Firm Characteristics and Propensity for Cloud Computing Adoption

Full paper

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Abstract (Required)

Cloud Computing (CC) is emerging as a new paradigm of providing IT support of firms’ processes and activities, which has a great potential to offer important 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, which concern firm’s strategy, processes, technology, personnel on the propensity to adopt CC. Its theoretical foundation the Leavitt’s Diamond framework. 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 findings provide interesting insights as to the kind of firms for which the CC is perceived as more appropriate and beneficial.

Keywords (Required)

cloud computing, adoption, strategy, process, technology, personnel

Introduction

Cloud computing (CC) has emerged as a disruptive convergence of advancements in the areas of virtualization, distributed computing, data-center automation, multi-tenancy, Web services and services delivery over the Internet, which can radically change the way information technology (IT) services for firms are developed, deployed, scaled, updated, maintained and paid for, and finally lead to ‘a new paradigm’ of organizational 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).

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, 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) (Etro, 2009; Armbrust et al., 2010; Marston et al., 2011; Venters and Whitley, 2012; Berman et al., 2012). 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 the adoption of CC 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.

This paper consists of seven sections. In the next section a relevant literature review is presented, while in the following one the research hypotheses are formulated. Then there is a section describing the data and the method of this study, followed by a section presenting and discussing the results. The final section summarizes the conclusions and suggests future research directions.

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 dimensions) 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, and King, 1993; Lucas and Baroudi, 1994; Lytinen and 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 have 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 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 and Whitley, 2012). Therefore we expect that firms adopting an IT investment reduction strategy will have a strong motivation and propensity to adopt CC. So, our first research hypothesis is:

**H1.** 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 in the rapidly changing modern economy) using the ‘traditional’ in-house practices. 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 and Whitley, 2012; Brynjolfsson et al., 2010). 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:

**H2.** The adoption of an innovation-oriented strategy has a positive effect on the propensity for Cloud Computing adoption.

**H2a.** The adoption of a product or service innovation oriented strategy has a positive effect on the propensity for Cloud Computing adoption.

**H2b.** 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, taxation, 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. CC can be quite valuable 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:

**H3.** Operational complexity has a positive effect on the propensity for Cloud Computing adoption:

**H3a.** Having multiple production locations has a positive effect on the propensity for Cloud Computing adoption

**H3b.** Having an international scope of sales has a positive effect on the propensity for Cloud Computing adoption

**H3c.** Having an international 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; b) to enable their personnel to
work from customers’ premises (this leading to better interaction with the customers), 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), through the Internet. 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, and allow them to use more types of devices for this purpose. Thus, our
fourth hypothesis is:

H4. 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 extension of the existing IT infrastructure using new technologies:
data warehousing/data mining technologies, and 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.

However, we can have arguments in the opposite direction as well: firms having sophisticated IT
infrastructure can gain more from migrating to the cloud, in order to reduce their ICT operations, support
and maintenance costs. Therefore, we have formulated two alternative research hypotheses on this:

H5a. The degree of sophistication of firm’s IT infrastructure has a positive effect on the propensity for
Cloud Computing adoption.

H5b. 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 (e.g. Arvanitis and Loukis (2013)), and CC in particular (e.g. Nuseibeh (2011)), has
concluded that specificity of the corresponding ICT assets (defined as the degree or required
customization of them) reduces the propensity for ICT outsourcing. Therefore, we expect that electronic
interconnection of firm’s ICT infrastructure with the ones of suppliers and customers will increase the
Corresponding ICT 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:

H6a. The degree of electronic interconnection of firm’s IT infrastructure with suppliers and customers has
a positive effect on the propensity for Cloud Computing adoption.

H6b. The degree of electronic interconnection of firm’s IT infrastructure 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
enhancing firm’s IT infrastructure by using 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 (such as mobile commerce and mobile remote access to firm’s IS) (Marston et
al., 2011; Venters and Whitley, 2012; Bhagyashree and Borkar, 2012; Verma, 2013). So, the next two research hypotheses concern these two technologies:

**H7.** Interest in adopting data warehousing and data mining technologies has a positive effect on the propensity for Cloud Computing adoption.

