Do Strategy, Processes, Personnel and Technology Affect Firm's Propensity to Adopt Cloud Computing? – An Empirical Investigation

Abstract

Purpose – Previous empirical research on Cloud Computing (CC) adoption factors has examined the effects of only a small number of firm's characteristics on CC adoption, and this has resulted in a limited understanding about firm's internal conditions that favor and promote it. So, the research objective of this paper is to investigate empirically the effects of a wide set of firm's characteristics, which concern four important aspects of it, its strategy, processes, personnel, and technology, on the propensity to adopt CC.

Design/Methodology/Approach – Having as theoretical background the Technology, Organization, and Environment (TOE) theory of technological innovation adoption, in combination with Scott-Morton's framework on firm's main elements, which is used for elaborating the organizational perspective of this theory, twelve research hypotheses have been developed based on previous CC and management literature. They were tested using data collected through the e-Business W@tch Survey of the European Commission from 676 European firms from three traditional manufacturing sectors.

Findings – Our results reveal three characteristics of a firm that affect positively its propensity to adopt CC for all firm sizes: the adoption of ICT investment reduction strategy, the adoption of product/service innovation strategy and the sophistication of firm's administration support ICT infrastructure. Furthermore, they reveal five additional characteristics of a firm that affect positively the propensity for CC adoption only in the small firms: the adoption of process innovation strategy, the employment of ICT personnel, as well as the sophistication of firm's production support, e-sales and e-invoicing ICT infrastructures.

Research implications/limitations – First, our study proposes a theoretical foundation for the elaboration of the organizational perspective of the TOE theory of technological innovation adoption, which opens a new stream of CC adoption factors research, investigating the effects of a wide range of firm's characteristics on CC adoption. Second, our study enriches the empirical literature on CC adoption factors, by examining the effects of different kinds of strategies, processes and ICT infrastructures, and also of ICT personnel, which have not been examined in previous relevant empirical literature, on firm's propensity for CC adoption. The main limitation of our study is that it has been based on data from only three European manufacturing sectors, so findings may have been influenced to some extent by this specific sectoral and national context.

Practical implications - Our findings provide new interesting insights concerning specific firm's characteristics and therefore internal conditions that increase its propensity for CC adoption, and reveal specific kinds of strategy, processes and ICT infrastructures for which CC is more appropriate and beneficial; these are also shedding light on the main aspects of CC usefulness - value potential perceived by firms, as well as the envisioned ways/forms of CC exploitation. These insights can be useful to both CC user firms, as well as CC provider firms, for supporting various CC related decisions.

Originality/value – We have developed a theoretical foundation for extending our knowledge concerning the characteristics and internal conditions of firms that favor/promote the adoption of CC, which enables the substantial extension of the existing knowledge base on CC adoption factors, quite useful for both CC user and provider firms. Based on this theoretical foundation we have formulated and tested twelve research hypotheses concerning effects of firm's strategic directions, processes, ICT infrastructures and ICT personnel, which have not been investigated previously, on CC adoption propensity; our findings provide interesting and practically relevant novel insights concerning kinds of strategy, processes and ICT infrastructures that favor/promote CC adoption, as well as the role of ICT personnel.

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

Paper type - Research paper

1. Introduction

Cloud computing (CC) constitutes a substantial paradigm shift in the production, delivery and financing of the Information and Communication Technologies (ICT) services that firms require for supporting their activities and processes: in this new paradigm these ICT services are not produced internally by firm's ICT unit, but externally by various CC services providers, and are delivered from a distance through the Internet; they are not financed through firm's ICT capital investments, but through regular ICT operational expenses (usually monthly payments to CC services providers) (Dwivedi and Mustafee, 2010; Marston et al., 2011; Venters and Whitley, 2012; Yang and Tate, 2012; Willcocks et al., 2013; Müller et al., 2015). CC can provide significant benefits to firms: reduction of the cost of the ICT support of their activities and processes, conversion of ICT related capital investments to operating expenses, ubiquitous access using different kinds of devices, and provision of flexible and cost-effective ICT support of firm's growth and scalability; also, rapid and low cost provision of the ICT support required for process, product and service innovations, as well as to new emerging ICTs, such as business intelligence/analytics, Internet of Things (IoT), big data, etc. (Armbrust et al., 2010; Iyer and Henderson, 2010 and 2012; Marston et al., 2011; Venters and Whitley, 2012; Berman et al., 2012; Willcocks et al., 2013; Demirkan and 2013; Müller et al., 2015). However, at the same time CC can pose to firms some significant risks: service availability risks, and in general performance related risks, data security risks (associated with firm's data integrity and confidentiality) and also economic risks (associated with 'hidden costs' and also 'lock-in' to CC services provider) (Benlian and Hess, 2011; Venters and Whitley, 2012; Ackermann et al., 2012; Fernandes et al., 2014). These risks have resulted in CC adoption by firms lower than the initial expectations (Low and Chen, 2011; Oliveira et al., 2014; Kung et al., 2015; Yigitbasioglu, 2015; Siepermann et al., 2016).

This has motivated considerable empirical research on CC adoption factors (Bayramusta and Nasir, 2016; Senyo et sl., 2018), aiming to identify factors that affect positively or negatively the adoption of CC by firms, which is briefly reviewed in Section 2.1. As mentioned there, most of this empirical research use as main theoretical foundation the Technology, Organization and Environment (TOE) theory of technological innovation adoption (Tornatzky and Fleischer, 1990; Baker, 2011); according to this theory the adoption of technological innovations by firms is influenced by three categories of factors: technological, organizational and environmental ones. However, as explained in more detail in 2.1, in this previous CC adoption factors research the first and the third category of factors have received much more research attention, while limited research has been conducted concerning the second category (organizational factors): the effects of only a small number of firm's characteristics on CC adoption have been investigated. This has resulted in a limited understanding of firm's characteristics and therefore internal conditions that favor and promote CC adoption, which would be quite useful for both CC user firms and CC service provider ones; furthermore, obtaining such an understanding would lead to interesting and practically useful insights concerning the main aspects of CC usefulness and value potential perceived by firms, as well as the particular ways and forms of CC utilization they envision. The above research gap is highly important, since firm's characteristics are expected to shape to a significant extent both the benefits that CC can generate, and also the risks it can pose, and therefore to have a significant impact on firm's propensity to adopt CC. For the above reasons it is necessary the existing knowledge base about CC adoption factors to be enhanced and complemented with new knowledge on firm's characteristics and internal conditions that affect CC adoption positively or negatively. However, there is a lack of theoretical foundations for conducting research in this direction (in order to provide guidance for the selection of specific firm's characteristics/internal conditions to be used as independent

variables in CC adoption studies). The TOE theory, on which, as mentioned above, most of the previous empirical research on CC adoption factors has been based, is rather generic (Zhu and Kraemer, 2005; Baker, 2011; Gangwar et al., 2014), so it is necessary to elaborate its three perspectives (technological, organizational and environmental), in order to provide guidance and assistance for the selection of specific variables for each perspective to be used as independent variables in CC adoption studies. For this purpose, some 'second level' theoretical foundations have been used (Baker, 2011; also see section 2.1 for the case of CC adoption factors' research). In particular, as explained in 2.1, for elaborating the technological perspective of the TOE theory many empirical CC adoption studies have used the Diffusion of Innovation (DOI) theory (Rogers, 2003); also, for elaborating the environmental perspective of the TOE theory several empirical CC adoption studies have used the institutional theory (DiMaggio and Powell, 1983 and 1991). On the contrary, such an elaboration has not been attempted for the organizational perspective of the TOE theory, and this results in a lack of theoretical foundations for guiding the extensive required (for the reasons mentioned above) research concerning the selection firm's characteristics that affect CC adoption: for providing guidance and assistance for the selection of specific firm characteristics to be used as independent variables in CC adoption studies.

