Firm Characteristics and Propensity for Cloud Computer Adoption

Kyriakou, N., Loukis E.

University of the Aegean, Greece

Introduction

Cloud computing (CC) has emerged as a disruptive convergence of advancements in the areas of virtualization, distributed computing, data-center automation, multitenancy, Web services and services delivery over the Internet, which can radically change the way information technology (IT) services are developed, deployed, scaled, updated, maintained and paid for, and finally lead to 'a new paradigm' of computing (Marston et al., 2011; Venters and Whitley, 2012; Oliveira et al., 2014). The US National Institute for Standards and Technology (NIST) define 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" (NIST, 2009). 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 resources required to provide the requisite quality-of service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provide 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".

CC can provide significant benefits to firms: reduction of IT ownership and operation costs, conversion of related capital investments to operating costs, provision of practically infinite computing resources available on demand, provision of flexible cost-effective computing capacity to support growth IT services' quality improvement, flexibility to respond to fluctuating IT loads, focus on core competencies, quick and low cost development of new information systems (IS) to support innovations, reduction of IT related barriers to entry of new firms, and quick and low cost access to new technologies (e.g. business analytics, mobile interactive applications) (Armbrust et al., 2010; Marston et al., 2011; Venters and Whitley, 2012; Berman et al., 2012). According to Etro (2009), the introduction of CC is expected to have a positive impact on entry and competition in many sectors with high IT infrastructure requirements, as it can reduce drastically the fixed IT related costs, and also turn some of them into variable costs, and this can have a strong effect on the market structure of many sectors and on the global macroeconomic performance. CC can be quite advantageous to the economy and society in general, as it enables better utilization of IT infrastructures. However, it is widely recognized that CC can pose some risks as well: service availability and in general performance risks, data security risks (concerning lack of control of, unauthorized access to or modification of firm's data resources) and also economic risks (associated with 'hidden costs' and also CC services provider 'lock-in') (Benlian et al., 2009; Saya et al., 2010; Venters and Whitley, 2012). Furthermore, CC seems more appropriate and beneficial for some kinds of firms, and much less for some others. For the above reasons the adoption of CC by firms has been lower than the initial expectations (Saya et al., 2010; Benlian and Hess, 2011; Hsu et al., 2014; Oliveira et al, 2014).

This has motivated considerable research for understanding better the factors that affect positively or negatively CC adoption by firms (it is briefly reviewed in the next section). However, most of this research focuses on the effects of the perceived technological characteristics of CC on its adoption; on the contrary, there has been much less research on the effect of firm characteristics on CC adoption. Firm characteristics (such as strategy, processes, technology, personnel) shape to a significant extent the perceived technological characteristics of CC, and also the magnitude of both the benefits that CC generates and the risks it poses; so we expect that firm characteristics will affect the propensity to adopt CC. This paper contributes to filling this research gap. It empirically investigates and compares the effects

of a wide range of firm characteristics, concerning firm's strategy, processes, technology and personnel, on the propensity to adopt CC. Its theoretical foundation the Leavitt's Diamond framework (Leavitt, 1964), which constitutes one of the most 'classical' and widely recognized and used views of the firm in management science. Our research is based on a dataset collected through the e-Business W@tch Survey of the European Commission from 676 European manufacturing firms from the glass, ceramic, cement and sectors. We expect that the findings of this empirical study will allow us to understand better in what kind of firms CC is perceived as more appropriate and beneficial, and in which ones it is perceived as less appropriate and beneficial. This is going to be useful both for CC services providers (in order on one hand to focus their marketing efforts on firms' segments having higher probabilities of CC adoption, and on the other hand to design improvements of their offerings for making them more attractive for more firms' segments), and for CC services potential users (in order to make better CC adoption decisions).

This paper consists of six sections. In the following section 2 a relevant literature review is presented, and in section 3 the research hypotheses are formulated. In section 4 the data and the method of this study are described. In section 5 the results are presented. Finally, in section 6 conclusions are summarized and future research directions are suggested.

Literature Review

The first empirical CC adoption studies were based on various adaptations of the Technology Acceptance Model (TAM). The most representative of them was the one of Wu (2011), which used data collected from 42 Taiwanese managers, and concluded that the main factors affecting intention to use CC are perceived ease of use, followed by perceived usefulness, both of them being affected by social influences and marketing.

