more capabilities and functionality; or use IaaS and PaaS services for hosting some of the existing applications and data at a lower cost).

The internal ICT relationship, between the personnel of the ICT unit and the personnel of the business units (who are users or potential users of ICT for supporting their work), was also found to impact positively the benefits generated from CC usage. Previous IS literature has highlighted the importance in the on-premises model of this internal ICT relationship, for the effective exploitation of ICT in the firm, and the

achievement of high levels of business benefits from ICT usage (Feeny and Willcocks, 1998; Ravichandran and Lertwongsatien, 2005; Liang et al., 2010; Gu and Jung, 2013). These two groups of firm's human resources have quite different roles, tasks, views and educational background, but at the same time they possess valuable complementary knowledge and skills, which should be combined in order to make efficient and effective exploitation of ICT in the firm. Our findings indicate that this holds for the CC model as well. The existence of good internal ICT relationship can be highly beneficial concerning the exploitation of CC as well. It facilitates the combination of the technological knowledge and skills of the ICT unit personnel, with the business knowledge and skills (e.g. on existing business activities and processes, as well as their strengths and weaknesses) of the business units, in order to make a rational selection, exploitation and combination of appropriate CC services, leading to the generation of higher levels of benefits from CC usage.

Finally, our findings indicate that the development of high level of internal capability for rapid implementation of various interconnections/integrations of existing firm's IS, so that there is interoperability of them (= one IS can use data and functionality of others), impacts positively CC benefits. While the abovementioned capability for ICT strategic planning connected with overall strategic directions, as well as the development of internal ICT relationship, can be good sources of ideas for highly valuable, rare and inimitable by competitors combinations and integrations of different CC services (probably from different providers), and also with elements of the on-premises IS, it is important to have a strong capability to technically implement rapidly and reliably these integrations internally at a low cost as well. This can increase significantly the business value generated for the firm from CC usage, in comparison with the isolated, uncoordinated and fragmented use of CC services, without integration among them and with on-premises IS. It is a system of interconnected internal and external ICT services, strongly coupled with other non-technical resources and capabilities, as well strategic directions that can generate high levels of business value, and also differentiation from the competitors.

On the contrary, the size of firm's ICT personnel does not seem to affect CC benefits. This indicates that what matters for the generation of benefits from CC is not the simple employment of ICT human resources, but the development based on them of some critical ICT capabilities for ICT strategic planning connected with overall strategic directions, for building good and productive internal ICT relationships with firm's business units, and for interconnecting/integrating external and internal technological components. Also, we found that the external ICT relationship with ICT vendors does not affect the benefits generation from CC. This indicates that the external co-operation capabilities that these relationships develop in a firm, as well as the specific mechanisms and procedures (formal or informal) for managing effectively these relationships, are not very much transferable to (useful for) the development and management of the relationships with the CC service providers: this probably happens

because the nature and the subject of the relationships with ICT vendors are quite different from the ones with the CC service providers.

6.1.5 Conclusions

There have been high expectations about the potential of this new innovative CC model of sourcing ICT services to offer important advantages and benefits to firms, which are associated mainly with ICT costs reduction, and enhancement of firm's agility as well as innovation activity. However, limited empirical research has been conducted in order to understand to what extent these expectations are realized, what are the magnitudes of the benefits that firms really obtain from CC services usage, and which factors affect them (so that appropriate interventions can be designed for increasing CC benefits).

This paper contributes to filling this important research gap. It formulates a set of research hypotheses concerning the effects of firm's 'hard ICT capital', and also some types of firm's 'soft ICT capital', on the benefits generated by CC. It has as theoretical foundation the RBV theory (Wernerfelt, 1984; Barney, 1991; Barney and Clark, 2007). It basic idea is that some types of both hard as well as soft ICT capital that firms possess enable a more sophisticated and valuable CC exploitation; in particular, they enable the design and implementation of complex combinations and integrations of many different CC services (possibly from different providers), and also with elements of firm's 'on-premises' ICT infrastructure, which can be highly valuable, and at the same time more rare and difficult to imitate, which lead to higher levels of CC benefits. This seems to be confirmed by our analysis.

Our research hypotheses have been tested using data collected through a survey from 363 Greek firms, from which CC benefits regression models have been estimated. From these models, it has been concluded that the sophistication of firm's ICT infrastructure (an overall measure of firm's hard ICT capital) has a positive impact on the benefits obtained from CC. Furthermore, three out of the five examined types of soft ICT capital have been found to impact positively the benefits that CC generates: the information systems (IS) interconnection/integration capability, the ICT strategic planning and alignment capability, and the internal relationship between firm's ICT unit and business units. Our findings reveal some aspects of firm's ICT capital that affect the generation of value from this new innovative CC paradigm.

Our study has interesting implications for research and practice. With respect to the former it extends the research that has been conducted concerning the effects of various types of firm's hard and soft ICT capital (both resources and capabilities) on different aspects of its performance, which concerns the classical on-premises model, to the CC model of sourcing ICT services required by firms, using a sound theoretical foundation: the RBV theory. Furthermore, it contributes to the development of a 'theory of CC business value', based on the unique combination of different

(commoditized and widely available) CC services, and also with firm's internal resources and capabilities (both technological and non-technological ones). With respect to practice the findings of our research can be useful to CC service providers, in order to provide guidance to their clients for increasing the business value they obtain from CC; also, they can be useful to management and ICT firms' practitioners, as well as relevant consultants, in order to design appropriate interventions for the maximization of the business value firms obtain from CC.

6.2 Cloud Computing Adoption Management Actions and Benefits

6.2.1 Introduction

Cloud Computing (CC), if properly exploited and managed, has a high potential to offer significant benefits to firms, which concern both reductions of the ICT and in general the operating costs of the firm, leading to efficiency gains, as well as facilitation and support of innovation activity (Berman et al., 2012; Iyer and Henderson, 2010; Muller et al., 2015; Venters and Whitley, 2012; Willcocks et al., 2013; Willcocks et al., 2014). This study contributes to filling the existing research gap concerning CC benefits' determinants. It is focusing on the actions firms should take, on one hand with respect to their relationships with their external CC services providers, and on the other hand with respect to their internal ICT skills and organization, in order to generate higher levels of benefits from CC. In particular, our study empirically investigates the effects of:

a) the degree of contractual and relational governance of firm's relationships with its CC services providers,

b) as well as the degree of adaptation of the skills of firm's ICT personnel, as well as of its internal ICT organization, to this new CC paradigm,

on the magnitude of the benefits generated by CC. Building on previous research, on one hand in the area of ICT outsourcing (concerning the determinants of its outcomes and benefits), and on the other hand in the area of CC (concerning the firm level adaptations it necessitates in ICT skills and organization), we formulate four relevant research hypotheses.

6.2.2 Research Hypotheses

Based on the above background we developed four research hypotheses, which concern the effects of the contractual and relational governance of firm's relationships with its CC service providers, as well as the adaptation to the CC paradigm of firm's ICT personnel skills and ICT organization, on the magnitude of the benefits generated by CC. The research model of our study is shown below in Fig. 2.