This paper makes a twofold contribution towards filling the above research gaps:

i) It proposes a theoretical foundation for this missing elaboration of the organizational perspective of the TOE theory, which can be of wide usefulness for the abovementioned required future research.

ii) Based on this theoretical foundation, twelve research hypotheses have been developed, about the effects of a wide set of firm's characteristics, which concern four important aspects of it, its strategy, processes, personnel, and technology, on its propensity to adopt CC. These research hypotheses have been tested using a dataset collected through the e-Business W@tch Survey of the European Commission from 676 European firms from the glass, ceramic and cement manufacturing sectors of six European countries (Germany, France, UK, Italy, Spain and Poland). Our study has been conducted in a sectoral context different from the ones of most previous empirical studies on the adoption of various ICT, which have been conducted mainly in unrepresentative highly innovative and technologically advanced manufacturing or service sectors; the sectoral context of our study is more representative: it focuses on the above three 'traditional' manufacturing sectors, which are rather conservative in terms of adoption of new ICT and innovative business practices in general (Empirica GmbH, 2009).

In particular, the research objective of this study is to investigate the effects of different kinds of firm's strategies and processes, as well as the effects of the degree of development and sophistication of different kinds of firm's ICT infrastructures (supporting different firm's functions), on CC adoption propensity. This enables the identification of specific kinds of strategies, processes and ICT infrastructures that favor and promote the adoption of CC, for which CC is perceived as more appropriate and beneficial, and can be effectively and efficiently supported by CC. Furthermore, the above will allow deeper insights concerning the main aspects of CC usefulness and business value potential perceived by firms, as well as specific ways and forms of CC utilization they envision (i.e. specific kinds of strategies, processes, ICT infrastructures/functions that can be supported through CC). Also, our study aims to investigate the effects of the ICT personnel on firm's propensity to adopt CC, which will enable a better understanding of the role of ICT human resources in CC adoption. Our study will create valuable knowledge on the types of firms (e.g. with respect to strategy, processes, personnel and technology) in which CC is perceived as more advantageous, and the ones in which CC is perceived as less suitable. The results of our study will be useful for CC service provider firms in order to: a) optimize and fine tune their services for the kinds of strategies, processes and ICT infrastructures/functions for which CC is perceived by firms as more appropriate and beneficial, formulate accordingly their marketing messages (emphasizing these specific aspects of CC usefulness and business value), and focus their marketing efforts on firms' segments (with respect to strategy, processes and ICT infrastructures) that are more likely to adopt CC; b) develop new CC services in order to support additional kinds of strategies, processes and ICT infrastructures/functions, for which CC is currently perceived by firms as less

appropriate and beneficial, enabling expansion to firms' segments currently exhibiting low propensity to adopt CC. Furthermore, the above findings can be quite useful also to CC user (or potential user) firms, in order to support their decisions concerning the adoption of CC, as well as the ways of using it (for supporting kinds of strategies, processes and ICT infrastructures/functions, for which CC is perceived by other firms as more appropriate and beneficial).

Our paper is structured in six sections. In the following Section 2 relevant literature is reviewed, while in Section 3 the research hypotheses are developed. Then in Section 4 the data and the method of this study are described, followed by Section 5 presenting and discussing the results. The final Section 6 summarizes the conclusions and suggests future research directions.

2. Literature Review

2.1 Cloud Computing Adoption Factors Research

As mentioned in the Introduction, considerable empirical research has been conducted on CC adoption factors (Bayramusta and Nasir, 2016; Senyo et sl., 2018). A review of this previous empirical literature on factors affecting CC adoption has been conducted using the 'Systematic Literature Review' (SLR) methodology proposed by Okoli (2015), which offers the advantage of being focused on the information systems (IS) domain. Initially a search for relevant papers was conducted in Google Scholar, Elsevier, Springer, Emerald, as well as in the Association of Information Systems (AIS) journals and conferences, using as key words 'cloud' or 'SaaS' or 'IaaS' or 'PaaS' in combination with 'adoption' and 'factors' or 'determinants'; then we proceeded to the relevant references of the papers we initially found, etc. The whole set of papers we finally found on CC adoption factors was carefully read and analyzed, and then the main streams of this research were identified. In particular, in CC adoption factors' research we can distinguish three main streams, which differ in their theoretical foundation as well as the scope of the examined factors. The first stream of CC adoption factors' research has been based on the Technology Acceptance Model (TAM) and its extensions (Davis, 1986; King and He, 2006; Turner et al., 2010), making various adaptations of it to the particular characteristics of CC (Wu, 2011; Opitz et al., 2012; Gupta et al., 2013). The second stream examines the effects of factors concerning firm's external environment on CC adoption (Saya et al., 2010; Kung et al., 2015; Yigitbasioglu, 2015; Maqueira-Marín et al., 2017), based mainly on the institutional theory (DiMaggio and Powell, 1983 and 1991). These two streams of CC adoption factors' research have a rather narrow scope, and do not examine the effects of firm's characteristics on CC adoption. On the contrary, the third stream, which is the most extensive, has a broader scope, is based on the TOE theory of technological innovation adoption (Tornatzky and Fleischer, 1990; Baker, 2011), and examines the effects of a wider range of technological, organizational and environmental factors on CC adoption. Since the research objective of our study is to investigate the effects of firm's characteristics on CC adoption, this third stream is the most relevant to our study (as it includes the examination of the effects of organizational factors), so in the following paragraphs we review in more detail the main studies of this stream.

A central feature of this research stream is that because the TOE theory is rather generic (Zhu and Kraemer, 2005; Baker, 2011; Gangwar et al., 2014), a significant part of the studies based on TOE, in order to elaborate the technological perspective of it, and define the specific technological factors to be examined as independent variables, use the DOI theory (Rogers, 2003). In particular, they make use of the five characteristics of an innovation that according to this theory determine the degree of its adoption: relative advantage, compatibility, complexity, trialability and observability. Also, some studies of this stream, in order to elaborate the environmental perspective of the TOE theory, and define the specific environmental factors to be examined as independent variables, use the institutional theory (DiMaggio and Powell, 1983 and 1991); they use the three main types of pressures from the external institutional

environment that according to this theory shape the decisions and practices of organizations. However, such an elaboration has not been attempted for the organizational perspective of the TOE theory.

Low et al. (2011) examine the effects of a set of technological factors (CC relative advantage, complexity and compatibility), organizational factors (top management support, firm size and technological readiness) and environmental factors (competitive pressure and trading partner pressure) on CC adoption. They conclude that perceived CC relative advantage, top management support, firm size, competitive pressure and trading partner pressure have positive statistically significant effects on CC adoption. Also, Mangula et al. (2014) investigate the effects of a similar set of technological factors (relative advantage, compatibility, complexity, trialability, observability), organizational factors (organizational readiness, top management support) and environmental context (market pressure, market competition, vendor marketing, trust in vendor, government support) on the adoption of Software as a Service (SaaS) services. They conclude that compatibility, observability, market competition and government support have statistically significant positive effects, and complexity has a negative one, with SaaS adoption. Oliveira et al. (2014) examine the effects of three CC technological characteristics (relative advantage, complexity, and compatibility), three organizational context characteristics (top management support, firm size, and technological readiness) and two environmental context characteristics (competitive pressure, regulatory support) on CC adoption. They conclude that relative advantage, technological readiness, top management support and firm size have statistically significant positive effects on CC adoption, while complexity has a negative effect. Hsu et al. (2014) focus on a more narrow set of four factors, examining the effects of CC perceived benefits and also business concerns about CC (technological factors), ICT capability (it includes ICT personnel and ICT budget - organizational factor) and external pressure (environmental factor) on CC adoption intention; they find that CC perceived benefits and ICT capability have statistically significant positive impact on CC adoption, while the business concerns about various aspects of CC have statistically significant negative impact on CC adoption, and the external pressure does not affect it. Gutierrez et al. (2015) investigate the effects of a similar set of technological factors (relative advantage, complexity, and compatibility), organizational factors (top management support, firm size, and technological readiness) and environmental factors (competitive pressure, trading partners pressure) on CC adoption; they conclude that competitive pressure, complexity, technological readiness, and trading partner pressure have a significant positive influence on the adoption of CC services. Gangwar et al. (2015), combine the TOE theory with the TAM, and find that CC relative advantage, compatibility and complexity, as well as organizational readiness, top management commitment and training/education on CC, affect CC adoption intention, through the perceived ease of use and the perceived usefulness, acting as mediating variables; furthermore, competitive pressure and CC services providers' support were found directly affecting CC adoption intentions. An interesting study conducted by Martins et al. (2016) combines the use of the DOI theory for the elaboration of the technological perspective of the TOE theory, with the use of the institutional theory for the elaboration of its environmental perspective. It investigates the effects of three technological factors (CC relative advantage, compatibility and complexity), two organizational factors (technology competence and top management support) and three environmental factors (coercive, normative, and mimetic pressures) on SaaS diffusion in firms. They conclude that relative advantage, complexity, technology competence, top management support, and normative pressures influence the intention to adopt SaaS; also relative advantage, technology competence, top management support, coercive pressures, and normative pressures influence the adoption of SaaS; finally, top management support and normative pressures influence the routinization of SaaS in the firm. Hsu and Lin (2016) investigate the effects of six technological factors (CC relative advantage, ease of use, compatibility, trialability, observability, and security), four organizational factors (firm size, scope, satisfaction with existing IS, and cost reduction potential of CC) and two environmental factors (competition intensity and regulatory environment) on CC adoption intensity. They conclude that relative advantage, observability, security, cost reduction potential, satisfaction with existing IS and competition intensity affect firms' intention to adopt CC. Senyo et al. (2016), in a quite different national context from the abovementioned