Most of the subsequent CC adoption empirical research was based on the Technology, Organization and Environment (TOE) theory (Baker, 2011), which identifies three groups of factors that affect the adoption of technological innovations by firms: technological (= perceived characteristics of the technological innovation), organizational (= firm's characteristics) and environmental (= characteristics of firm's external environment) ones. Using TOE theory as their theoretical foundation Low et al. (2011), based on data from a sample of 111 Taiwanese high-tech industry firms, examine the effect of a set of technological factors (relative advantage, complexity and compatibility), organizational factors (top management support, firm size and technology readiness) and environmental factors (competitive pressure and trading partner pressure) on CC adoption. They found that perceived relative advantage, top management support, firm size, competitive pressure and trading partner pressure have statistically significant effects on CC adoption. Another TOE-based study has been conducted by Hsu et al. (2014), which examines the effect of perceived benefits and business concerns (technological factors), IT capability (IT personnel and budget - organizational factor) and external pressure (environmental factor) on CC adoption intention, using data from 200 Taiwanese firms. It concluded that the first three of these factors are significant determinants of CC adoption while the fourth is not. Mangula et al. (2014), using data from 147 Indonesian firms, examine the effect 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 found that compatibility, observability, market competition and government support have a positive correlation with SaaS adoption, while complexity has a negative correlation with it. Oliveira et al. (2014) using data from 369 Portuguese firms examine the effects of three CC innovation characteristics (relative advantage, complexity and compatibility), two organizational context characteristics (top management support, firm size), one technological context characteristic (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 positive effects on CC adoption, while complexity has a negative effect.

Furthermore, there are a few CC adoption empirical studies based on the synthesis of other theoretical frameworks. Saya et al. (2010), based on the institutional theory and the real options theory, and using data collected from 101 ICT professionals from Singapore and Japan, formulated and estimated a four

layers structural equation CC adoption model. They conclude 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 on the provided real options by CC adoption (concerning ICT applications growth, abandonment and deferral) and finally the intention to adopt CC. Benlian et al. (2009), having as theoretical foundation the theory of reasoned action in combination with previous research on ICT outsourcing and application service provision (ASP), using data collected through a survey of 349 IT executives at German companies, examine the effects of perceived SaaS opportunities (cost advantages, strategic flexibility, focus on core competencies, access to specialised resources and quality improvements) and SaaS risks (performance, economic, strategic, security and managerial ones) on the intention to increase the level of its adoption. They conclude that the perceived cost advantages have the strongest positive effect, followed by strategic flexibility and the quality improvement; the focus on core competencies and the access to specialized resources do not have statistically significant effects. Furthermore, the security risks have the strongest negative effect, followed by the performance, economic and strategic risks; the managerial risks do not have statistically significant effects. Wu et al. (2013) study empirically the effects of two information processing requirements related factors (business process complexity and entrepreneurial culture) and two information processing capacity related factors (applications, functionality and compatibility) on the intention to adopt CC, using data from 289 USA manufacturing and retail firms. The theoretical foundations of this study are the innovation diffusion theory (DOI) (focusing mainly on its relative advantage and compatibility dmansions) and the 'information processing view' (IPV) of the firm. They conclude that business process complexity and also applications compatibility have negative effects on CC adoption intention while, on the contrary, entrepreneurial culture and applications functionality have positive effects.

From the above review of previous empirical literature on CC adoption it is concluded that limited research on the effect of firm characteristics on CC adoption has been conducted, examining the effects of only a small number of firm characteristics. This study contributes to filling this research gap, by empirically investigating and comparing the effects of a wide range of firm characteristics (which have not been investigated previously), concerning firm's strategy, processes, technology and personnel on the propensity to adopt CC, having as theoretical foundation the Leavitt's Diamond view of the firm (Leavitt, 1964).

Research Hypotheses

The Leavitt's Diamond (Leavitt, 1964) constitutes one of the most 'classical' and widely recognized views of the firm in management science, which has been extensively used in IS research and practice for long time (e.g. Danziger, Kraemer, Dunkle, & King, 1993; Lucas & Baroudi, 1994; Lyytinen & Newman, 2008; Nograšek and Vintar, 2014; Blumberg et al., 2014). It views firms as consisting of four main elements: task (= firm's goals/strategies and work processes for achieving them), technology (= technology used for performing work processes), people (= skills of firm's human resources) and structure (= firm's organization in departments and also relationships, communication patterns and coordination among them). We used it as theoretical foundation of this study: for each of the above four main firm's elements we reviewed previous relevant literature in order to identify characteristics of it that might have an impact on the propensity to adopt CC; we managed to identify such characteristics for the first three elements (task, technology and personnel), and for each of these characteristics we developed a corresponding research hypothesis.

The 'task' element has been divided into two sub-elements: strategy and processes. For the former we identified two characteristics of it that might have an impact on the propensity to adopt CC: adoption of an IT investment reduction strategy, and adoption of an innovation-oriented strategy; similarly, for the latter we identified two characteristics of it likely to affect CC adoption propensity: operational complexity and use of telework.