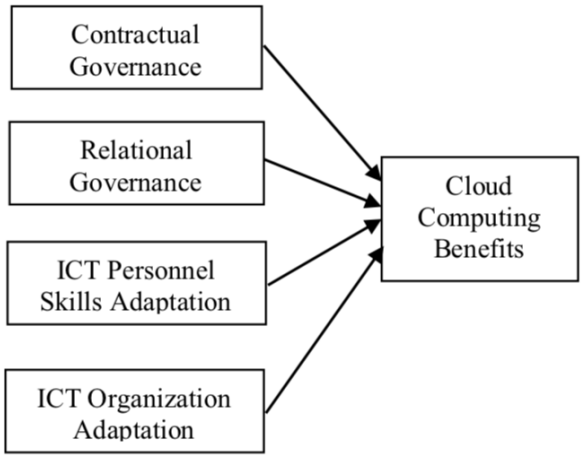

Figure 2. CC Benefits' Determinants Research Model

Our first research hypothesis concerns the effect of the degree of contractual governance of firm's relationships with its CC service providers on the benefits it obtains from CC. Higher degree of contractual government means more comprehensive and complex contracts with the CC service providers, which clearly describe in detail the CC services to be provided, their quality levels, as well as the ways and procedures of measuring them, and specific sanctions/penalties if they are not achieved (Brown et al., 2006; Goo et al., 2009; Poppo and Zenger, 2002). These are expected to lead to the provision of higher quality of CC services, and reduce opportunistic behaviors of CC service providers; this will result in higher quality of electronic support of firm's activities and business processes, provision of all agreed capabilities and functionalities, as well as levels of availability and security, etc. Contract clauses that define sanctions/penalties for lower levels of CC services quality motivate their providers to increase their efforts to keep the quality at the agreed levels and reduce relevant problems.

Furthermore, the description in the contracts of specific forms and ways of communication between the firm and its CC service providers, as well as procedures for handling problems and contingencies, and for resolution of disputes, will result in addressing quicker and more effectively any problems, contingencies and disputes that might appear, preventing possible reductions of service quality, cost overruns, or high 'transaction costs' (Williamson, 1985; Williamson, 1989) that might result from them.

Complex and comprehensive contracts include also clauses with detailed procedures for covering new additional needs of the client firm, beyond the ones mentioned in the contract, such as needs for higher volumes of services, for new services, for new technologies, etc. (Goo et al., 2009) (Oshri et al., 2015; Poppo and Zenger, 2002). These enable the firm to access rapidly and with good terms the appropriate CC services required in order to respond to various changes/challenges in its external environment, such as introduction of new products, services and pricing policies by

competitors, changes in customers' needs/preferences, need for satisfying specialized requirements of specific customers, opportunities for expansion in new markets, etc.; so they enable the firm to exploit better the CC for improving its 'organizational agility' (Lu and Ramamurthy, 2011). Furthermore, such new needs-oriented clauses allow the firm to use CC in order to exploit rapidly and at low cost new technologies without having to make additional investments. Also, they enable the firm to access rapidly and with good terms the appropriate CC services required for the electronic support and facilitation of method/process innovations (= new or significantly improved methods/processes), as well as products/services innovations (=new or significantly improved products/services). Therefore, complex and comprehensive contracts, which include clauses with effective procedures and good terms for addressing new CC services needs of the client firm, are expected to higher levels of innovation and agility related benefits from CC.

For all the above reasons, we expect that higher degree of contractual governance of firm's relation-ships with CC its services providers (meant as more complex and comprehensive contracts with them) will lead to more benefits from CC. So, our first research hypothesis is:

H1: *The degree of contractual governance has a positive effect on CC benefits.*

Our second research hypothesis concerns the effect of the degree of relational governance of firm's relationships with its CC service providers on the benefits it obtains from CC. Higher degree of relational governance leads to more open and extensive exchange of information between the firm and its CC services providers, with trust and constructive attitude from both sides, aiming at mutual benefit and satisfaction, as well as long term relationship (Goo et al., 2009; Lioliou et al., 2014; Poppo and Zenger, 2002).

This includes on one hand provision by the firm to its CC services providers of extensive information concerning its activities, internal business processes, problems, strategic goals and directions, as well as the resulting ICT support needs. On the other hand, it includes provision to the firm by its CC service providers of extensive information concerning the whole range of their services, their technological capabilities, and the continuous improvements and enrichments of them, as well as proposals for a better exploitation of them by the firm. The above enable a better and more rational selection by the firm of the most appropriate CC services, as well as customizations of them, and also their integration with firm's on-premises IS (based on extensive relevant technical information and knowledge transferred by the CC services providers), and in general a better use and exploitation of the full range of capabilities of these CC services.

Furthermore, they enable the firm to rapidly discover and take advantage of the continuous improvements and enrichments that CC providers introduce in these CC

services; and also, to exploit rapidly and at low cost new technologies (e.g. business analytics, big data, mobile technologies, etc.), by using relevant new CC services that providers continuously introduce (Delen and Demirkan, 2013; Jain and Kumar, 2015), without having to make additional investments. The above result in higher quality and lower cost of the electronic support of firm's activities and business processes, as well as better facilitation and support of innovation.

Higher degree of relational governance creates also a positive attitude in both parties for solving problems in close co-operation, resolving disputes, as well as responding positively to requests for changes required by the other party, aiming at mutual benefit and satisfaction, and abstaining from opportunistic behaviors (Goo et al., 2009; Lioliou et al., 2014; Poppo and Zenger, 2002). This reduces the deteriorations in the quality of firm's electronic support, as well relevant costs' overruns, which are usually caused by such problems and disputes; in general, this reduces firms' 'transaction costs' (Williamson, 1985; Williamson, 1989) in its relationships with CC service providers. At the same time, a positive attitude of the CC service providers towards firm's requests for changes in the provided services (e.g. for higher volumes of already used CC services, or for new services, or new technologies), will enable the firm to make better use of CC for the support of innovations (in methods/processes or/and products/ services) as well as the enhancement of firm's agility; therefore, it will increase innovation and agility related benefits from CC.

For all the above reasons, we expect that higher degree of relational governance of firm's relation-ships with its CC services providers will lead to more benefits from CC. So, our second research hypothesis is:

H2: *The degree of relational governance has a positive effect on CC benefits.*

The adoption of CC should be accompanied by changes/adaptations in the skills of firm's ICT personnel, as well as its internal ICT organization (which initially are both aligned with the 'on premises' paradigm of internal provision of ICT services), to the needs of the CC paradigm, in order to achieve higher levels of benefits from CC (Ragowsky et al., 2014; Schneider and Sunyaev, 2016; Willcocks et al., 2013; Willcocks et al., 2014). So, our third and fourth research hypotheses concern the effects of these ICT skills and organization adaptations respectively on CC benefits.

In particular, this ICT skills adaptation, according to the above mentioned literature, should include two main aspects, a technological and a business related one: a) an enrichment of the technological knowledge and skills of firm's ICT personnel concerning the CC technologies, the capabilities they provide, their interconnection/integration with on-premises IS, the monitoring of their quality, etc.; and b) an enrichment of the business knowledge and understanding of the ICT personnel, concerning firm's operations, processes, goals and strategic directions, and in general development of a stronger business orientation of the ICT personnel,

towards the achievement of not only technological goals, but also business goals a well, and generation of business value and innovation. This second aspect is the most important one, as it is going to enable firm's ICT personnel to co-operate with the personnel of the business units (which has a stronger role, involvement and contribution in the CC paradigm than in the traditional on-premises paradigm of sourcing ICT services), sharing a 'common business language', for: i) the examination, from a business support perspective, of the existing numerous CC services of interest for the firm; ii) the selection of the most cost-effective and appropriate ones for supporting its operations, business processes and needs in general; iii) the identification of highly valuable integrations that have to be implemented between these CC services and the existing on-premises IS of the firm; iv) the rational use and exploitation of the full range of capabilities of these CC services, as well as adaptations of them required in order to respond to various changes/challenges in firm's external environment (i.e. new CC services, or changes in the already used ones) for improving its agility; and also v) the identification of CC services that can enable and support beneficial innovations in firm's processes as well as products and services.