studies (Ghana), examine the effects of three technological factors (CC relative advantage, security concern, compatibility), four organizational factors (firm size, firm scope, top management support, technological readiness) and three environmental factors (competitive pressure, trading partners' pressure, regulatory support) on CC adoption. Their findings indicate that relative advantage, security concern, top management support, technology readiness, competitive pressure and trading partners' pressure affect CC adoption. Recently, Kumar et al. (2017) use the TOE theory in combination with the TAM and as theoretical foundations, and examine the effects of the two main TAM factors (CC perceived usefulness and ease of use), as well as three technological factors (relative advantage, compatibility, security concerns), three organizational factors (firm size, top management support, technological readiness) and two environmental factors (external pressure, service providers' support) on CC adoption intention by Indian SMEs. Their analysis reveals that relative advantage, security concerns, top management support, external pressure and service providers' support are the factors that influence intention to adopt CC. Another recent study by Alkhater et al. (2018) investigate the effects of a wide set of technological factors (CC quality of services, security concerns, privacy concerns, trust, relative advantage, compatibility, trialability), organizational factors (top management support, technology readiness) and environmental factors (compliance with firms' regulations, data physical location, external support, industry and culture) on firms' intention to adopt CC. They found that the CC quality of service and the trust to CC have positive impact, while security and privacy concerns have negative impact.

From the review of previous empirical research on CC adoption factors it has been concluded that most of it uses the TOE theory as 'first-level' theoretical foundation. However, the technological and environmental perspectives of it have received much more research attention, and the organizational one much less; the impact of a wide range of technological and environmental factors on CC adoption have been empirically investigated, but only a small number of organizational factors (mainly size, top management support, and general technological/organizational readiness). This results in a limited understanding of firm's characteristics/internal conditions that favor and promote the adoption of CC, which would be quite useful for both CC user and service provider firms, allowing interesting and practically useful insights concerning the main aspects of CC usefulness and value potential perceived by firms, as well as the particular ways and forms of CC utilization they envision. Also, as mentioned above, in many studies of CC adoption factors the technological and the environmental perspectives of the TOE theory have been elaborated, using as 'second-level' theoretical foundations the DOI theory and the institutional theory respectively, in order to provide guidance for the selection of specific technological and environmental factors to be used as independent variables. However, this has not happened for the organizational perspective of the TOE theory, which has not been elaborated using some theoretical foundation, in order to provide guidance for the selection of specific organizational factors to be used as independent variables in CC adoption factors' studies. Our study contributes to filling both these abovementioned important research gaps: a) it proposes a theoretical foundation for the elaboration of the organizational perspective of the TOE theory; b) based on this theoretical foundation it formulates and tests twelve research hypotheses concerning effects of firm's strategic directions, processes, ICT infrastructures and ICT personnel, which have not been investigated previously, on CC adoption propensity.

2.2 Conceptualizations of Firm's Elements

In order to identify an appropriate theoretical foundation for the abovementioned elaboration of the organizational perspective of the TOE theory, which can provide substantial guidance for the selection of organizational factors to be used as independent variables in CC adoption studies, we reviewed existing conceptualizations of the main elements of a firm. The most important and representative of them are outlined in this section. The Leavitt's Diamond framework (Leavitt, 1964) definitely constitutes the most 'classical' and widely recognized and used one. It views firms as consisting of four elements: i) task (= firm's goals/strategies and work processes for achieving them); ii) people (= skills of firm's human

resources); iii) technology (= technologies used for performing the above work processes), and iv) structure (= firm's organization in departments and relationships, communication patterns and coordination among them). An extension of it has been developed as part of the 'Management in the 1990s' program of the MIT, which analyses the above 'task' element into 'strategy' and 'processes' (Scott-Morton, 1991). Porter (1985) proposed the 'value chain' model, which constitutes a conceptualization of firm's main elements from an activities' perspective, and defines five primary activities (inbound logistics, operations, outbound logistics, marketing and sales, service) as well as four support ones (firm infrastructure, human resources management, technology development, procurement). Mintzberg (1998) proposed another conceptualization of firm's main elements from a structural perspective, and defines the following five main structural elements of a firm: a) operating core (carrying out the basic work of the firm: processing the inputs and producing the output); b) support staff (supporting the functioning of the operating core); c) middle line (supervising directly and coordinating the operating core); d) technostructure (providing support for firm's adaptation to its environment, as well as for the standardization of the work processes of the operating core and their outputs); and e) strategic apex (top management responsible for determining the strategic directions of the firm). Galbraith (2002) proposed the 'Star Model', which is a conceptualization of the main elements of a firm, aiming mainly to be used for the internal design of firms; it includes five main elements: strategy, processes, people, structure, and rewards. It should be noted that all these conceptualizations emphasize also the interconnection among the main elements they propose, and suggest that change in one of them necessitates also appropriate changes/adaptations of the others.

From the above conceptualizations, we finally selected the one of Scott-Morton (1991), in order to be used for the elaboration of the organizational perspective of the TOE theory, for the following reasons:
I) It is more comprehensive and broad, and includes a wide range of firm's elements (in contrast with others having a narrower perspective, such as the conceptualization proposed by Mintzberg (1998), which focus on firm's main elements from a structural perspective, and the conceptualization proposed by Porter (1985), focusing on firm's main elements from an activities perspective);
II) It is a more detailed variant of Leavitt's Diamond framework (Leavitt, 1964), and also is more appropriate for our study than the 'Star Model' proposed by Galbraith (2002), as it includes additionally the 'technology' element, which is quite relevant for CC adoption research;
III) There has been extensive usage of Scott-Morton (1991) framework, or its simpler variant Leavitt's Diamond framework, in previous IS research (e.g. Danziger et al., 1993; Lucas and Baroudi, 1994; Wigand, 2007; Lyytinen and Newman, 2008; Borman, 2010; Blumberg et al., 2014).

3. Research Hypotheses

The Scott-Morton (1991) framework has been used in our study as theoretical foundation for the elaboration of the organizational perspective of the TOE theory, in order to provide guidance for the selection of firm's characteristics to be used as independent variables. In particular, for each of the five main elements of a firm proposed by the above framework (strategy, processes, personnel, technology, and structure), we reviewed previous CC and management literature in order to identify particular characteristics of a firm that might have an impact on CC adoption propensity, and based on them we developed our research model, which is shown in Fig.1, and our research hypotheses. We managed to identify such characteristics only for the first four elements (strategy, processes, personnel, and technology), but not for the fifth one (structure); for each of these characteristics, we developed a relevant research hypothesis concerning its effect on CC adoption propensity.