So our first hypothesis concerns the effect of adopting an IT investment reduction strategy on the propensity for CC adoption. Due to the existing economic recession many firms adopt strategies of IT

investment reduction. However, very often this does not allow them them to increase the computing power and the functionality of their IT infrastructures in order to meet new business needs, or to take advantage of new emerging IT (e.g. CRM or business analytics), which might be quite beneficial; these can have negative impact on firms' long term competitiveness. CC can be quite useful for such firms, as it enables them to increase the computing power (e.g. by using Infrastructure as a Service (IaaS)) and also the functionality of their IT infrastructures (e.g. by using Software as a Service (SaaS)) in order to meet new business needs, and also to exploit and use new emerging IT and novel types of applications, without having to make additional IT investments (Marston et al., 2011; Venders, Whitley, 2012). Therefore we expect that firms adopting a IT investment reduction strategy will have a strong motivation and propensity to adopt CC. So, our first research hypothesis is:

Hypothesis 1. The adoption of an IT investment reduction strategy has a positive effect on the propensity for Cloud Computing adoption.

In the modern economy firms increasingly have to make innovations in the products and services they offer to their customers, and also in their internal production and administrative processes, in order to remain competitive – or even just to survive. However, such innovations very often necessitate the development of complex supporting IT infrastructures, and this can be costly (requiring considerable IT capital investments) and also can take too much time (which is quite negative taking into account the rapid pace of changes in the modern economy) using the 'traditional' in-house practices. This can increase significantly the barriers to and the risks of innovation. Previous CC literature has emphasized that it can provide benefits associated not only with IT cost reduction, but also with innovation support and facilitation as well, as it enables the rapid development of the required supporting IT infrastructures, at a low cost, without requiring IT capital investments (Marston et al., 2011; Venders, Whitley, 2012; Brynjolfsson et al., 2010). Therefore CC can reduce the cost and time related barriers and also the risks of innovation. So we expect that firms adopting an innovation-oriented strategy will have a strong motivation and propensity to adopt CC. Thus, our second hypothesis is:

Hypothesis 2. The adoption of an innovation-oriented strategy has a positive effect on the propensity for Cloud Computing adoption.

Hypothesis 2a. The adoption of a product or service innovation oriented strategy has a positive effect on the propensity for Cloud Computing adoption.

Hypothesis 2b. The adoption of a process innovation oriented strategy has a positive effect on the propensity for Cloud Computing adoption.

High complexity of firm's operations, due to having multiple production locations (which necessitate rational allocation of production among them, communication, co-ordination and central monitoring, and also organization of complex materials'/products' shipments to/from them), or international scope of sales (i.e. selling to customers beyond firm's country, which means having to manage many different legislations, regulations, taxations, specific needs, etc., and also having to organize complex shipments to many geographic locations) or procurement (i.e. having suppliers beyond firm's country, posing similar challenges) increases the requirements for relevant information storage and processing. This leads to high costs for the development, maintenance and operation of the required IS, which can increase firm's operating costs and reduce its competitiveness. CC can be quite valuabel in such cases, as it can drastically reduce the above costs, and also transform them to 'operating expenses'. So we expect that firms having complex operations (due to multiple production locations, or international scope of sales or procurement) will have a higher motivation and propensity to adopt CC. For these reasons our third hypothesis is:

Hypothesis 3. Operational complexity has a positive effect on the propensity for Cloud Computing adoption:

Hypothesis 3a. Having multiple production locations has a positive effect on the propensity for Cloud Computing adoption

Hypothesis 3b. Having an international scope of sales has a positive effect on the propensity for Cloud Computing adoption

Hypothesis 3c. Having an international geographical scope of procurement has a positive effect on the propensity for Cloud Computing adoption.

The ICT have fundamentally changed the structure of how and where work is performed, changing dramatically the geographical distribution of it (Baptista and Huang, 2013). Firms adopt telework in order a) to reduce the costs associated with maintaining an office environment, by offering to their personnel the opportunity to work from home, being connected with the firm's IT infrastructure; b) to enable their personnel to work from customers' premises (this leading to better interaction with the customers and deeper understanding of their problems), or while they are travelling, accessing firm's IT infrastructures. CC by nature can provide teleworking capabilities at a low cost: according to Mohamed and Pillutla (2014) "cloud computing makes telework better alternative to commuting". In particular, CC services allow firm's employees to access their data and applications, from anywhere, using various devices (laptops, tablets, smartphones), as long as there is an active Internet connection. Therefore firms using telework have a strong motivation and propensity to adopt CC in order to reduce its costs, and also to extend it to more employees, allow them to use more types of devices for this purpose, etc. Thus, our fourth hypothesis is:

Hypothesis 4. The use of telework has a positive effect on the propensity for Cloud Computing adoption.