**H8.** 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 in the selection of the most appropriate CC services and providers, the formulation of the contacts, and the monitoring and management of these relations. Thus, our ninth hypothesis is:

**H9.** 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 specialized ‘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:

**H10.** Previous experience of IT outsourcing has a positive effect on the propensity for Cloud Computing adoption.

**Data and Method**

In this study we have used firm level data collected through the “e-Business Survey 2009” survey, conducted by the e-Business Market W@tch (www.ebusiness-watch.org) under the auspices of the European Commission. In this survey were collected 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 (corresponding questions of the above survey) 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). 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 production locations variable (having initially four possible values) was recoded as a three valued variable (1: one location/2: two or three locations/3: more than three locations). The variables of sophistication of IT infrastructure, and the electronic interconnection with suppliers and customers 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)). With respect to the degree of electronic interconnection 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 also calculated the association between the dependent variable and each of the abovementioned independent ones, using 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). This was performed initially for the whole sample. Then it was divided into two sub-samples of similar sizes: the first included the small firms (with 1-49 employees - 53.8% of the sample), while the second included the medium and large firms (with 50 or more employees – 46.2% of the sample); we then repeated the same calculations for each sub-sample, in order to examine to what extent the results are affected by firm size (we did not create separate sub-samples for the medium and for the large firms, because they would be much smaller (especially the large firms’ one) than the small firms’ sub-sample, making comparison difficult (as smaller sample size increases the confidence intervals of the estimated association measures, and therefore affects their significances)). It should be noted that we did not estimate a regression model because there were high levels of correlation 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 calculated Sommer’s D coefficient (second column) and the Kendall tau-b coefficient (third column) values with respect to the independent variable (propensity for CC adoption) for the whole sample. The same are shown in Table 2 for the small firms’ sub-sample, and in Table 3 or the medium and large firms’ sub-sample. Note that statistically significant values are shown in bold.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sommer’s D</th>
<th>Kendall tau-b</th>
<th>Research Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Investment Reduction Strategy</td>
<td>0.162</td>
<td>0.166</td>
<td>H1</td>
</tr>
<tr>
<td>Product/Service Innovation Strategy</td>
<td>0.106</td>
<td>0.113</td>
<td>H2a</td>
</tr>
<tr>
<td>Process Innovation Strategy</td>
<td>0.091</td>
<td>0.099</td>
<td>H2b</td>
</tr>
<tr>
<td>Multiple Production Location</td>
<td>0.033</td>
<td>0.035</td>
<td>H3a</td>
</tr>
<tr>
<td>International Scope of Sales</td>
<td>0.003</td>
<td>0.003</td>
<td>H3b</td>
</tr>
<tr>
<td>International Scope of Procurement</td>
<td>-0.028</td>
<td>-0.029</td>
<td>H3c</td>
</tr>
<tr>
<td>Use of Telework</td>
<td>0.068</td>
<td>0.074</td>
<td>H4</td>
</tr>
<tr>
<td>Sophistication of IT Infrastructure</td>
<td>0.144</td>
<td>0.163</td>
<td>H5</td>
</tr>
<tr>
<td>Electronic Interconnection with Suppliers</td>
<td>0.133</td>
<td>0.139</td>
<td>H6</td>
</tr>
<tr>
<td>Electronic Interconnection with Customers</td>
<td>0.141</td>
<td>0.143</td>
<td>H6</td>
</tr>
<tr>
<td>Interest in Data Warehousing</td>
<td>0.280</td>
<td>0.294</td>
<td>H7</td>
</tr>
<tr>
<td>Interest in Mobile Services</td>
<td>0.185</td>
<td>0.205</td>
<td>H8</td>
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</table>
### Table 1. Sommer’s D and Kendall tau-b values for the whole sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>D</th>
<th>tau-b</th>
<th>Research Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment of IT Personnel</td>
<td>0.158</td>
<td>0.164</td>
<td>H9</td>
</tr>
<tr>
<td>IT Outsourcing</td>
<td>0.123</td>
<td>0.123</td>
<td>H10</td>
</tr>
</tbody>
</table>