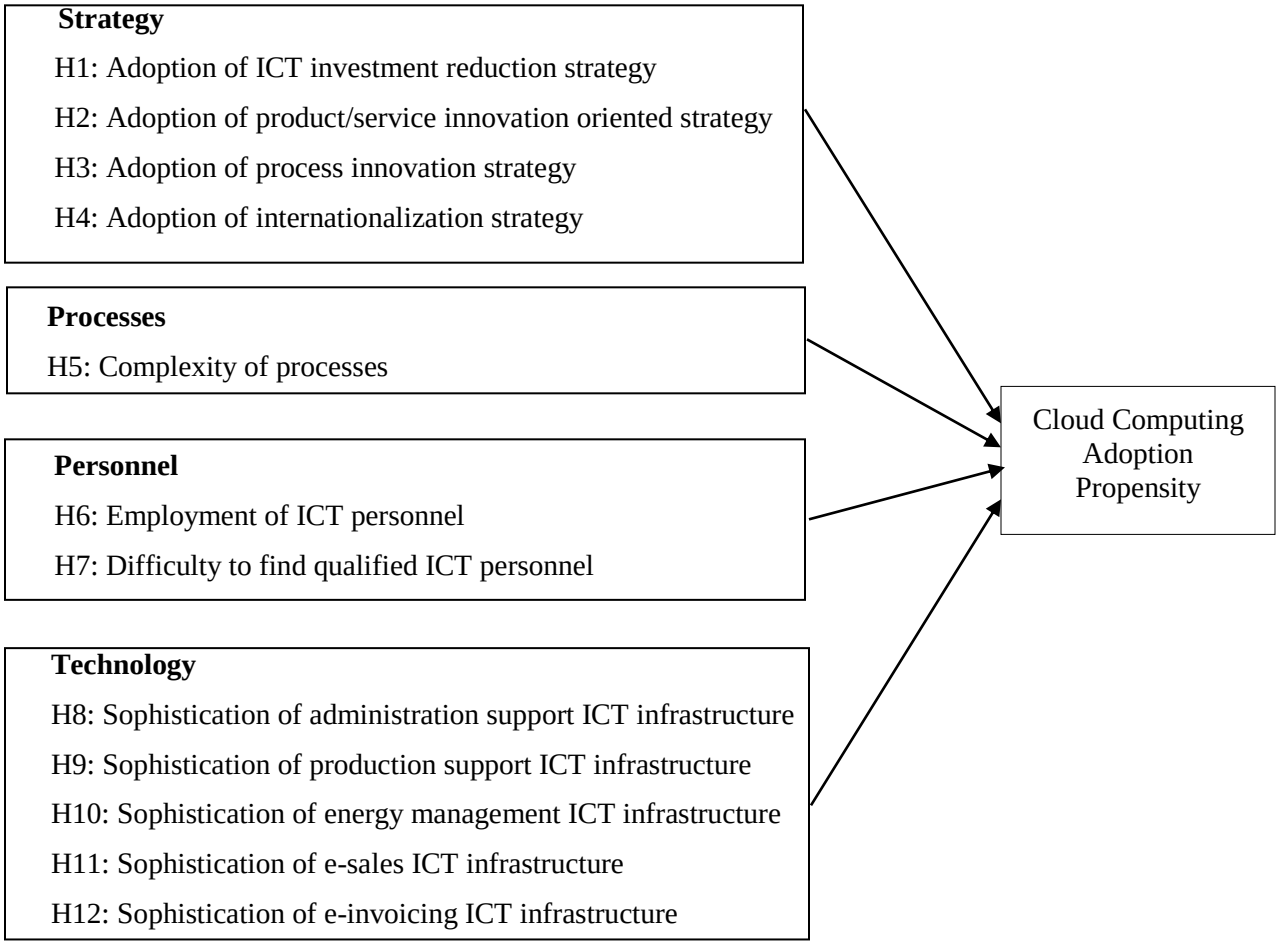

Figure 1. Research Model

3.1 Strategy

The main benefit from CC adoption that is mentioned in the relevant literature (Marston et al., 2011; Venters and Whitley, 2012; Müller et al., 2015) is the reduction of the need for ICT investments. Firms often adopt strategies of investment reduction, which include reductions in ICT investment, for various internal reasons (e.g. decrease of profits that can finance investment, difficulty of borrowing from banks), as well as external reasons (e.g. economic recession or stagnation). As a result of this they cannot make necessary upgrades of their ICT infrastructure (e.g. increase the power and capacity of critical hardware components of it, enhance its functionality, etc.), which are required in order to meet new business needs; also they cannot take advantage of the numerous new emerging ICT (e.g. mobile technologies, business analytics, big data, Internet of Things, etc.) that might be highly beneficial for them. These can impact negatively firms' competitiveness and performance. The use of CC can be quite useful for these firms, as it enables them to upgrade their ICT infrastructures (e.g. increase the power and capacity of critical hardware components of it by using Infrastructure as a Service (IaaS)), enhance its functionality by using Software as a Service (SaaS)), in order to meet new business needs, and also to exploit new emerging ICT (by using appropriate SaaS services), without having to make additional ICT investments. Therefore, we expect that firms adopting ICT investment reduction strategy will have a strong motivation and propensity to adopt CC. So, our first research hypothesis is:

H1. The adoption of ICT investment reduction strategy has a positive effect on the propensity for CC adoption.

Previous CC literature has emphasized that CC can provide benefits associated not only with the reduction of ICT investments and costs, but also with the ICT support of innovations in firms' products, services, and processes: it enables providing the required ICT support for these innovations rapidly, at low cost, and without requiring additional ICT investments (Brynjolfsson et al., 2010; Marston et al., 2011; Venders and Whitley, 2012; Willcocks et al., 2013; Müller et al., 2015). CC can be particularly useful for supporting and facilitating innovations based on new emerging ICTs, such as business intelligence/analytics, Internet of Things (IoT), big data, advanced collaboration support environments, etc., enabling rapid, low cost and less risky experimentation with them (Demirkan and Delen, 2013; Al-Aqrabi et al., 2015; Hashem et al., 2015; Liu et al., 2015; Tan and Kim, 2015). In the modern economy innovation is increasingly relying on ICT (Kleis et al., 2012; Arvanitis et al., 2012).

Firms adopting a product/service innovation oriented strategy usually require extensive ICT support, initially for the R&D needed for the design of these innovations (e.g. IS supporting the required collaboration as well as knowledge and document sharing among employees from different functional departments and geographic locations, as well as the advanced processing of relevant data), then for their implementation and finally for the market launch of the new products/services. This ICT support can be costly, require significant ICT investments, and also its development can take some time, which will increase the 'time-to-market' of the new products/services, with negative consequences for their commercial success (especially if in the fast moving modern economy competitors manage to introduce earlier similar product/service innovations). So, we expect that firms adopting a product/service innovation oriented strategy will have a strong motivation and propensity to use CC services, in order to obtain this required ICT support for their product/service innovations rapidly, at low cost and without making ICT investments. We expect this propensity to be even stronger for firms already using ICT applications in order to support the design, or/and implementation or/and market launch of product/service innovations, because: a) they already have some familiarization and experience concerning the use of ICT for the above purposes, so they can be more effective in searching for, selecting and then using relevant CC services; b) they have a good motivation to use CC in order to reduce the operation, support and maintenance costs of the above ICT applications, and also gain access to more and better relevant functionalities. Thus, our second research hypothesis is:

H2. The adoption of product/service innovation oriented strategy has a positive effect on the propensity for Cloud Computing adoption.

Similar hold for the process innovation oriented strategies, which are increasingly adopted by firms in order to increase their internal efficiency. Firms adopting a process innovation oriented strategy usually require ICT support for the design of process innovations, as well as for the implementation of the new processes, which can be costly and require significant ICT investments; also its development can take some time, and this can lead to significant delays in the migration to the new processes, and therefore in the realization of the targeted efficiency improvements. So, we expect that firms adopting a process innovation oriented strategy will have a strong motivation and propensity to adopt CC, in order to obtain the required ICT support of their process innovations rapidly, at a low cost and without making ICT investments. We expect this propensity to be even stronger for firms already using ICT applications in order to support the design or/and implementation of process innovations for the same reasons a) and b) mentioned above. Thus, our third research hypothesis is:

H3. The adoption of process innovation oriented strategy has a positive effect on the propensity for Cloud Computing adoption.