At the same time, highly valuable will be the above-mentioned first technological aspect of the adaptation of firm's ICT personnel skills (enrichment of their technological knowledge and skills on CC technologies). It is going to enable firm's ICT personnel to examine in-depth from a technological perspective the existing numerous CC services of interest for the firm (e.g. the specific technologies and platforms they are based on, their security mechanisms, their reliability, as well as their integration capabilities); this will lead to a better selection of CC services to be used by the firm, which not only provide extensive business support, but also are technologically sound and reliable. Furthermore, this technological aspect of firm's ICT skills' adaptation will enable firm's ICT personnel to implement the above identified integrations between the selected CC services and firm's on-premises IS.

Therefore, the above adaptations of firm's ICT skills to the CC paradigm are expected to result in higher both efficiency related benefits, as well as innovation support and agility enhancement related ones, from CC. So, our third research hypothesis is:

H3: *The degree of ICT skills adaptation has a positive effect on CC benefits.*

Beyond the above adaptations of ICT skills, the same literature (Ragowsky et al., 2014; Schneider and Sunyaev, 2016; Willcocks et al., 2013; Willcocks et al., 2014) concludes that adaptations are required in ICT organization within the firm as well. The most important of them is at a strategic level: development of a CC strategy, linked with firm's overall strategy, concerning the types of CC services that will be used, the applications they will be used for, the business objectives of CC use, and also the applications that will remain 'on-premises'. This will enable the firm to advance beyond the uncoordinated and fragmented use of CC services, just for addressing

short terms problems and needs of specific business units, with minimal integration between them and with the on-premises IS (which will provide a lower level of CC benefits), towards a more strategic and mature approach to CC use: to define a complete set of CC services to be used in order to support firm's strategic directions, address its weaknesses, leverage its strengths, seize external opportunities and cope with external threats. Having the above higher-level business objectives as a guide for the selection and exploitation of CC services will lead to higher levels of benefits from CC, concerning the improvement of firm's efficiency as well as agility, the exploitation of strategic new technologies and the support of innovations (Berman et al., 2012; Karpovich et al., 2017).

Furthermore, CC adaptations are required not only at the strategic level, but also at the level of processes as well. The development of new relevant processes within the firm for dealing with CC (e.g. for the quality control of the CC services, for the cooperation with firm's CC providers, as well as for the cooperation between firm's ICT unit and its business units) will lead to more benefits from CC, associated mainly with higher quality of electronic support of firm's activities and business processes, and lower cost of it.

The same literature (Ragowsky et al., 2014; Schneider and Sunyaev, 2016; Willcocks et al., 2013; Willcocks et al., 2014) has concluded also that CC adaptations are required at the level of structure as well: a) decentralization of CC related decision making, and b) change of the role of firm's ICT unit. The decentralization, to some extent, of the CC related decisions from the ICT unit to the business units of the firm will increase the involvement of the latter in the exploration of the existing CC services, their assessment, and finally the selection and exploitation of the most cost-effective and suitable ones, in order to support existing operations and business processes, as well as innovations in firm's processes, products and services. This involvement of firm's business units can be quite valuable, due to the deep knowledge they possess about firm's operations and processes, as well as their strengths and weaknesses, and also about firm's products and services, and the ones of competitors, and in general market trends. This deep knowledge can contribute to gaining more benefits from CC use, associated with higher quality and lower cost electronic support of firm's activities and processes, and also with rapid and low cost electronic support of innovations, as well access to new technologies, through relevant CC services.

Furthermore, the change/adaptation of the role of firm's ICT unit, from the internal provision of ICT services towards the central coordination and support of the exploitation of various external CC services, and also their interconnection – integration with firm's on-premises IS, will enable the ICT unit to put more effort on and increase its contribution to the rational and beneficial selection and use of CC services, leading to more efficiency and innovation related benefits from them.

For the above reasons, we expect that higher degree of adaptation of firm's ICT organization to the CC paradigm will lead to higher levels of benefits from CC. So, our fourth research hypothesis is:

H4: *The degree of ICT organization adaptation has a positive effect on CC benefits.*

6.2.3 Model Specification

The data for this study collected from Greek firms through a survey – the definitions of all variables used in this study are shown in the Appendix E. In order to test out research hypotheses H1 to H4 a linear regression model was estimated using the above data, having the following specification:

$$CC\_BEN_i = b_o + b_1*C\_GOV_i + b_2*R\_GOV_i + b_3*ICT\_SKL\_AD_i + b_4*ICT\_ORG\_AD_i + b_5*D\_SIZE_i + b_6*D\_SECT_i + e_i \quad (1)$$

The dependent variable of this model is the magnitude of firm's benefits from CC (CC_BEN), measured though a six items scale, shown in the Appendix E, which has been developed based on previous literature on the benefits offered by CC (Marston et al., 2011; Muller et al., 2015; Venters and Whitley, 2012).

Our model includes four main independent variables, which correspond to the four research hypotheses H1 to H4. The first two of them are the degree of contractual and relational governance of firm's relationships with its CC services providers (C_GOV and R_GOV respectively); the former has been measured through a four items scale, and the latter through a five items scale, both shown in the Appendix E, which were developed based on previous empirical research on contractual and relational governance (Goo et al., 2009; Oshri et al., 2015; Poppo and Zenger, 2002). For each of the above three multi-item scales a principal components analysis was performed; for all three of them the analysis gave one factor (based on the eigenvalues>1 criterion), confirming the uni-dimensionality of these scales, which was used as a measure of the corresponding variable. The other two independent variables of our model are the degrees of adaptation of firm's ICT skills and organization to the CC paradigm (ICT_SKL_AD and ICT_ORG_AD; for measuring them we used a six items scale, shown in the Appendix E, which was developed based on previous qualitative research on the adaptations that CC necessitates in firm's ICT skills and organization (Ragowsky et al., 2014; Willcocks et al., 2013; Willcocks et al., 2014). A principal components analysis with Varimax rotation was performed of this scale, which gave two factors (based on the eigenvalues>1 criterion). From an examination of the loadings of the items on these two factors it was concluded that the first of them had very high loadings (exceeding 0.9) of the first two items concerning ICT skills adaptations, and much lower loadings of the other four items; therefore, this first

factor corresponds to ICT skills adaptation, so it was used as a measure of the ICT_SKL_AD variable. The second factor had high loadings (between 0.75 and 0.85) of the last four items, and much lower loadings of the first two items; therefore, this second factor corresponds to ICT organization adaptation, so it was used as a measure of the ICT_ORG_AD variable.

Finally, in our model we have also included two dummy independent variables: one size dummy (D_SIZE), in order to capture the effects of firm size on CC benefits, taking value 1 for small-sized firms with less than 50 employees, 2 for medium-sized firms with 50 to 249 employees and 3 for large-sized firms with 250 or more employees; and another sector dummy (D_SECT), in order to capture the effects of firm sector on CC benefits, taking value 0 for service sectors' firms and 1 for manufacturing or construction sectors' firms.