For the 'technology' element of Leavitt's Diamond we have identified four firm's characteristics that might have an impact on its propensity to adopt CC. The first two of them concern the existing IT infrastructure of the firm: degree of sophistication, and degree of electronic interconnection with suppliers and customers; the other two concern the extention of the existing IT infrastructure using new technologies: interest in adopting data warehousing and data mining technologies, and interest in providing mobile services.

So our fifth research hypothesis concerns the effect of the degree of firm's IT infrastructure sophistication on the propensity to adopt CC. In previous literature (Hugos and Hulitzky, 2010; Marston et al., 2011; Venders and Whitley, 2012) it is argued that CC is more useful for the firms that do not have sophisticated IT infrastructure: CC will enable them to gain rapid access to more IT capabilities and functionalities, and at a much lower cost than with the 'traditional' in-house practices. For this reason we would expect that firms having weak IT infrastructures with limited capabilities and sophistication have a stronger motivation and propensity to adopt CC than the ones having highly sophisticated IT infrastructures (as the latter have already extensive IT support of their business processes, so it is less likely to be interested in CC services). However, we can have arguments in the opposite direction as well: firms having sophisticated IT infrastructure can gain more from migrating to the cloud due to the opportunities it offers for the reduction of their ICT operations, support and maintenance costs. Therefore, we have formulated two alternative research hypotheses on this:

Hypothesis 5a. The degree of sophistication of firm's IT infrastructure has a positive effect on the propensity for Cloud Computing adoption.

Hypothesis 5b. The degree of sophistication of firm's IT infrastructure has a negative effect on the propensity for Cloud Computing adoption.

Our sixth hypothesis concerns the impact of the electronic interconnection of firm's IT infrastructure with the ones of its customers or suppliers on its propensity to adopt CC. Previous research on the adoption of ICT outsourcing in general (e.g. Arvanitis and Loukis (2013)), and CC in particular (e.g. Nuseibeh (2011)), has concluded that asset specificity (defined as the degree or customization of providers' assets used for providing the service) reduces the propensity for both. Therefore we expect that electronic interconnection of firm's ICT infrastructure with the ones of suppliers and customers will increase the corresponding provider's assets specificity, so it will have a negative effect on firm's propensity for CC adoption. However, we can have arguments in the opposite direction as well: CC providers increasingly provide low cost capabilities for integration of their SaaS offerings with various other software applications, and also maintain these interconnections (in cases of new versions/releases of these applications or their APIs). Therefore firms having interconnections of their IT infrastructures with the ones of their customers and suppliers might have a good motivation to adopt CC, in order to reduce the costs of maintaining these interconnections, and also increase them (connect with additional customers and suppliers). Therefore, we have formulated two alternative research hypotheses on this as well:

Hypothesis 6a. The degree of electronic interconnection of firm's IT with suppliers and customers has a positive effect on the propensity for Cloud Computing adoption.

Hypothesis 6b. The degree of electronic interconnection with suppliers and customers has a negative effect on the propensity for Cloud Computing adoption.

One of the most important advantages of CC strongly emphasized in relevant literature is that it enables experimenting with and exploiting new emerging IT, rapidly, at a low cost and without having to make additional investments, with the most widely mentioned of them being data warehousing/data mining and mobile services (Marston et al., 2011; Venters and Whitley, 2012; Bhagyashree and Borkar, 2012; Verma, 2013). So the next two hypotheses concern these two technologies. Firms' data processing activities produce massive amounts of data, from which useful knowledge can be extracted concerning customers and their buying behaviour and preferrences, marketing activities production processes, procurement, expenses, etc., using data warehousing/data mining technologies; however, this requires additional investments on hardware and software, and specialised personnel. The use of relevant SaaS services offers very good advantages with respect to the adoption and exploitation of these technologies: reduced costs, short deployment time, elasticity and scalability. So our next seventh hypothesis is:

Hypothesis 7. Interest in adopting data warehousing and data mining technologies has a positive effect on the propensity for Cloud Computing adoption.

Mobile devices (e.g., smartphone and tablet PCs) are increasingly becoming an essential part of human life, as effective and convenient communication tools not bounded by time and place, so firms are moving towards exploiting this mobile channel in order to reach out potential customers, advertise and sell their products and services, and also for crowdsourcing, crowdfunding and for supporting many internal operations (Dinh et al., 2013). However, the infrastructure to support mobile applications and services needs to be continuously available for customers and employees; customers who do not have access to an application or service on their mobile device, will most likely try competitors' ones. Also, the required infrastructure for providing high availability mobile services to customers and employees can be costly. CC can provide high levels of uptime for mobile applications and services, and in general high technical quality in this area, elesticity and scalability, at low cost (Venters and Whitley, 2012; Dinh et al., 2013). Therefore, our eighth hypothesis is:

Hypothesis 8. Interest in providing mobile services has a positive effect on the propensity for Cloud Computing adoption.