According to the 'information processing view' of the firm, higher complexity of firm's internal processes (due to complexity of its products, services and production methods), as well as supply chain processes, increase information processing requirements (for managing this complexity), and this necessitates the development of higher information processing capabilities, which includes more ICT support (Melville and Ramirez, 2008). Therefore, we expect that the adoption of internationalization

strategy (research hypothesis 4), and also the complexity of processes due to having a wide geographic scope of production, sales and procurement activities (research hypothesis 5), will increase the complexity of both the internal and supply chain processes, and therefore firm's information processing requirements; this is going to increase the needs for ICT support, and the propensity to adopt CC.

Management science research has identified the increasing internationalization of firms as one of the most important trends of the modern economy (Singla and George, 2013; Cavusgil and Knight, 2015; Johnson et al., 2017; Calabrese and Manello, 2018): numerous firms of all sizes expand their sales, procurement and also production activities beyond the borders of their home country, to other countries, in order to achieve economies of scale, and also take advantage of low cost or high quality production factors (such as raw materials, labor, energy, etc.) available in these countries. However, the internationalization is a highly 'information intensive' strategy, as it requires extensive information storage and processing (e.g. in order to manage the different legislations, regulations, taxations, administrative obligations, etc. of these countries, to prepare complex export and import documents, to monitor and coordinate a wider range of activities in several countries, as well as complex international shipments). Furthermore, it is often necessary to make adaptations of the products/services sold in firm's domestic market, in order to fulfill the specific needs and preferences of these other countries: this necessitates initially the design of many country-specific variants of these products/services, and then sophisticated planning and monitoring of their production. All the above require extensive and highly sophisticated ICT support, which can be costly and require significant ICT investments. Also, the adoption of internationalization strategy increases the exposure of the firm to competition in several countries, and this creates pressures for efficiency improvements, which usually require more ICT support. The use of CC enables providing all the above-mentioned extensive ICT support that the internationalization strategy inherently requires, rapidly, at low cost and without making ICT investments. Also, as CC services are accessible from everywhere, they can be used by firm's units in all the countries in which it has a presence, providing direct support of their activities, as well as co-ordination with headquarters. For all the above reasons we expect that firms adopting internationalization strategy will c. So, our fourth research hypothesis is:

H4. The adoption of internationalization strategy has a positive effect on the propensity for Cloud Computing adoption.

3.2 Processes

High complexity of firm's processes also increases the requirements for information storage and processing, and therefore for ICT support, so it is expected to increase firm's propensity for CC adoption for obtaining this ICT support. The complexity of processes' increases if the firm has multiple production locations, which necessitates more complex production planning, rational allocation of the production to these locations, central monitoring and co-ordination of them, and also organization of complex materials' and products' shipments to/from/between them. Furthermore, the complexity of processes increases also if the firm has a broad geographic scope of sales and procurement activities. A firm can have various levels of geographical scope of these activities: within a single region, in several regions, in the whole country, or in several countries; as the level of activities' geographical scope increases, more complex processes are required (e.g. for monitoring and coordinating sales and procurement activities, as well as shipments, and also a bigger network of trade partners and resellers, in a wider geographic area). Higher complexity of processes increases the amount of information that has to be stored about them and processed, and this necessitates more extensive and sophisticated ICT support. The use of CC can be quite valuable for providing this ICT support rapidly, at a low cost and without having to make relevant ICT investments. So, we expect that firms having more complex processes will have a higher motivation and propensity to adopt CC. However, there are arguments in the opposite direction as well. Highly complex processes might be to some extent specific to the firm, and constitute important 'core activities' of it,

which are sources of competitive advantages; therefore, according to the Transaction Cost Economics theory (Williamson, 1985 and 1989), firms will have tendency not to outsourcing such activities or their ICT support infrastructure, and keep them in-house, and have full control of them. An empirical analysis conducted by Wu et al. (2013) found a negative impact of processes complexity on CC adoption intention, which was against their relevant research hypotheses. For the above reasons, we have formulated two alternative research hypotheses on this:

H5a. Complexity of firm's processes has a positive effect on its propensity for Cloud Computing adoption.

H5b. Complexity of firm's processes has a negative effect on its propensity for Cloud Computing adoption.

3.3 Personnel

Previous research on CC adoption factors has investigated empirically the effect of firm's 'technological readiness', which is a composite concept including firm's ICT infrastructure and ICT personnel, on CC adoption, with mixed results: as mentioned in 2.1 some studies found a positive statistically significant effect (the ones of Oliveira et al. (2014), Hsu et al. (2014), Gutierrez et al. (2015) and Senyo et al. (2016)), while some other studies found that this effect is not statistically significant (the ones of Low et al. (2011), Kumar et al. (2017) and Alkhater et al. (2018)). We believe that this 'technological readiness' concept merges two quite different characteristics of a firm, its ICT infrastructure (without discriminating between the different kinds of ICT infrastructures that modern firms have) and its ICT personnel, which should be examined separately as to their effects on CC adoption. In this direction our study investigates separately the effect of ICT personnel on CC adoption propensity (research hypothesis 6), as well as the effects of five different salient kinds of firm's ICT infrastructures, on CC adoption propensity (research hypotheses 8 to 12).

The human capital of firms has been widely recognized as being of critical importance for innovation, since it is the main determinant of firms' knowledge 'absorptive capacity', which enables them to identify and absorb useful knowledge from their external environment, assimilate it, combine it with their pre-existing internal knowledge, and exploit it for innovation (Vandenbussche et al., 2006; Vinding, 2006; Lopez-Garcia and Montero, 2012). The adoption of CC by a firm is an important innovation in the way it accesses and uses ICT for supporting its activities; it necessitates acquisition and assimilation of extensive external knowledge about the numerous existing CC services in the market, and then combination of it with firm's internal knowledge about its activities and processes, leading finally to the selection and exploitation of the most appropriate CC services for the firm. Therefore, of critical importance for this innovation (i.e. CC adoption) is firm's 'relevant' human capital: the ICT personnel. Previous literature has revealed the importance of the specialized ICT personnel for ICT-based innovation in general (Arvanitis et al., 2013), and for CC services adoption and use in particular (Ross, 2011). Firm's ICT personnel has an important role to play with respect to the adoption and effective utilization of CC, which includes the following critical tasks: a) examine on one hand the existing CC services and providers in the market, the detailed services they offer, their prices and terms, their advantages and disadvantages; and b) on the other hand the activities, processes and the resulting specific needs of the firm; c) then select the most appropriate CC providers and services in order to satisfy these specific needs; d) formulate and negotiate the contracts with the selected providers; e) monitor and manage these relationships; f) integrate CC services with 'on-premises' ICT infrastructure. Therefore, we expect that firms possessing 'relevant' human capital, i.e. employing ICT personnel, will have a higher propensity to adopt CC. Thus, our sixth research hypothesis is:

H6. The employment of ICT personnel has a positive effect on the propensity for Cloud Computing adoption.

However, sometimes it is not easy to find sufficiently qualified ICT personnel by firms, especially for new emerging ICT (e.g. mobile technologies, business analytics, big data, Internet of Things, etc.). There has been extensive debate among academics as well as government policy makers about the existing shortages of ICT skills and competences, which constitute a major barrier to the digital transformation and competitiveness of firms (Cepis, 2014; Hüsing et al., 2015; Cedefop, 2016). CC seems to be a good way to address this problem. According to previous CC literature, one of the most important benefits that CC provides is access to high-level ICT skills (Armbrust et al., 2010; Marston et al., 2011; Venters and Whitley, 2012; Yang and Tate, 2012). Therefore, we expect that firms having difficulty to find qualified ICT personnel will have a strong motivation and propensity to adopt CC, so our seventh research hypothesis is:

H7. Having difficulty to find qualified ICT personnel has a positive effect on the propensity for Cloud Computing adoption.