6.2.4 Results

In Table 11 we can see the estimated CC benefits regression model, according to the specification described (equation 1); for each independent variable, the standardized regression coefficients are shown (statistically significant ones at the test levels of 1%, 5% and 10% are shown with ***, ** and * respectively). All four main independent variables, the degree of contractual and relational governance of firm's relationships with CC services providers, as well as the degree of adaptation of firm's ICT skills and organization to the CC paradigm, have statistically significant positive effects on CC benefits; so, all four research hypotheses H1 – H4 are supported. Also, firm's size dummy has a statistically significant negative effect on CC benefits, indicating that smaller firms gain more benefits from CC (which is in agreement with the expectations of relevant theoretical literature (e.g. Marston et al., 2011; Muller et al., 2015; Venters and Whitley, 2012); on the contrary, the effect of the sector dummy is not statistically significant, indicating that service, manufacturing and construction sectors gain similar levels of benefits from CC. The R^2 value of the model is high (0,523), indicating that its independent variables explain a large proportion of the variation of the dependent variable.

Independent Variable	Standardized b Coefficient
C_GOV	**0.188***
R_GOV	**0.224***
ICT_SKL_AD	**0.330****
ICT_ORG_AD	**0.180****
D_SIZE	**-0.292****
D_SECT	-0.083
N	115
R Square	0.523
F	**15.052****

(*, **, and * denote statistical significance at the 10%, 5% and 1% test level respectively)**

Table 11. Cloud computing benefits regression model

We remark that the degree of adaptation of firm's ICT skills has the strongest positive impact on CC benefits among all four examined factors (standardized coefficient 0.329). This result indicates the importance of the enrichment of the knowledge and skills of firm's ICT personnel, through appropriate training, about CC technologies, as well as firm's operations, business processes and strategic directions, for gaining high levels of benefits from CC. This enables the ICT personnel to establish a shared language and understanding, as well as a productive interaction and co-operation, with the personnel of firm's business units, for achieving a highly beneficial exploitation of CC by the firm; and also, to deal effectively with the technologic aspects of CC usage by the firm, as well with the integration of the external CC services (possibly from different providers) with firm's internal on-premises IS (Ragowsky et al., 2014). These lead to more benefits from CC. The above also indicate the central role and importance of ICT personnel, after appropriate adaptation of their skills to the needs of this new CC paradigm, for its success and for the generation of high business value from it.

The second strongest positive effect is the one of the relational governance of firm's relationships with its CC services providers on CC benefits (standardized coefficient 0.224). This is in agreement with the conclusions of previous empirical research concerning the positive impact of the relational governance on the outcomes and benefits of ICT outsourcing (Goo et al., 2009; Lacity et al., 2010; Lacity et al., 2017; Oshri et al., 2015). This result indicates that though CC services are a simple form of ICT outsourcing, based on the remote provision of highly standardized and minimally customizable ICT services, which are easily accessible in a self-service mode, with minimal interaction with their service provider (Marston et al., 2011; Schneider and Sunyaev, 2016), the development of a relationship with CC service providers continues to be important. This relationship is of critical importance on one hand for solving existing problems and resolving disputes, and on the other hand for gradually increasing the benefits generated by CC services usage, though open and extensive exchange of information and co-operation between the firm and its CC services providers, leading to the collaborative generation of ideas for a better exploitation of all the capabilities offered by these CC services. Furthermore, this relationship facilitates the evolution of CC services used by the firm, in order to meet its evolving needs (e.g. due to changes in its external environment, or innovations in its processes, products and services).

Finally, similar are the positive effects of the contractual governance of firm's relationships with its CC services providers, and the adaptation of ICT organization within the firm, on CC benefits (standardized coefficients 0.188 and 0.178 respectively). Therefore, having comprehensive and complex contracts with the CC service providers, defining the exact services to be provided, their quality levels, as well as sanctions for not achieving them, has a positive impact on the benefits obtained from CC, though this impact is lower than the one of the relational governance. This

is also in agreement with the conclusions of previous empirical research concerning the positive impact of the contractual governance on the outcomes and benefits of ICT outsourcing (Goo et al., 2009; Lacity et al., 2010; Lacity et al., 2017; Oshri et al., 2015). Also, positive impact on CC benefits has the adaptation of the organization of ICT in the firm as well, however lower than the one of the adaptation of its ICT skills. The development of a strategic approach to CC exploitation, as well as specific processes for managing it, the adaptation of the role of firm's ICT unit to the needs of the CC paradigm, and the decentralization of CC related decisions to some extent from the ICT unit to firm's business units, lead to more benefits from CC. However, such organizational changes are more difficult and slow to implement, reach maturity, and provide significant benefits; so, we expect that over time they will deliver more benefits.

6.2.5 Conclusions

Though extensive empirical research has been conducted concerning the factors that affect the adoption of CC by firms, quite limited empirical research has been conducted concerning the factors that affecting the benefit firms obtain from the use of CC services. However, this research is necessary because CC is a new paradigm of sourcing ICT services for supporting firms' activities and processes, so firms still do not know how to exploit it rationally and effectively, and what actions to take in order to gain more benefits from CC.

The study presented in the previous sections contributes to filling this research gap. It empirically investigates the effects of the contractual and relational governance of firm's relationships with its CC services providers, as well as the adaptations of the skills of firm's ICT personnel, and its internal ICT organization, to this new CC paradigm, on the magnitude of CC benefits. This study has been based on data collected through a questionnaire from 115 Greek firms using CC services, which have been used for the estimation of a CC benefits regression model. It has been concluded that all the above four examined factors impact positively the benefits firms obtain from CC. The effect of the adaptation of the skills of firm's ICT personnel has the strongest effect on CC benefits, followed by the relational governance of the relations with its CC services providers.

Our study has interesting implications for research and practice. With respect to the former it extends the empirical research that has been conducted concerning the effects of contractual and relational governance on the outcomes and benefits of ICT outsourcing relationships, to the CC paradigm of external sourcing ICT support services. Furthermore, it creates some first evidence concerning the effects of the adaptations of firm's ICT skills and organization to the CC paradigm on the benefits generated from it. With respect to practice our findings provide some guidance to firms' management for generating higher levels of value from CC. They indicate that

the first action firms have to take for this purpose is to provide training to their ICT personnel, both technological (concerning CC technologies) and business related (concerning firm's operations, business processes and strategic directions). Also, firms have to build good and long relationships with their CC service providers, which promote information exchange, trust, collaborative problem solving, flexibility and mutual adaptation. Furthermore, firms should develop comprehensive contracts with their CC service providers, that pro-vide them sufficient safeguards; and also proceed to adaptations of their internal ICT organization to the CC paradigm: create new relevant strategies and processes, change the role of the ICT unit and increase the involvement of the business units.

This study has two main limitations. First, it has been based on data collected from one country (Greece); so, it is necessary our research questions to be investigated in other national contexts as well. Second, it does not discriminate between different types of CC services, such as IaaS, PaaS and SaaS; so it is necessary to investigate our research questions for specific types of CC services.

Chapter 7: Conclusions and Implications

7.1 Conclusions Summarization

The research presented in this Ph.D. Dissertation has provided interesting and practically relevant conclusions about the effects of different kinds of firm's characteristics on the propensity to adopt CC. In particular, the sophistication of firm's ICT infrastructure has a strong positive effect on firms' propensity to adopt CC, which indicates that it is not firms with deficient ICT infrastructure that mainly use CC in order to enhance it, but firms with sophisticated ICT infrastructures in order to reduce their high operating and maintenance costs. Similarly, strategies of ICT investment reduction increase firms' CC adoption propensity; however, this does not hold for innovation strategies, which do not affect CC adoption propensity. These indicate that firms (at least of the glass, ceramic and cement sectors, from which the data for this part of our research have been collected) view CC as a means of reducing ICT investment, but not as a means of supporting innovation.