For the 'people' element of Leavitt's Diamond we have identified two firm's characteristics that might have an impact on its propensity to adopt CC: employment of IT personnel and previous experience of ICT outsourcing. Previous literature has revealed the importance of the specialized IT human resources for ICT-based innovation (Arvanitis et al., 2013). With respect to CC adoption the IT personnel has an important role in examining on one hand the existing CC services and providers, their advantages and disadvantages, and on the other hand the needs of the firm, and also for selecting the most appropriate CC services and providers, for formulating the contacts, and for monitoring and managing these relations. Thus, our ninth hypothesis is:

Hypothesis 9. The employment of IT personnel has a positive effect on the propensity for Cloud Computing adoption.

CC constitutes a special form of on-demand IT outsourcing, so we expect that firms with previous experience in outsourcing some of their IT activities could more readily adopt CC (Benlian and Hess, 2011). The personnel of such firms are more familiar with allowing third parties to operate on their behalf, by outsourcing a portion of their workload or operations. They have developed skills and specialised 'know-how' on IT outsourcing (e.g. concerning the selection of service providers, the negotiations and contracting with them, the monitoring and management of such relations, the critical success factors, etc.), and also some trust in this model of IT services provision. Therefore we expect that previous experience of IT outsourcing leads to the development of collective knowledge and intelligence in this area, which increases the propensity to adopt CC. Thus, our tenth hypothesis is:

Hypothesis 10. Previous experience of IT outsourcing has a positive effect on the propensity for Cloud Computing adoption.

Data and Method

In this study we used firm level data collected through the "e-Business Survey 2009" survey. This survey was conducted by the e-Business Market W@tch (www.ebusiness-watch.org) under the auspices of the European Commission. In this survey were collect data concerning the use of various types of IT, and also IT skills and investment by firms of the European glass, ceramic and cement industries. Data were collected through computer-assisted telephone (CATI) interviews from a sample of 676 firms from six European countries (Germany, France, Italy, Poland, Spain, UK); 53.8% of the sample firms were small (with 1-49 employees), 33.6% were medium (with 50-249 employees) and the remaining 12.6% were large firms (with more than 250 employees).

The definitions of all variables used in this study (questions of the above survey used) can be found in the Appendix. The dependent variable is the propensity for CC adoption (Cloud), which has three possible values (very relevant, partly relevant, not relevant). All independent variables are either binary, or have three or four possible values. In the first category we have the adoption of IT investment reduction strategy, the adoption of product/process innovation strategy, the employment of IT personnel and the existence of previous experience of IT outsourcing variables (0 for 'No' and 1 for 'Yes'). Variables with three possible values include interest in data warehousing/data mining and interest in mobile services (2: very relevant/1: partly relevant/0: not relevant). The scope of sales and procurement variables (having initially three possible values) were recoded as binary; similarly the prouction locations variable (having initially four possible values) was recoded a three valued variable (1: one location/2: two or three locations/3: more than three locations). The variables of sophistication of IT infrastructure, electronic interconnection with suppliers and electronic interconnection with customer variables have been computed from a number of binary variables. In particular, the degree of sophistication of firms' IT infrastructure variable has been computed as the average of three binary variables: use of ERP systems (yes/no), use of SCM systems (yes/no) and use of CRM systems (yes/no)). For the degree of electronic interconnection with suppliers and customers we have used two variables: one concerning the degree of electronic interconnection with suppliers (computed as the average of three binary variables: EDI connection with suppliers (yes/no), ERP connected with suppliers' ones (yes/no) and share information with suppliers (yes/no)); and another one concerning the degree of electronic interconnection with customers (calculated as the average of three binary variables: EDI connection with customers (yes/no), ERP connected with customers' ones (yes/no) and share information with customers (yes/no)).

In order to test the research hypotheses H1 - H10, we perform chi square tests and also calculate two measures of association between two ordinal variables (Somers' d and Kendall's tau-b). In particular, Somers' d ranges from -1 to 1, which means that values close to an absolute value of 1 indicate a strong relationship between the two variables, and values close to 0 indicate little or no relationship between the variables. On the other hand, Kendall's tau-b range from -1 to 1, but a value of -1 or 1 can be obtained only from square tables. The sign of the coefficient indicates the direction of the relationship, and its absolute value indicates the strength, with larger absolute values meaning stronger relationship. It should be noted that we did not estimate a regression model because there were high correlations between our independent variables (according to the econometric literature (e.g. Greene, 2011; Gujarati, 2008) if we have high levels of correlation between the independent variables of a regression (multi-collinearity problem), then the regression coefficients are not reliable measures of the impact of the independent variables on the dependent variable).

Results

In Table 1 are shown for all independent variables the Sommers D coefficient (third column) and the Kendall tau-b coefficient (fourth column) values with respect to the independent variable (propensity for CC adoption), and also the corresponding chi square test significance (second column). Note that statistically significant values are shown in bold.