3.4 Technology

Our final five research hypotheses concern the effects of the degree of sophistication of five important kinds of firm's ICT infrastructures on CC adoption propensity. The main kind of ICT infrastructure firms usually develop aims to support their administrative functions, such as sales, procurement, warehouse management, production planning, financial management, human resources management, etc.; in its more mature form it includes an enterprise resource planning (ERP) system, a customer relationship management (CRM) system and a supply chain management (SCM) system (Laudon and Laudon, 2014). Another important kind of ICT infrastructure that manufacturing firms often develop aims to support their production execution functions: the design of products (computer-aided design – CAD) as their production/manufacturing (computer-aided manufacturing – CAM) (Laudon and Laudon, 2014; Xu, 2012). Furthermore, as the three manufacturing sectors investigated in this study (glass, ceramic and cement) are 'energy intensive', they are consuming large quantities of energy, and this is one of their major costs; for this reason, firms of these sectors are often using ICT-enabled energy management systems to systematically monitor and analyze their energy consumption (Empirica GmbH, 2009). Another class of ICT infrastructures that firms develop is oriented towards the support of their transactions with their external environment; the main kinds of ICT infrastructures of this class are the e-sales and the e-invoicing ones (Laudon and Laudon, 2014). For each of these five kinds of ICT infrastructures, higher degree of sophistication leads to higher operations, support and maintenance costs, which increase the motivation to migrate some parts of it to the cloud, in order to reduce these costs: for instance, IaaS services can be used for hosting some of its applications, and also SaaS services for replacing some older and/or bespoke applications with more modern standard software packages (Hugos and Hulitzky, 2010). Also, higher degree of sophistication results in higher familiarization and experience concerning the use of ICT for supporting the specific firm's function, and therefore higher ability and effectiveness in searching for relevant CC services, selecting the most appropriate ones, and then exploiting them productively, which increase the propensity to use CC. So, our final five research hypotheses are:

H8. The degree of sophistication of firm's administration support ICT infrastructure has a positive effect on the propensity for Cloud Computing adoption.

H9. The degree of sophistication of firm's production support ICT infrastructure has a positive effect on the propensity for Cloud Computing adoption.

H10. The degree of sophistication of firm's energy management ICT infrastructure has a positive effect on the propensity for Cloud Computing adoption.

H11. The degree of sophistication of firm's e-sales ICT infrastructure has a positive effect on the propensity for Cloud Computing adoption.

H12. The degree of sophistication of firm's e-invoicing ICT infrastructure has a positive effect on the propensity for Cloud Computing adoption.

4. Data and Method

In this study we have adopted a quantitative approach based on a survey, as it enables collecting data from a large number of firms, and drawing from them conclusions of higher generality (Ragin and Amoroso, 2018). In particular, we have used data collected through the "e-Business Survey" conducted by the e-Business Market W@tch, an international observatory organization of the European Commission. In this survey firm level data were collected concerning the use of various types of ICT, the ICT skills, the ICT investment, and also the innovation activity, as well as firm background information, from 676 firms of the European Glass, Ceramic and Cement manufacturing sectors, of six European countries: Germany, France, Italy, Poland, Spain, and UK. For this purpose, a questionnaire was prepared and then tested (with respect to structure, comprehensibility of questions, average interview length) through pilot interviews, conducted by the main contractor of this survey, with 15 firms, which led to some small modifications and improvements. Using this new version of the questionnaire, data were collected through interviews, which were conducted using computer-assisted telephone interview (CATI) techniques, with the main ICT decision makers of the firms, who were usually either heads of ICT department, or had higher management positions, so they had a complete and deep knowledge about the use of various ICT in the firm. The composition of the sample of our study by size, sector, and country is shown in Table 1.

Table 1. Composition of the sample of the study by size, sector and country

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

Our dependent variable is the propensity for CC adoption, which has three possible values (the firm perceiving the CC as very relevant, partly relevant, or not relevant). With respect to the independent variables we have three binary (yes/no) strategy related ones: adoption of ICT investment reduction strategy, adoption of product/services innovation strategy, and adoption of process innovation strategy. Furthermore, we also have four independent variables concerning ICT-based innovation strategies. The first two of them refer to ICT-based product/service innovation strategy, and assess to what extent ICT has played an important part a) in the R&D process that has led to the new products/services, and b) in the market launch of the new products/services (they both have three possible values: not at all, partly, fully); we also calculated an overall ICT-based product/service innovation strategy variable, which is binary and takes the 'yes' value when at least one of a) or b) happens (partly or fully). The other two refer to ICT-based process innovation strategy, and assess to what extent ICT has played an important part i) in the design of the new processes, and b) in the implementation of the new processes (similarly they both have three possible values: not at all, partly, fully); we also calculated an overall ICT-based process innovation strategy variable, which is binary and takes the 'yes' value when at least one of i) or ii) happens (partly or fully). Finally, we have three variables concerning the internationalization strategy, which refer to sales, procurement and production internationalization: share of exports as percentage of firm's total sales, share of imports as percentage of firm's total procurement, and also having production locations outside Europe (binary variable - yes/no).

With respect to processes, we have three independent variables concerning the complexity of firm's sales, procurement and production processes: geographic scope of sales, geographic scope of procurement (they both have three possible values: regional, country and international) and geographic scope of production (having four possible values: 1 location, 2 locations, 3 locations, more than 3 locations) (wider geographic scope of these activities increases the complexity of the corresponding processes. With respect to personnel we have two binary (yes/no) independent variables: employment of ICT personnel, and difficulty to find qualified ICT personnel. Finally, for technology we have five independent variables, which concern the degree of sophistication of five main kinds of firm's ICT infrastructure, which aim to support administrative functions, production execution, energy management, e-sales and e-invoicing respectively. The variable for the degree of sophistication of firm's administration support ICT infrastructure was computed as the average of three binary variables (yes/no): use of ERP (Enterprise Resource Planning), CRM (Customer Relationship Management), and SCM (Supply Chain Management) systems. The variable for the degree of sophistication of firm's production support ICT infrastructure was computed as the average of two binary variables (yes/no): use of CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing) systems. The degree of sophistication of firm's energy management ICT infrastructure was measured through a variable assessing the extent of use of an ICT-enabled energy management system to systematically monitor and analyse firm's energy consumption (having three possible values: not at all, in some units, in the total plant). Finally, the degree of sophistication of firm's e-sales and e-invoicing ICT infrastructures were measured through the percentage of orders received online and the percentage of invoices sent in electronically format respectively.

In order to test our research hypotheses H1 - H12, we estimated the association between the dependent variable and each of the abovementioned independent ones, by calculating four well-established measures of association: a) the Somers' d; b) the Kendall's tau-b (they are both measures of association between ordinal variables, and range from -1 to 1, with the sign indicating the direction of the association, and the absolute value indicating its strength); c) the Pearson's correlation (which is acceptable also for ordinal variables); and d) the partial correlation, controlling for sector (using for this purpose two sectoral binary dummy variables) and size (using two binary size dummies: one taking value 1 for large firms having 250 or more employees, and 0 for all other firms, and another one taking value 1 for medium firms having between 50 and 249 employees, and 0 for all other firms, having small firms as reference group). The calculation of these partial correlations allows the identification of spurious correlations, which are due to similar impacts of sector or/and size on both variables (e.g. correlations due to positive effects of size on both the dependent and an independent variable), by calculating these correlations after the extraction of the effects of sector and size from both variables. 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 estimates of the effects of the independent variables on the dependent variable. So, for our case the above measures of association (Somers' d, Kendall's tau-b, Pearson's correlation and partial correlation) are more reliable estimates of the corresponding effects than the regression coefficients.

These measures of association were initially calculated for the whole sample. According to CC literature (Marston et al., 2011; Venters and Whitley, 2012; Müller et al., 2015) the main source of the benefits/advantages that CC provides are the economies of scale that the CC providers can achieve, which cannot be achieved by small firms, but can probably be achieved to some extent by larger firms, we also examined to what extent our results (effects of the examined firm characteristics on CC adoption propensity) are affected by firm size. For this purpose, our sample 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. 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 comparisons difficult (as smaller sample size increases the confidence intervals of the estimated association measures, and affects their levels of significance).

5. Results and Discussion

In Table 2 we can see for all independent variables the calculated Sommer's D, Kendall tau-b, Pearson correlation and partial correlation (controlling for sector and size) values with respect to the dependent variable (propensity for CC adoption) for the whole sample, in Table 3 for the small firms' sub-sample, and in Table 4 for the medium and large firms' sub-sample. Statistically significant values (having significance lower than 10%) and supported research hypotheses are shown in bold.