Furthermore, the employment of specialized ICT personnel and previous experience of ICT outsourcing were found to positively affect firm's propensity to adopt CC, as they increase firm's capabilities to select the most useful CC services, manage the relationships with their providers, and generate business value from them. Despite the expectations that CC would be more beneficial for smaller than larger firms, we could not find any significant effect of size on the propensity of CC adoption in the sectors investigated in this study. Finally, the ICT skills of firm's employees and the price and quality competition it faces do not appear to affect the propensity to adopt CC.

Also, our results indicate that different national contexts may have a significant effect on CC adoption determinants. In particular, we have found that in Southern European firms the adoption of a CC investment reduction strategy and the interest in new ICT (such as data warehousing, data mining, mobile services) affect positively CC adoption propensity; this indicates that they view CC as a mean to reduce ICT investment expenditure, and also as a low cost and risk means of experimenting with and exploiting new emerging ICT. In contrast, for Northern European firms, it is the adoption of innovation strategy, as well as the electronic cooperation with other firms that affect CC adoption propensity positively; this reveals a quite different perception of CC in comparison with the Southern European firms. Norther European firms see CC as a means of supporting and facilitating product/service innovation, as well as reducing cost and increasing capabilities of their external electronic collaboration with other firms for the development of innovations. These findings indicate that Southern European firms are mainly oriented towards 'first-level' benefits from CC: ICT cost (and especially ICT investment) reduction, as well as exploitation of new emerging ICT; on the contrary Northern European firms are mainly oriented towards 'second-

level' transformation related benefits from CC, which are associated with support and facilitation of innovation and external collaboration.

Finally, our results provide evidence about a relationship between two important trends of modern economy, the open innovation and the CC. In particular, the inter-organizational collaboration with other firms for the design of innovations impacts positively the propensity for CC adoption; so, firms view CC as an efficient and effective means to support the inter-organizational design of innovation. Also, the use of ICT in order to support inter-organizational collaboration for the design of innovations has an even stronger positive effect on firm's propensity to adopt CC; so firms view CC also as an effective means of reducing the costs and increasing the capabilities and flexibility of already existing electronic support of open inter-organizational innovation design collaboration. At the same time, with respect to the inter-organizational collaborative implementation of innovations (an equally important component of open innovation) we have found that the use of ICT in order to support firm's operational collaboration with other firms for the implementation of innovations has a positive effect on the propensity for CC adoption. This indicates that firms see CC as a means to reduce the cost and increase the capabilities and flexibility of existing ICT support of open inter-organizational innovation implementation.

Highly interesting and practically relevant have been as well the conclusions of the second part of the research presented in this Ph.D. Dissertation concerning the determinants of the benefits/business value that firms obtain from CC. In particular, four out of the six examined types of firm's ICT hard and soft capital have been found to contribute to generating higher benefits from this innovative CC model of sourcing ICT services. The capability for developing ICT strategies and plans, which are connected with the overall strategies and plans of the firm (ICT strategic alignment), seems to have the strongest positive effect on CC benefits among all types of ICT capital examined in this study. The second strongest effect was the one of the ICT infrastructure sophistication. Therefore the development and operation of a sophisticated ICT infrastructure leads to the accumulation of valuable collective knowledge and experience concerning the efficient and effective use of ICT for supporting firm's activities and business processes, which can be useful for the rational selection, exploitation and combination of the most appropriate and cost-effective CC services, leading to the generation of higher levels of benefits from CC usage. The internal ICT relationship, between the personnel of the ICT unit and the personnel of the business units (who are users or potential users of ICT for supporting their work), was also found to impact positively the benefits generated from CC usage. Finally, our findings indicate that the development of high level of internal capability for rapid implementation of various interconnections/integrations of existing firm's IS, so that there is interoperability of them (= one IS can use data and functionality of others), impacts positively CC benefits. Interconnections/integrations between the CC

services we use, as well as with our on-premises IS, can increase significantly the business value generated for the firm from CC usage, in comparison with the isolated, uncoordinated and fragmented use of CC services, without integration among them and with on-premises IS.

Finally, all examined four CC adoption management actions impact positively the benefits firms obtain from CC usage. The adaptation of firm's ICT skills has the strongest positive impact on CC benefits. This result indicates the importance of the enrichment of the knowledge and skills of firm's ICT personnel, through appropriate training, about CC technologies, as well as firm's operations, business processes and strategic directions, for gaining high levels of benefits from CC. This enables the ICT personnel to establish a shared language and understanding, as well as a productive interaction and co-operation, with the personnel of firm's business units, for achieving a highly beneficial exploitation of CC by the firm; and also, to deal effectively with the technologic aspects of CC usage by the firm, as well with the integration of the external CC services (possibly from different providers) with firm's internal on-premises IS. The second strongest positive effect on CC benefits is the one of the relational governance of firm's relationships with its CC services providers. This result indicates that though CC services are a simple form of ICT outsourcing, based on the remote provision of highly standardized and minimally customizable ICT services, which are easily accessible in a self-service mode, with minimal interaction with their service provider, the development of a relationship with CC service providers continues to be important. Lower and of similar magnitude are the positive effects of the contractual governance of firm's relationships with its CC services providers, and the adaptation of ICT organization within the firm, on CC benefits. Therefore, it can be concluded that having detailed and comprehensive contracts with the CC service providers, defining the exact services to be provided, their quality levels, as well as sanctions for not achieving them, has a positive impact on the benefits obtained from CC, though this impact is lower than the one of the relational governance (at least in the Greek national context, from which the firm level data for this second part of our research have been collected).

Also, positive impact on CC benefits has the adaptation of the organization of ICT in the firm as well, however lower than the one of the adaptation of its ICT skills. The development of a strategic approach to CC exploitation, as well as specific processes for managing it, the adaptation of the role of firm's ICT unit to the needs of the CC paradigm, and the decentralization of CC related decisions to some extent from the ICT unit to firm's business units, lead to more benefits from CC.

7.2 Implications for Research and Practice

The empirical study presented in this Dissertation has interesting implications for both research and practice. With respect to the former it enriches our knowledge in several

highly important areas: CC adoption factors, open innovation, European North-South division, CC business value determinants, ICT resources and capabilities, governance of inter-organizational relations, as well as ICT outsourcing.

In particular, it investigates the effects of a wide range of firm characteristics, concerning firm's strategy, technological infrastructure and human resources, which had not been examined in previous relevant empirical literature, on CC adoption. It reveals specific types of firm strategies, and also characteristics of firm's technological infrastructure and human resources that favor CC adoption. Furthermore, it adds new knowledge concerning the association of open innovation with this novel ICT trend, the CC, providing evidence on the value of the latter as a cost-effective support and facilitator of the former.

Regarding the debate on the European North-South division, which recently has become quite intensive both at the academic and the political level, we add some new evidence concerning significant differences between these two regions in the exploitation of this new CC model of ICT support of firms' activities and processes: the European North seems to make a more advanced exploitation of CC (for innovation and inter-firm collaboration) than the European South, which might contribute to the increase of the productivity and economic performance gap between them.