### Table 2. Sommer’s D and Kendall tau-b values for the small firms’ sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>D</th>
<th>tau-b</th>
<th>Research Hypothesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Investment Reduction Strategy</td>
<td>0.180</td>
<td>0.186</td>
<td>H1</td>
</tr>
<tr>
<td>Product/Service Innovation Strategy</td>
<td>0.087</td>
<td>0.097</td>
<td>H1</td>
</tr>
<tr>
<td>Process Innovation Strategy</td>
<td>0.134</td>
<td>0.152</td>
<td>H1</td>
</tr>
<tr>
<td>Multiple Production Location</td>
<td>0.015</td>
<td>0.015</td>
<td>H2a</td>
</tr>
<tr>
<td>International Scope of Sales</td>
<td>-0.039</td>
<td>-0.040</td>
<td>H3a</td>
</tr>
<tr>
<td>International Scope of Procurement</td>
<td>0.053</td>
<td>0.056</td>
<td>H3b</td>
</tr>
<tr>
<td>Use of Telework</td>
<td>0.074</td>
<td>0.082</td>
<td>H4</td>
</tr>
<tr>
<td>Sophistication of IT Infrastructure</td>
<td>0.115</td>
<td>0.129</td>
<td>H5</td>
</tr>
<tr>
<td>Electronic Interconnection with Suppliers</td>
<td>0.156</td>
<td>0.165</td>
<td>H6</td>
</tr>
<tr>
<td>Electronic Interconnection with Customers</td>
<td>0.135</td>
<td>0.135</td>
<td>H6</td>
</tr>
<tr>
<td>Interest in Data Warehousing</td>
<td>0.448</td>
<td>0.460</td>
<td>H7</td>
</tr>
<tr>
<td>Interest in Mobile Services</td>
<td>0.309</td>
<td>0.348</td>
<td>H7</td>
</tr>
<tr>
<td>Employment of IT Personnel</td>
<td>0.210</td>
<td>0.217</td>
<td>H9</td>
</tr>
<tr>
<td>IT Outsourcing</td>
<td>0.087</td>
<td>0.088</td>
<td>H10</td>
</tr>
</tbody>
</table>
Employment of IT Personnel | 0.085 | 0.088 | H9
IT Outsourcing | 0.128 | 0.129 | H10

Table 3. Significance of chi square test, Sommer’s D and Kendall tau-b for the medium and large firms

We remark that there are considerable differences between the above two sub-samples with respect to the effects of the examined firm characteristics on the propensity for CC adoption. In particular, we remark that the adoption of IT investment reduction strategy has a statistically significant positive association with the propensity for CC adoption, in the whole sample, and in both sub-samples, 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); therefore hypothesis H2a is supported. The above indicate that firms of all sizes view CC as an effective way of accessing additional ICT resources in order on one hand to support better their processes and activities in times of ICT investment reductions, and on the other hand – but to a lower extent - to support product and service innovation. The adoption of process innovation strategy has a statistically significant positive association with the propensity for CC adoption, in the whole sample, and in the small firms’ sub-sample, but not in the medium and large firms’ sub-sample. Therefore hypothesis H2b is supported only for the small firms. This indicates that small firms view CC as an effective way for providing ICT support of process innovations, but this does not hold for the medium and large firms (probably because their processes are quite complex and specific, and this increases required assets’ specificity, so it is not possible to find appropriate CC offerings).

On the contrary all operational complexity variables do not have statistically significant associations with the propensity for CC adoption, so hypotheses H3a, H3b and H3c are not supported. Only for the medium and large firms there is a statistically significant negative association of international procurement scope with the propensity for CC adoption; this probably indicates that the former – especially for the case of the medium and large firms - generates high complexity requirements, leading to higher assets’ specificity, making it difficult to find appropriate CC offerings. The use of telework has a positive association with the propensity to adopt CC, in the whole sample, and in the small firms’ sub-sample, but not in the medium and large firms’ sub-sample. Therefore hypothesis H4 is supported only for the small firms, which means that these firms view CC as a cost-effective way of supporting telework of their employees (while the medium and large ones already have sufficient internal ICT resources for this).

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, in the whole sample, and in both sub-samples, so hypotheses H5a and H6a are supported. The same happens with the interest in exploiting the new technologies of data warehousing/data mining, so hypothesis H7 is also supported. Therefore firms of all sizes view CC as a cost-effective way of obtaining access to these new data warehousing/data mining technologies. However, the interest in providing mobile services to employees and customers has a statistically significant positive association with the propensity to adopt CC, in the whole sample, and in the small firms’ sub-sample, but not in the medium and large firms’ sub-sample. Therefore hypothesis H8 is supported only for the small firms, which means that these firms view CC as a cost-effective way of introducing mobile services (while the medium and large ones already have sufficient internal ICT resources for this).