Variable	Significance of chi square test	Sommer's D	Kendall tau-b
IT Investment Reduction Strategy	**0.000**	**0.162**	**0.166**
Product/Service Innovation Strategy	**0.011**	**0.106**	**0.113**
Process Innovation Strategy	**0.030**	**0.091**	**0.099**
Multiple Production Location	0.364	0.033	0.035
International Scope of Sales	0.986	0.003	0.003
International Scope of Procurement	0.300	-0.028	-0.029
Use of Telework	0.154	0.068	0.074
Sophistication of IT Infrastructure	**0.000**	**0.144**	**0.163**
Electronic Interconnection with Suppliers	**0.000**	**0.133**	**0.139**
Electronic Interconnection with Customers	**0.001**	**0.141**	**0.143**
Interest in Data Warehousing	**0.000**	**0.280**	**0.294**
Interest in Mobile Services	**0.000**	**0.185**	**0.205**
Employment of IT Personnel	**0.000**	**0.158**	**0.164**
IT_Outsourcing	**0.005**	**0.123**	**0.123**

Table 1. Sommer's D and Kendall tau-b Coefficients - chi square test significances

In particular, we remark that the adoption of IT investment reduction strategy has a statistically significant positive association with the propensity for CC adoption, so our first hypothesis H1 is supported. The same happens with the adoption of product/service innovation strategy, but to a lower extent (having lower values of association with the dependent variable), and with the adoption of process innovation strategy, to an even lower extent; therefore hypotheses H2a and H2b are supported. On the contrary all operational complexity variables do not have statistically significant associations with the propensity for CC adoption, so hypotheses H3a, H2b and H2c are not supported. The same happens with the use of telework variable, so hypothesis H4 is not supported, too. Furthermore, we can see that the sophistication of IT infrastructure variable, and both electronic interconnection (with suppliers and customers) variables have statistically significant positive associations with the propensity for CC adoption, so hypotheses H5a and H6a are both supported. The same happens with the variables concerning the interest in expoiting the new technologies of data warehousing/datamining and mobile services, so hypotheses H7 and H8 are also supported. Both the personnel related variables (concerning the employment of IT personnel and the existence of previous experience of IT outsourcing) have statistically significant positive associations with the propensity for CC adoption, so the corresponding hypotheses H9 and H10 are supported as well.

The values of the two association measures of the independent variables shown in Table 1 allow a comparison of their effects on the propensity for CC adoption. We remark that interest in the adoption of data/data mining technologies and the provision of mobile services have the stronger effects (with Sommer's D/Kendall tau-b values 0.280/0.294 and 0.185/0.205 resepctively). They are followed by the IT investment reduction strategy variable and the employment of IT personnel (values 0.162/0.166 and 0.158/0.164 respectively); then follow closely the sophistication of firm's IT Infrastructure and its electronic interconnection with suppliers and customers (values 0.144/0.163, 0.133/0.139 and 0.141/0.143 respectively). Finally, the previous experience of IT outsourcing and the adoption of product/service innovation strategy and process innovation strategy have the weakest effects on the propensity for CC adoption (0.123/0.123, 0.112/0.126, 0.091/0.099 respectively).

Conclusions

CC is an emerging new paradigm of providing IT support of firms' processes and activities, which has a great potential to offer huge benefits, but at the same time firms perceive that it poses some risks as well. Its adoption by firms has been lower than the initial expectations. So it is quite important to conduct research on its adoption by firms and identify factors that affect it positively or negatively. Our study makes a contribution in this direction by empirically investigating and comparing the effects of a wide range of firm characteristics, concerning firm's strategy, processes, technology and personnel on the propensity to adopt CC. It has been based on a dataset collected through the e-Business W@tch Survey of the European Commission from 676 European firms from the glass, ceramic, cement and sectors.

Our results indicate that in this sectoral context the strongest driver of CC adoption is firms' interest in adopting and exploiting two important new IT (data warehousing/data mining), viewing CC as a good way to proceed in this direction rapidly, at a low cost, having the form of operating expenses, without having to make investments for this purpose. The second strongest driver is the adoption of an IT investment reduction strategy, while much lower is the impact of the adoption of products/services and process innovation strategies; therefore firms view CC as a good solution to increase the computing power and the functionality of their IT infrastructures in order to meet new business needs, or to take advantage of new emerging IT, despite existing IT investment reduction strategies, and (however to a much lower extent) as a cost-efficient way of developing the IT infrastructure required for supporting products/services and process innovations. Another equally strong driver of CC adoption is the employment of IT personnel, who are quite important for examining on one hand the existing CC services and providers in the market, and on the other hand the needs of the firm, and then for selecting the most appropriate CC services and providers, for formulating and negotiating the contacts, and for monitoring and managing these relations. Slightly weaker drivers of CC adoption by firms are the sophistication of their IT infrastructures and their interconnection with suppliers and customers, as CC has the potential to decrease the corresponding high support, upgrade and maintenance costs. Also, the existence of previous experience of IT outsourcing affects positively the propensity to adopt CC, as the collective knowledge and intelligence developed with respect to the former is useful for proceeding with the latter.