Concerning the unexplored area of CC business value, it generates valuable new knowledge about specific types of firm's ICT hard and soft ICT capital (= specific ICT resources and capabilities), as well as CC adoption management actions, that can increase the benefits and in general the business value that firms gain from CC usage. Furthermore, our findings add to the existing knowledge in the area of ICT resources and capabilities, concerning their impact on business value generation from CC. Especially for the extensively discussed in previous literature capability of ICT strategic alignment (meant as development of ICT strategies and plans, which are connected with the overall strategies and plans of the firm), our study reveals its importance for gaining high levels of benefits from CC.

Finally, it creates new knowledge in the area of governance of inter-organizational relations: it extends the empirical research that has been conducted regarding the effects of contractual and relational governance on the outcomes and benefits of ICT outsourcing relationships, to the CC paradigm of external sourcing of ICT support services. In particular, it reveals that though CC is a simple form of ICT outsourcing (remote provision of highly standardized and minimally customizable ICT services, which are easily accessible in a self-service mode, with minimal interaction with their service provider), both the relational and the contractual governance of it are important for its success. Furthermore, it creates new knowledge on the effects of adaptations of firm's ICT skills and organization to the CC paradigm on the benefits it generates.

With respect to practice, our findings provide guidance to firms' management concerning CC adoption and business value generation from it. In particular, our study provides useful guidance and directions to firms' managers having to make decisions about the adoption of CC, as to the types of firms from a technological infrastructure, strategy and human resources perspectives, which are more appropriate for adopting CC. Our results also indicate that firms can start with lower risk uses of CC (e.g. use CC for hosting existing applications in order to reduce their operations, support and maintenance costs), and then, leveraging the experience gained from them, proceed to higher risk uses of CC (e.g. for supporting innovations in processes, products and services). Also, firms should not underestimate the importance of ICT personnel for the rational and beneficial adoption of CC (believing that CC makes ICT personnel unnecessary). Furthermore, as firms gradually move from 'closed innovation' models, to 'open innovation' ones, in order to take advantage of the resources of other firms for the successful design, implementation and commercialization of innovations, the use of CC can provide a low lost and high capabilities electronic support of the required extensive collaborations and exchanges of data and knowledge.

Our study provides useful guidance and directions to firms' managers also for obtaining high levels of benefits and business value from CC. It is quite important to place emphasis on the contracts with the CC service providers (making them sufficiently detailed and comprehensive), but this is not enough: much more important is the development of relationships with CC service providers, which are characterized by trust, mutual adaptations, open and extensive exchange of information and co-operation, collaborative generation of ideas for a better exploitation of all the capabilities offered by the CC services, as well as long term co-operation perspectives.

Also, since the ICT skills and the ICT organization of firms currently correspond to the existing 'on-premises' paradigm of ICT services production, it is necessary to change them, and adapt them to the new CC-based paradigm of ICT services production (as this is based to a significant extent on external ICT services providers); ICT personnel should become more business aware/oriented, and business personnel should be more involved in their ICT support through an appropriate mix of external and internal ICT services. Finally, firms' management should place emphasis in the development of their ICT resources and especially their ICT capabilities, which seem to be critical for the productive exploitation of CC, and the generation of high levels of business value from it; it is particularly important to develop their 'soft ICT capital', especially with respect to ICT strategic alignment, and ICT internal and external relationships.

7.3 Limitations and Future Research

The research presented in this Dissertation has four main limitations, which should be addressed by future research. The first limitation is that in the first part of it concerning CC adoption factors many of the variables we used (the dependent variable CC adoption propensity and several independent variables) are binary. This was due to the use of an existing dataset (collected as part of the e-Business Market W@tch initiative of the European Commission), on the collection of which we had not control. So further relevant research is needed for investigating the research questions of the first part of our research, based on more detailed measurements of these variables (using ordinal scales with more levels, or interval scales, or even multi-item scales). A second limitation is that we do not distinguish between different categories of CC services (IaaS, PaaS, SaaS), as they might differ as to the factors affecting their adoption as well as the benefits/business value they generate and their determinants. So further research is required for investigating our research questions for each of the abovementioned three main categories of CC services, identifying both similarities and differences among them. A third limitation is that the first part of our research (on CC adoption factors) has been based on data from only three European manufacturing sectors (glass, ceramics and cement), which are rather conservative in terms of adoption of new ICT, and innovative business practices in general, so that findings may have been influenced to some extent by this particular sectoral context. Similarly, the second part of our research (on the determinants of CC benefits/business value) has been based on data collected from only one country (Greece), which has experienced a long (since 2009) and severe economic crisis. Therefore our main research questions should be investigated in more sectoral and national contexts. Finally a fourth limitation is that in the second part of our research we have used as dependent variable a CC benefits factor, calculated through Principal Components Analysis from six individual variables, which measured the extent of both 'operational capabilities' improvement benefits (reduction of costs and improvement of quality of ICT support of firm's business processes and activities) and 'dynamic capabilities' () improvement benefits (support and facilitation of innovation, exploitation of new technologies, improvement of agility) . So it would be interesting if future research could investigate the determinants of the extent of each of these two different types of CC benefits,

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Appendix A

Variable	Question/Definition
Prop_Cloud	How relevant is cloud computing for your company (very relevant, partly relevant, or not relevant)?
ICT_Infr_Soph	Does your company use an ERP system, that is Enterprise Resource Planning? (yes/no)
	Does your company use a SCM system, that is Supply Chain Management? (yes/no)
	Does your company use a CRM system, that is Customer Relationship Management? (yes/no)
	Does your company use a SRM system, that is Supplier Relationship Management? (yes/no)
ICT_Invest_Red	Have you cancelled or significantly downsized any ICT or e-business projects in the last 12 months? (yes/no)
Prodserv_Inn	During the past 12 months, has your company launched any new or substantially improved products or services? (yes/no)
Proc_Inn	During the past 12 months, has your company launched any new or substantially improved processes? (yes/no)
ICT_Pers	Does your company currently employ ICT practitioners? (yes/no)
Empl_ICT	Do employees have problems because of insufficient ICT skills? (yes/no)
ICT_Outs	In the past 12 months, has your company outsourced any ICT services to external service providers, which were previously conducted in-house? (yes/no)
Pr_Comp	How important are the following factors for competition in your main market? (very important, important, not so important) a) price, b) quality
Qual_Comp	
D_Medium	Dummy variable for medium firms: 50-249 employees
D_Large	Dummy variable for large firms: more than 250 employees

Appendix B

Variables	Definitions
Dependent variables	
CLOUD_PROP	Relevance of cloud computing; binary variable: 1: very relevant, partly relevant; 0: not relevant
Independent variables	
Inducement effects	
ICT_INVEST_RED	Impact of the economic crisis on ICT investment plans or on ICT projects; binary variable: 1: yes, no ICT or e-business projects were cancelled or significantly downsized or yes, ICT or e-business projects were cancelled or significantly downsized; 0: no impact
INNO	Introduction of product or process innovations in in the past 12 months; binary variable: 1: yes; 0: no
INNOPC	Introduction of process innovations in in the past 12 months; binary variable: 1: yes; 0: no
NEW_ICT_TECH	Relevance of service-oriented architectures and/or data warehouses; data mining and/or mobile services such as mobile commerce and remote access technologies; binary variable: 1: yes; 0: no
COLLAB_ELC	Use of software applications other than E-mail to collaborate in the development of new products or processes; binary variable: 1: yes; 0: no
Rank effects	
OUTS	Outsourcing of ICT services in the past12 months; binary variable: 1: yes; 0: no
EXPORT	International market as most important sales market; binary variable; 1: yes; 0: no
INTER	Part of a multinational enterprise; 1: yes; 0: no
PCOMP	Importance of price competition in the main market; 3-level ordinal variable: 0: not important; 1: quite important; 2: very important
Medium-sized	50 to 249 employees
Large	250 employees and more
Stock, order, epidemic effects	