Variable	Sommer's D	Kendall tau-b	Correlation	Partial Correlation	Research Hypothesis
ICT Investment Reduction Strategy	**0.162**	**0.166**	**0.178**	**0.155**	**H1**
Product/Service Innovation Strategy	**0.106**	**0.113**	**0.105**	**0.079**	**H2**
ICT-based Product/Service Innovation Strategy – R&D	**0.173**	**0.174**	**0.158**	**0.126**	**H2**
ICT-based Product/Service Innovation Strategy - Launch	**0.141**	**0.143**	**0.138**	**0.112**	**H2**
ICT-based Product/Service Innovation Strategy - Overall	**0.156**	**0.161**	**0.149**	**0.117**	**H2**
Process Innovation Strategy	**0.091**	**0.099**	**0.102**	**0.069**	**H3**
ICT-based Process Innovation Strategy – Processes Design	**0.139**	**0.143**	**0.149**	**0.104**	**H3**
ICT-based Process Innovation Strategy – Processes Implement.	**0.154**	**0.160**	**0.162**	**0.120**	**H3**
ICT-based Process Innovation Strategy - Overall	**0.149**	**0.156**	**0.157**	**0.116**	**H3**
Sales Internationalization			0.004	-0.033	H4
Procurement Internationalization			0.020	0.003	H4
Production Internationalization	0.047	0.051	0.053	0.009	H4
Geographic Scope of Sales	-0.004	-0.005	0.002	-0.055	H5
Geographic Scope of Procurement	-0.023	-0.026	-0.039	-0.065	H5
Geographic Scope of Production	0.035	0.037	0.064	0.010	H5
Employment of ICT Personnel	**0.158**	**0.164**	**0.188**	**0.149**	**H6**
Difficulty to find ICT Personnel	0.034	0.048	0.063	0.041	H7
Administration Support ICT Infrastructure	**0.144**	**0.163**	**0.185**	**0.148**	**H8**
Production Support ICT Infr.	**0.081**	**0.091**	**0.088**	**0.053**	**H9**
Energy Management ICT Infrastr.	0.051	0.053	0.052	0.034	H10
e-Sales ICT Infrastructure	0.053	0.054	0.072	0.057	H11
e-Invoicing ICT Infrastructure			**0.114**	**0.100**	**H12**

Table 2. Sommer's D, Kendall tau-b, Correlations and Partial Correlations for the whole sample

Variable	Sommer's D	Kendall tau-b	Correlation	Partial Correlation	Research Hypothesis
ICT Investment Reduction	**0.180**	**0.186**	**0.177**	**0.175**	**H1**

Strategy					
Product/Service Innovation Strategy	**0.087**	**0.097**	**0.105**	**0.111**	**H2**
ICT-based Product/Service Innovation Strategy – R&D	**0.110**	**0.110**	**0.118**	**0.126**	**H2**
ICT-based Product/Service Innovation Strategy - Launch	**0.149**	**0.151**	**0.173**	**0.178**	**H2**
ICT-based Product/Service Innovation Strategy - Overall	**0.145**	**0.149**	**0.167**	**0.153**	**H2**
Process Innovation Strategy	**0.134**	**0.152**	**0.152**	**0.153**	**H3**
ICT-based Process Innovation Strategy – Process Design	**0.205**	**0.205**	**0.200**	**0.201**	**H3**
ICT-based Process Innovation Strategy – Process Implement.	**0.241**	**0.246**	**0.233**	**0.237**	**H3**
ICT-based Process Innovation Strategy - Overall	**0.245**	**0.251**	**0.236**	**0.238**	**H3**
Sales Internationalization			-0.015	-0.017	H4
Procurement Internationalization			-0.029	-0.041	H4
Production Internationalization	0.038	0.059	0.050	0.053	H4
Geographic Scope of Sales	-0.064	-0.078	-0.079	-0.089	H5
Geographic Scope of Procurement	0.004	0.005	0.003	-0.005	H5
Geographic Scope of Production	0.016	0.017	0.042	0.045	H5
Employment of ICT Personnel	**0.210**	**0.217**	**0.247**	**0.249**	**H6**
Difficulty to find ICT Personnel	-0.011	-0.023	-0.022	-0.026	H7
Administration Support ICT Infrastructure	**0.112**	**0.126**	**0.193**	**0.191**	**H8**
Production Support ICT Infr.	**0.095**	**0.113**	**0.106**	**0.098**	**H9**
Energy Management ICT Infrastr.	-0.002	-0.002	0.032	0.037	H10
e-Sales ICT Infrastructure	**0.127**	**0.133**	**0.163**	**0.166**	**H11**
e-Invoicing ICT Infrastructure			**0.224**	**0.221**	**H12**

Table 3. Sommer's D, Kendall tau-b, Correlations and Partial Correlations for the small firms

Variable	Sommer's D	Kendall tau-b	Correlation	Partial Correlation	Research Hypothesis
ICT Investment Reduction Strategy	**0.120**	**0.123**	**0.148**	**0.143**	**H1**
Product/Service Innovation Strategy	**0.092**	**0.096**	**0.076**	**0.069**	**H2**
ICT-based Product/Service Innovation Strategy – R&D	**0.174**	**0.176**	**0.148**	**0.139**	**H2**
ICT-based Product/Service Innovation Strategy - Launch	**0.105**	**0.107**	**0.086**	**0.074**	**H2**
ICT-based Product/Service Innovation Strategy - Overall	**0.126**	**0.129**	**0.101**	**0.093**	**H2**
Process Innovation Strategy	0.013	0.013	0.021	-0.011	H3
ICT-based Process Innovation Strategy – Processes Design	0.058	0.059	0.074	0.070	H3
ICT-based Process Innovation Strategy – Processes Implement.	0.060	0.062	0.074	0.069	H3

ICT-based Process Innovation Strategy – Overall	0.048	0.050	0.063	0.056	H3
Sales Internationalization			-0.004	-0.044	H4
Procurement Internationalization			0.059	0.040	H4
Production Internationalization	0.020	0.020	0.025	0.023	H4
Geographic Scope of Sales	0.010	0.011	0.021	-0.011	H5
Geographic Scope of Procurement	-0.065	-0.069	-0.086	-0.108	H5
Geographic Scope of Production	-0.009	-0.010	0.018	0.038	H5
Employment of ICT Personnel	0.085	0.088	0.110	0.107	H6
Difficulty in finding ICT Personnel	0.047	0.059	0.078	0.077	H7
Administration Support ICT Infrastructure	**0.124**	**0.138**	**0.131**	**0.128**	**H8**
Production Support ICT Infrastr.	0.037	0.040	0.033	0.036	H9
Energy Management ICT Infrastr.	0.057	0.059	0.043	.037	H10
e-Sales ICT Infrastructure	-0.018	-0.018	-0.006	-0.012	H11
e-Invoicing ICT Infrastructure			0.023	0.010	H12

Table 4. Sommer's D, Kendall tau-b, Correlations, Partial Correlations for the medium and large firms

From the above three tables 2, 3 and 4 we can see that the adoption of ICT investment reduction strategy has a statistically significant positive association with the propensity for CC adoption in the whole sample, and also in both sub-samples (however stronger in the small firms); so, our first hypothesis H1 is supported. The adoption of product/service innovation strategy has also a statistically significant positive association with the propensity for CC adoption in the whole sample, and also in both sub-samples, however weaker in comparison with the adoption of ICT investment reduction strategy; so, hypothesis H2 is also supported. Similar hold for the adoption of ICT-based product/service innovation strategy, however its association with CC adoption propensity is much stronger. 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; so, hypothesis H3 is supported only for the small firms. Similar hold for the adoption of ICT-based process innovation strategy, but its association with CC adoption propensity is much stronger. Finally, none of the internationalization strategy variables has statistically significant association with the propensity for CC adoption, so hypothesis H4 is not supported.