Finally, with respect to the personnel related variables (concerning the employment of IT personnel and the existence of previous experience of IT outsourcing) there are also differences between our two subgroups. Both have statistically significant positive associations with the propensity for CC adoption in the whole sample, but the same happens only in the small firms’ sub-sample for the employment of ICT personnel, and on the contrary only in the medium and large firms’ sub-sample for the IT outsourcing. Therefore hypothesis H9 is supported only for the small firms (as nearly all medium and large firms have IT personnel), while hypothesis H10 is supported only for the medium and large firms (as small firms rarely use ICT outsourcing).
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 reveal five firm characteristics that affect positively firm’s propensity for CC adoption for all firms’ sizes (at least in the three examined sectors); two of them concern firm’s strategy: the adoption of IT reduction strategy, the adoption of product/service innovation strategy; the remaining three concern firm’s ICT infrastructure: its sophistication and electronic interconnection (with suppliers and customers), and also firm’s interest to enhance it using data warehousing/data mining technologies. Furthermore our results reveal three more firm characteristics that affect positively the propensity for CC adoption only in the small firms: the adoption of process innovation strategy, the interest in mobile services and the employment of IT personnel; and finally one firm characteristic that affects positively the propensity for CC adoption only in the medium and large firms: previous experience of IT outsourcing.

The findings of this empirical study enable a better understand of the kind of firms in which CC is perceived as more appropriate and beneficial. This is 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). Our study has two main limitations: the use of secondary data (however collected from a highly reliable European Commission initiative), and its limited sectoral and national scope. Further research is required concerning the effects of firm characteristics on CC adoption, in various sectorial 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). Also, this research should be based on the use of multiple items for the reliable measurement of the main dependent and independent variables.

REFERENCES


NIST. 2009. NIST Definition of cloud computing v15, NIST, Editor. 2009, National Institute of Standards and Technology, Gaithersburg, MD.


## APPENDIX – Variables definitions - questions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Cloud</td>
<td>How relevant is cloud computing for your company (very relevant, partly relevant, or not relevant)?</td>
</tr>
<tr>
<td>IT Investment Reduction Strategy</td>
<td>Has the economic crisis lead you to cancel or significantly downsizing any ICT investments/projects in the last 12 months? (yes/no)</td>
</tr>
<tr>
<td>Product Innovation</td>
<td>During the past 12 months, has your company launched any new or substantially improved products or services? (yes/no)</td>
</tr>
<tr>
<td>Process Innovation</td>
<td>During the past 12 months, has your company introduced any new or significantly improved internal processes? (yes/no)</td>
</tr>
<tr>
<td>Production Locations</td>
<td>In how many locations does your company operate production plants? (more than 3 locations/ 3 locations/ 2 locations / 1 location)</td>
</tr>
<tr>
<td>Geographical Scope of Sales</td>
<td>What is your company’s most significant sales market? (regional / country / international market)</td>
</tr>
<tr>
<td>Geographical Scope of Procurement</td>
<td>Do you procure primarily from suppliers in your region, country or from an international supplier base? (regional / country / international market)</td>
</tr>
<tr>
<td>Telework</td>
<td>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)</td>
</tr>
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</table>
| 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
<table>
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<tr>
<th>Firm Characteristics and Propensity for Cloud Computing Adoption</th>
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<tr>
<td>Information on their inventory levels or production plans electronically with you? (yes/no)</td>
</tr>
<tr>
<td>Interest in Data Warehousing</td>
</tr>
<tr>
<td>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)</td>
</tr>
<tr>
<td>Interest in Mobile Services</td>
</tr>
<tr>
<td>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)</td>
</tr>
<tr>
<td>Employment of IT Personnel</td>
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<tr>
<td>Does your company currently employ ICT practitioners? (yes/no)</td>
</tr>
<tr>
<td>Experience of IT-Outsourcing</td>
</tr>
<tr>
<td>In the past 12 months, has your company outsourced any ICT services to external service providers, which were previously conducted in-house? (yes/no)</td>
</tr>
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