EP	Percentage of firms reporting relevance of cloud computing in one of 15 sub-markets (3 sectors in 5 countries)
Subs-sector dummies	Ceramics, cement (reference: glass)
Country dummies	France, Italy, Spain, United Kingdom, Germany

	Glass	Ceramics	Cement	Total	
	N	N	N	N	%
Country					
Germany	43	43	94	180	32.4
United Kingdom	24	17	23	64	11.5
France	22	22	42	86	15.5
North	*89*	*82*	*159*	*330*	*59.4*
Italy	28	19	54	101	18.2
Spain	17	29	79	125	22.4
South	*45*	*48*	*133*	*226*	*40.6*
Total (N)	134	130	292	556	100
Percentage (%)	24.1	23.4	52.5	100	

Variable	N	Mean	Std. Dev.	Min	Max
All firms					
CLOUD_PROP	553	0.116	0.014	0	1
ICT_INVEST_RED	553	0.400	0.021	0	1
INNO	553	0.514	0.021	0	1
INNOPC	553	0.381	0.021	0	1
NEW_ICT_TECH	553	0.474	0.021	0	1
COLLAB_ELC	553	0.114	0.014	0	1
OUTS	553	0.165	0.016	0	1
EXPORT	553	0.208	0.017	0	1
INTER	553	0.125	0.014	0	1
PCOMP	553	1.640	0.025	0	2
Medium-sized	553	0.335	0.020	0	1
Large	553	0.090	0.012	0	1
EP	553	38.977	0.652	9.09	62.50
South					
CLOUD_PROP	226	0.185	0.026	0	1
ICT_INVEST_RED	226	0.544	0.033	0	1
INNO	226	0.544	0.033	0	1
INNOPC	226	0.416	0.033	0	1
NEW_ICT_TECH	226	0.588	0.033	0	1
COLLAB_ELC	226	0.137	0.023	0	1
OUTS	226	0.195	0.026	0	1
EXPORT	226	0.164	0.025	0	1
INTER	226	0.071	0.017	0	1
PCOMP	226	1.602	0.041	0	2
Medium-sized	226	0.407	0.033	0	1
Large	226	0.102	0.020	0	1
EP	226	43.358	1.206	12.5	62.50
North					
CLOUD_PROP	327	0.067	0.014	0	1
ICT_INVEST_RED	327	0.300	0.025	0	1
INNO	327	0.492	0.028	0	1
INNOPC	327	0.358	0.026	0	1
NEW_ICT_TECH	327	0.394	0.027	0	1
COLLB_ELC	327	0.098	0.016	0	1
OUTS	327	0.144	0.019	0	1
EXPORT	327	0.239	0.024	0	1
INTER	327	0.162	0.020	0	1
PCOMP	327	1.667	0.032	0	2
Medium-sized	327	0.284	0.025	0	1
Large	327	0.083	0.015	0	1
EP	327	35.950	0.676	9.09	54.55

	1	2	3	4	5	6	7	8	9	10	11	12
1 ICT_INVEST_RED	1.000											
2 INNO	0.126	1.000										
3 INNOPC	0.141	0.772	1.000									
4 NEW_ICT_TECH	0.210	0.192	0.177	1.000								
5 COLLAB_ELC	0.081	0.210	0.238	0.151	1.000							
6 OUTS	0.136	0.203	0.129	-0.066	0.064	1.000						
7 INTER	0.149	0.079	0.152	0.161	0.091	0.082	1.000					
8 EXPORT	0.141	0.117	0.136	0.030	-0.003	0.205	0.064	1.000				
9 PCOMP	0.102	0.014	-0.038	-0.015	-0.035	0.065	-0.074	-0.182	1.000			
10 Medium-sized	0.162	0.125	0.141	0.272	0.246	0.116	0.193	0.047	0.039	1.000		
11 Large	-0.015	0.044	0.072	0.103	-0.049	0.056	0.078	0.088	-0.164	-0.279	1.000	
12 EP	-0.063	-0.087	-0.126	-0.009	-0.083	-0.142	-0.079	-0.335	0.022	-0.053	0.089	1.000

	1	2	3	4	5	6	7	8	9	10	11	12
1 ICT_INVEST_RED	1.000											
2 INNO	0.170	1.000										
3 INNOPC	0.138	0.758	1.000									
4 NEW_ICT_TECH	0.100	0.256	0.298	1.000								
5 COLLAB_ELC	0.054	0.149	0.141	0.155	1.000							
6 OUTS	0.113	0.155	0.149	0.026	0.158	1.000						
7 INTER	0.147	0.098	0.105	0.273	0.218	0.175	1.000					
8 EXPORT	0.119	0.123	0.121	0.165	0.009	0.057	0.182	1.000				
9 PCOMP	0.092	-0.030	-0.018	0.015	-0.022	-0.003	0.041	-0.097	1.000			
10 Medium-sized	0.002	0.125	0.123	0.240	-0.048	-0.046	0.072	0.108	0.015	1.000		
11 Large	0.168	0.105	0.124	0.213	0.126	0.162	0.260	0.301	0.040	-0.189	1.000	
12 EP	0.007	-0.043	-0.058	-0.060	-0.035	-0.086	-0.045	-0.126	0.065	0.024	-0.106	1.000

	1	2	3	4	5	6	7	8	9	10	11	12
1 ICT_INVEST_RED	1.000											
2 INNO	0.159	1.000										
3 INNOPC	0.150	0.764	1.000									
4 NEW_ICT_TECH	0.187	0.235	0.254	1.000								
5 COLLAB_ELC	0.079	0.178	0.187	0.161	1.000							
6 OUTS	0.136	0.178	0.143	-0.001	0.117	1.000						
7 INTER	0.105	0.083	0.109	0.201	0.157	0.128	1.000					
8 EXPORT	0.100	0.115	0.120	0.094	-0.001	0.109	0.157	1.000				
9 PCOMP	0.081	-0.014	-0.030	-0.008	-0.031	0.024	0.009	-0.124	1.000			
10 Medium-sized	0.102	0.130	0.137	0.271	0.096	0.036	0.092	0.071	0.019	1.000		
11 Large	0.090	0.080	0.103	0.168	0.046	0.116	0.186	0.211	-0.052	-0.224	1.000	
12 EP	0.031	-0.050	-0.075	0.014	-0.044	-0.096	-0.086	-0.231	0.028	0.015	-0.036	1.000

Appendix C

Variable	Definition
Dependent variable	
Propensity for cloud computing adoption (CLOUD_PROP)	How relevant is cloud computing for your company ?
Independent variables	
Involvement of other firms in product/service innovations (COLL_PRODSER_INN)	Were external experts or business partners involved in developing new products or services?
Involvement of other firms in process innovations (COLL_PROC_INN)	Were external experts or business partners involved in developing new processes?
Use of software applications to collaborate with other firms for product/ service or process innovations (EL_COLL_INN)	Does your company use online software applications other than e-mail to collaborate with business partners in the development of new products, services or processes?
Geographical scope of procurement (GSC_PROC)	Do you procure primarily from suppliers in your region, in your country of from an international supplier base?
Use of SCM systems (E_SCM)	Do you use an SCM (Supply Chain Management) system ?
ICT investment reduction (ICT_INV_RED)	Have you cancelled or significantly downsized any ICT or e-business projects