Further research is required concerning the effects of firm characteristics on CC adoption, in various sectoral and national contexts, investigating the effects of a wider range of firm characteristics (possibly including structural ones as well) on the adoption of various types of CC services (e.g. IaaS, PaaS, SaaS).

REFERENCES

Armbrust, M., Fox, A., Griffith, R., Joseph, A., Katz, R., Konwinski, A., Lee, G., Patterson, D., Rabkin, A, Stoica I. and Zaharia M. (2010). 'A view of Cloud Computing', Communications of the ACM 53(4): 50-58.

Arvanitis, S. and Loukis, E. (2013). 'Outsourcing and firm performance – a comparative study of Swiss and Greek firms'. Industrial and Corporate Change, 22(3):771-806.

Arvanitis, S., Loukis, E., Diamantopoulou, V. (2013). 'The effect of soft ICT capitalon innovation performanceof Greek firms'. Journal of Enterprise Information, 26(6): 679-701.

Baker J. (2011). "The technology-organization-environment framework", in Dwivedi, Y., Wade, M. and Schneberger, S. (Eds), Information Systems Theory: Explaining and Predicting Our Digital Society, Springer, New York, NY, pp. 231-246.

Baptista, J. and Huang, J. (2013). 'Where Work Happens: Digitization of Work and the Fusion Between Physical and Digital Workspaces'. International Conference on Information Systems, Milan, Italy.

Benlian, A. and Hess T. (2011). 'Opportunities and Risks of Software-as-a-Service: Findings from a Survey of IT Executives. Decision Support Systems, 52(1): 232-246.

Benlian, A., Hess T and Buxmann P. (2009). 'Drivers of SaaS-Adoption – An Empirical Study of Different Application Types', Business & Information Systems Engineering, 1(5): 357-369.

Berman, S., Kesterson-Townes, L., Marshall, A. and Srivathsa, R. (2012). The power of cloud - Driving business model innovation. IBM Institute for Business Value, New York, USA.

Bhagyashree, A. and Borkar, V. (2012). 'Data Mining in Cloud Computing'. Proceedings Published by International Journal of Computer Applications.

Blumberg, M., Cater-Steel, A. and Soar, J. (2014). An Organisational Change Approach to Implementing IT Service Management. 25th Australasian Conference on Information Systems, 8th -10th Dec 2014, Auckland, New Zealand.

Brynjolfsson, E., Hofmann, P. and Jordan, J. (2010). "Economic and BusinessDimensions Cloud Computing and Electricity: Beyond the utility model",Communications of the ACM, 53(5): 32–34.

Danziger, J. N., Kraemer, K. L., Dunkle, D. E., & King, J. L. (1993). Enhancing the quality of computing service: Technology, structure, and people. Public Administration Review, 53(2), 161–169.

Dinh, H. T., Lee, C., Niyato, D. and Wang, P. (2013). A survey of mobile cloud computing: architecture, applications, and approaches. Wireless Communication and Mobile Computing, 13:1587–1611.

Etro F. (2009). 'The Economic Impact of Cloud Computing on Business Creation, Employment and Output in Europe. Review of Business and Economics, 54(2): 179-208.

Greene, W. H. (2011), 'Econometric Analysis - 7th edition', Prentice Hall Inc., New Jersey.

Gujarati, D. N. (2008), 'Basic Econometrics – 5th edition', Mc-Graw Hill Higher Education, New York.

Hsu P., Ray F. and Li-Hsieh S. (2014). 'Examining Cloud Computing Adoption Intention, Pricing Mechanism and Deployment Model', International Journal of Information Management, 34: 474-488.

Hugos M.H and Hulitzky D. (2010). Business in the Cloud: What Every Business Needs to Know about Cloud Computing. John Wiley & Sons.

Leavitt, H. J. (1964). Applied organization change in industry: structural, technical, and human approaches. In S. Cooper, H. J. Leavitt, & K. Shelly (Eds.), New perspectives in organizational research (pp. 55–71). Chichester: Wiley.

Low C, Chen, Y. and Wu, M. (2011). 'Understanding the Determinants of Cloud Computing Adoption'. Industrial management & Data Systems, 111(7): 1006-1023.

Lucas, H. C., & Baroudi, J. (1994). The role of information technology in organization design. Journal of Management Information Systems, 10(4), 9–23.