Appendix D

To what extent the use of CC services by your firm has provided the following benefits? (answer in a scale of 1 to 5, where: 5 = to a very large extent, 4 = to a large extent, 3 = to a moderate extent, 2 = to a small extent, 1 = not at all or to a very small extent)

CC_BEN	Reduction of the cost of the electronic support of your activities and business processes	1 2 3 4 5
	Improvement of the quality of the electronic support of your activities and business processes (e.g. by providing more capabilities/functionalities, higher availability)	1 2 3 4 5
	Use and exploitation of new technologies without need for additional investments	1 2 3 4 5
	Electronic support and facilitation of the rapid and lower cost introduction of products/services innovations (= new products/services or significantly improved ones)	1 2 3 4 5
	Electronic support and facilitation of the rapid and lower cost introduction of methods/processes innovations (= new methods/processes or significantly improved ones)	1 2 3 4 5
	An overall improvement of the 'organizational agility' of your firm, defined as its ability to respond to various changes/challenges in its external environment (e.g. introduction of new products, services and pricing policies by competitors, changes in market demand for your products and service, changes in customers' needs/preferences, need for satisfying special requirements of specific customers, need for changing the products/services mix you offer, opportunities for expansion in new markets)	1 2 3 4 5

To what extent does your firm have the following? (similar scale)

INTEGR_CAP	Capability of rapid internal implementation (by the ICT staff of your firm) of various interconnections/integrations of existing applications, so that there is interoperability of them (= one application can use data and functionality of other applications)	1 2 3 4 5
INT_REL	Good relationship, cooperation, mutual understanding and trust between the ICT personnel of your company and the personnel of its business units who use ICT	1 2 3 4 5

EXT_REL	Good relationship, cooperation, trust and exchange of information with ICT suppliers (of hardware, software, networks), and provision of sufficient support by them for solving all your relevant problems	1 2 3 4 5
ICT_STRAL_CAP	Capability for developing ICT strategies and plans which are connected with the overall strategies and plans of the firm (ICT strategic alignment)	1 2 3 4 5

To what extent you are using the following types of business software used in your firm? (similar scale)

ICTI_SO	Enterprise Resource Planning (ERP) system	1 2 3 4 5
	Customer Relationship Management (CRM) system	1 2 3 4 5
	Supply Chain Management (SCM) system (= software that supports the electronic exchange of information with customers, suppliers and business partners, such as inventory levels, orders, production, shipments, invoices, etc.)	1 2 3 4 5
	Business Intelligence/Business Analytics system (= software that supports advanced forms of processing business data, which lead to the creation of useful reports, as well as various types of causal or predictive models aiming at the support of decision-making – this can be either a separate software, or a module of an ERP or CRM system)	1 2 3 4 5
	Collaboration support system (= software that supports the internal collaboration between employees of the company, and/or external collaboration with customers, suppliers and partners, offering capabilities of sharing various forms of content (e.g. text files, images), forum, instant messaging (and other forms of communication), project management, etc.)	1 2 3 4 5

ICT_Personnel: Number of firm's ICT personnel (employees) _____

Number of firm's employees: _____

Appendix E

Answer the following questions in the scale of 1 to 5, where: 5 = to a very large extent, 4 = to a large extent, 3 = to moderate extent, 2 = to a small extent 1 = not at all

To what extent the contracts you have signed with your CC services providers include:

The detailed services that have to be offered by the service provider, their quality levels and the ways/procedures of measurement of them ?	1 2 3 4 5
Specific sanctions/penalties for the case that these quality levels are not achieved ?	1 2 3 4 5
Detailed descriptions of forms and ways of communication with the service provider, and procedures for handling problems and also for disputes' resolution ?	1 2 3 4 5
Detailed procedures for covering additional needs of your company in the future, e.g. needs for higher volumes of services, for new services, for new technologies, etc. ?	1 2 3 4 5

To what extent your relationships with your CC service providers have the following characteristics?

There is extensive provision of information by your company to your CC services providers, e.g. concerning your needs, your problems, your activities and internal business processes, your strategic goals, etc.	1 2 3 4 5
There is extensive provision of information by your CC services providers to your company, e.g. concerning the CC services they can offer to you, their technological capabilities, ways of better exploitation of them by your firm, etc.	1 2 3 4 5
There is a positive attitude from both parties for solving problems and resolving any disputes between your company and your CC services providers, aiming at mutual benefit and satisfaction of both parties	1 2 3 4 5
There is positive attitude and flexibility from both parties for responding positively to requests for changes of the other party (e.g. for making some changes in the services)	1 2 3 4 5
There is a positive attitude of both parties and interest in having a long term business relationship and co-operation	1 2 3 4 5

To what extent the use of CC services by your company has been accompanied/followed by the following complementary actions and internal changes for your adaptation to this new and different model of electronic support of your works and activities ?

Enrichment of the knowledge/skills of your IT personnel about CC (e.g. about the technologies of CC, the capabilities it provides, its interconnection/integration with on-premises information systems, the monitoring and management of the contracts and business relationships with CC providers)	1 2 3 4 5
Reinforcement of the knowledge/understanding that your IT staff has about the operations, processes and goals of your company, and the business orientation of your IT staff towards the achievement of business goals and the generation of business value and innovation	1 2 3 4 5
Development of new relevant processes in your company (e.g. for the quality control of the CC services, for your cooperation with your CC providers, for the cooperation between your IT unit/group and the other business units that use IT for supporting their works and activities, for meeting their needs for electronic support)	1 2 3 4 5
Development of strategy concerning the use of CC services (e.g. what types of CC services will be used, for which groups of applications, and with what objectives, and which groups of applications will remain in 'on-premises' systems)	1 2 3 4 5
Decentralization of IT decisions from the IT unit/group to the other business units that use IT for supporting their works and activities.	1 2 3 4 5
Change of the role of the IT unit/group of your company: from provision of IT services (through applications' development, software packages acquisition, systems administration and support) towards central coordination and support of the selection and use of various CC services, and also interconnection – integration of them with your own on-premises systems	1 2 3 4 5

To what extent the use of CC services by your company has provided the following benefits?

Reduction of the cost of the electronic support of your activities and business processes	1 2 3 4 5
Improvement of the quality of the electronic support of your activities and business processes (e.g. provision of more capabilities/functionalities, higher availability)	1 2 3 4 5
Use and exploitation of new technologies without need for additional investments	1 2 3 4 5

Electronic support and facilitation of the rapid and low cost introduction of products/services innovations (= new products/services or significantly improved ones)	1 2 3 4 5
Electronic support and facilitation of the rapid and low cost introduction of method/process innovations (= new methods/processes or significantly improved ones)	1 2 3 4 5
An overall improvement of the 'organizational agility' of your company, defined as its ability to respond to various changes/challenges in its external environment (e.g. introduction of new products, services and pricing policies by competitors, changes in market demand for your products and service, changes in customers' needs/preferences, need for satisfying special requirements of specific customers, need for changing the products/services mix you offer, opportunities for expansion in new markets)	1 2 3 4 5