Lyytinen, K., & Newman, M. (2008). Explaining information systems change: a punctuated socio-technical change model. European Journal of Information Systems, 17, 589–613.

Mangula, I.S., I. Weerd and S. Brinkkemper, "The Adoption of Software-as-Service: An Indonesian Case Study", Proceedings in Pacific Asia Conference on Information Systems (PACIS), 2014.

Marston S., Li Z., Brandyopadyay, S., Zhang J and Ghalsasi A. (2011). 'Cloud Computing – The Business Perspective', Decision Support Systems, 51(1): 176-189.

Mohamed, M. and Pillutla, S. (2014). 'Cloud Computing: A Collaborative Green Platform for the knowledge society'. VINE, 44(3): 357-374.

NIST (2009)., NIST Definitoon of cloud computing v15, NIST, Editor. 2009, National Institute of Standards and Technology: Gaithersburg, MD.

Nograšek, J., Vintar, M. (2014). E-government and organisational transformation of government: Black box revisited? Government Information Quarterly, 31:108–118.

Nuseibeh H. 2011. 'Adoption of Cloud Computing in Organizations', Proceedings of the Seventeeth Americas Conference on Information Systems, Detroit, Michigan.

Oliveira, T., Thomas, M., Espadanal, M. (2014). 'Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors', Information & Management, 51:497-510.

Saya S., Pee L. and Kankanhalli A. (2010). 'The Impact of Institutional Influences on Perceived Technological Characteristics and Real Options in Cloud Computing Adoption'. Proceedings of International Conference on Information Systems (ICIS), St. Louis, USA.

Srinivasan, S. (2014). 'Building Trust in Cloud Computing: Challenges in the Midst of Outages'. Proceedings of Informing Science & IT Education Conference (InSITE): 305-312.

Venters W. and Whitley E. (2012). 'A Critical Review of Cloud Computing: Researching Desires and Reality', Journal of Information Technology, 27: 179-197.

Verma, H., "Data-warehousing on Cloud Computing", International Journal of Advanced Research in Computer Engineering & Technology, 2, 2013, pp. 411 – 416.

Wu, W. W. (2011a). 'Developing an explorative model for SaaS adoption'. Expert systems with applications, 38(12): 15057-15064.

Wu, Y., Cegielski, C. G., Hazen, B. T. and Hall, D. J. (2013). 'Cloud Computing in Support of Supply Chain Information System Infrastructure'. Journal of Supply Chain Management, 49(3): 25-41.

APPENDIX – Variables definitions - questions

Variable	Definition
Cloud	How relevant is cloud computing for your company (very relevant, partly relevant, or not relevant)?
IT Investment Reduction Strategy	Has the economic crisis lead you to cancel or significantly downsiz any ICT investments/projects in the last 12 months? (yes/no)
Product Innovation	During the past 12 months, has your company launched any new or substantially improved products or services? (yes/no)
Process Innovation	During the past 12 months, has your company introduced any new or significantly improved internal processes? (yes/no)
Production Locations	In how many locations does your company operate production plants? (more than 3 locations/ 3 locations/ 2 locations / 1 location)
Geographical Scope of Sales	What is your company's most significant sales market? (regional / country /international market)
Geographical Scope of Procurement	Do you procure primarily from suppliers in your region, country or from an international supplier base? (regional / country /inter-national market)
Telework	Can employees of your company access your computer system remotely from outside the company, for instance from home, from field operation or while travelling? (yes/no)
Sophistication of IT Infrastructure	Do you use an ERP system, that is Enterprise Resource Planning? (yes/no)
	Do you use an SCM system, that is Supply Chain Management? (yes/no)
	Do you use a CRM system, that is Customer Relationship Management? (yes/no)
Electronic Interconnection with Suppliers	Does your company maintain EDI connections with suppliers? (yes/no)
	Is your ERP system connected with that of a supplier? (yes/no)
	Does your company share information on inventory levels or production plans electronically with suppliers? (yes/no)
Electronic Interconnection with Customers	Are you connected with customers through EDI?
	Is your ERP system connected with that of a customer? (yes/no)
	Do you have customers who share

	information on their inventory levels or production plans electronically with you? (yes/no)
Interest in Data Warehousing	Do you consider the topic of data warehouses and data mining to be very relevant, partly relevant, or not relevant for your company? (very relevant/ partly relevant/ not relevant)
Interest in Mobile Services	Do you consider the topic of mobile services such as mobile commerce and remote access technologies to be very relevant, partly relevant, or not relevant for your company? (very relevant/ partly relevant/ not relevant)
Employment of IT Personnel	Does your company currently employ ICT practitioners? (yes/no)
Experience of IT_Outsourcing	In the past 12 months, has your company outsourced any ICT services to external service providers, which were previously conducted in-house? (yes/no)
Size	Number of employees