The above indicate that in the examined manufacturing sectors firms view CC mainly as an efficient option for reducing the negative consequences of ICT reduction strategies, enabling them to make necessary upgrades of their ICT infrastructures for meeting new business needs, as well as to exploit new emerging ICTs, without having to make ICT investments, and with lower risk. CC is also perceived, but to a lesser extent, as an efficient way of providing the required ICT support for innovations in firm's products and services. Furthermore, it is also perceived as an efficient way of providing ICT support of process innovations, but only by the small firms; this does not hold for the medium and large firms, probably because their processes are usually more complex and firm-specific in comparison with the smaller firms, and this increases the 'specificity' of the required ICT assets, so according to the Transaction Cost Economics theory (Williamson, 1985 and 1989) it reduces the opportunities for and benefits from outsourcing them. Another interesting finding is that firms already using ICT applications in order to support innovations in their products, services and processes have a stronger tendency to use CC for such purposes, in order to reduce the operation, support and maintenance costs of these ICT applications, and also gain access to more and better relevant functionalities (for supporting both their past and future innovations); this tendency is strengthened due to the familiarization and experience they already have concerning the use of ICT for the above purposes, which increases their capabilities to

search for, select and then use effectively relevant CC services. On the contrary, firms do not regard CC as an effective option for acquiring the required extensive ICT support for internationalization strategies; a possible explanation is that these strategies on one hand increase the needs for ICT support (see relevant arguments of research hypothesis 4), but on the other hand make firms' processes, as well as their ICT support, more complex, firm-specific and even 'core activities' providing competitive advantage, reducing opportunities for and benefits from outsourcing them, and at increasing the motivation for having full internal control of them.

With respect to firm's processes, none of the examined measures of processes' complexity due to wide geographical scope of sales, procurement and production has statistically significant association with the propensity for CC adoption; so hypothesis H5 is not supported. This indicates that although the wider geographic scope of these activities increases the needs for ICT support, at the same time it leads to more complex and firm-specific processes (that tend to become 'core capabilities') and corresponding ICT support requirements, which reduces opportunities for and benefits from outsourcing them, and increases motivation for having full internal control of them. This finding is not in agreement with Wu et al. (2013), who found a negative impact of processes complexity on CC adoption intention (probably because the sample of their study covers a wide and heterogeneous range of manufacturing and retail sectors, having higher levels of processes complexity than the three manufacturing sectors examined in our study, making the adoption of CC even more difficult and less beneficial).

Regarding our personnel-related variables, the employment of ICT personnel has a statistically significant positive association with the propensity for CC adoption in the whole sample, and only in the small firms' sub-sample, but not in the medium and large firms' sub-sample. Therefore, hypothesis H6 is supported only for the small firms. This result indicates the important role of the ICT personnel for the effective adoption and utilization of CC in the small firms: only 17.3% of the small firms of our sample employ ICT personnel, who can perform better the CC-related tasks a) to f) mentioned in the justification of research hypothesis H6 in section 3.3, increasing the capability and therefore the propensity of these firms to adopt and use CC effectively. In the medium and the large firms there is more employment of ICT personnel: 36.6% of the medium firms and 72.9% of the large firms of our sample employ ICT personnel. However, the bigger numbers of ICT staff that medium and large firms usually have (in comparison with the small ones) on one hand enable them to perform better the abovementioned CC-related tasks a) to f), and this increases their capability and propensity to adopt CC, but on the other hand enable them to produce 'in-house' the required ICT services for supporting firm's activities and processes, which might reduce CC adoption propensity. These two different roles that ICT personnel can play with respect to CC adoption in medium and large firms can produce effects of different signs: positive effect the former, and negative effect the latter; so it is possible that in some sectoral contexts will dominate the positive effect, in some other sectoral contexts will dominate the negative effect, and in some others they will cancel one another (as it probably happens in the sectors examined in our study). The difficulty to find qualified ICT personnel does not have statistically significant association with the propensity for CC adoption, so hypothesis H7 is not supported.

Finally, with respect to our technology-related variables, the degree of sophistication of firm's administration support ICT infrastructure has statistically significant positive association with the propensity for CC adoption in the whole sample, and in both size sub-samples; therefore, hypothesis H8 is supported. On the contrary, the degree of sophistication of the production support, e-sales and e-invoicing ICT infrastructures have statistically significant positive associations with the propensity for CC adoption in the whole sample, and only in the small firms' sub-sample, but not in the medium and large firms' sub-sample; so, hypotheses H9, H11 and H12 are supported only for the small firms. The degree of sophistication of the energy management ICT infrastructure does not have statistically significant association with the propensity for CC adoption; so hypothesis H10 is not supported. The above results indicate that in the examined manufacturing sectors firms regard CC as an effective way to reduce the running costs (i.e. operation, support and maintenance costs) of highly sophisticated

administration support ICT infrastructures, which constitute their biggest size and most costly ICT infrastructures, as they support a wide range of administrative functions (such as sales, procurement, warehouse management, production planning, financial management, human resources management, etc.). Furthermore, the same holds for the production support ICT infrastructure (CAD/CAM), as well as for the e-sales and e-invoicing ones, but only in the small firms; a possible explanation for this is that these three kinds of ICT infrastructure are smaller and less costly (as they support a limited range of firm's functions) than the administration support one, so medium and large firms can achieve satisfactory economies of scale for them, therefore the use of CC services does not provide important benefits. Finally, our results indicate that firms do not perceive CC as an option for reducing the running costs of highly sophisticated energy management ICT infrastructures. A possible explanation is that these ICT infrastructures are even smaller and less costly, so there is less motivation for migrating parts of them to the CC; also, they are quite sector-specific, so there is limited supply of relevant CC services. The above findings exhibit some level of agreement with the part of the CC adoption factors literature that finds a positive statistically significant effect of 'technological readiness' on CC adoption (Oliveira et al. (2014), Gutierrez et al. (2015) and Senyo et al. (2016) – see section 2); however, our study draws more detailed conclusions on this, as it identifies specific components of firm's technological readiness that affect the CC adoption propensity of different categories of firms: the sophistication of administration support ICT infrastructure that has positive effect in firms of all sizes, and also the employment of ICT personnel, as well as the sophistication of production support, e-sales and e-invoicing ICT infrastructures, that have positive effects in the small firms.

6. Conclusions

Previous empirical research on CC adoption factors has examined the effects of only a small number of firm's characteristics on CC adoption, and this has resulted in a limited understanding about firm's internal conditions that favor and promote it. At the same time there is a lack of theoretical foundations for conducting more research in this direction, despite the potential usefulness of this research for both CC services providers and users. This paper contributes to filling both these research gaps: i) it proposes a theoretical foundation for this research, which constitutes an elaboration of the organizational perspective of the TOE theory (Tornatzky and Fleischer, 1990; Baker, 2011), based on Scott-Morton's framework on firm's main elements (Scott-Morton, 1991); ii) and then based on it investigates empirically the effects of a wide set of firm's characteristics that have not been dealt with in previous relevant research, which concern four important aspects of a firm, its strategy, processes, personnel and technology, on its propensity to adopt CC. For this purpose, we have used a dataset collected through the e-Business W@tch Survey of the European Commission from 676 European firms from the glass, ceramic and cement manufacturing sectors. It should be noted that the sectoral context of our study is quite different from the ones of the unrepresentative highly innovative manufacturing or service sectors, in which most previous empirical ICT adoption studies have been conducted: these three manufacturing sectors are rather conservative in terms of adoption of new ICT, and innovative business practices in general, so it is a quite interesting context for studying factors affecting the adoption of this new paradigm of ICT services sourcing.

Our results reveal three firm's characteristics – internal conditions that favor and promote the adoption of CC for all firms' sizes. Two of them concern firm's strategy: adoption of ICT reduction strategy, as well as adoption of product/service innovation strategy; while the third one concerns firm's technology: sophistication of firm's administration support ICT infrastructure. Furthermore, our results reveal five additional firm's characteristics – internal conditions that favor and promote the adoption of CC only in the small firms. One of them concerns firm's strategy: adoption of process innovation strategy; one concerns firm's personnel: employment of ICT personnel; and the remaining three concern

firm's technology: sophistication of firm's production support, e-sales and e-invoicing ICT infrastructures.

These results provide interesting insights concerning the types of firms, with respect to strategy, processes, personnel and technology, in which CC is perceived as quite advantageous, at least in the three examined manufacturing sectors. In particular, they indicate that CC is perceived as quite advantageous in firms of all sizes that: a) due to some internal or external reasons have to adopt an ICT investment reduction strategy, which does not allow them to make necessary upgrades of their ICT infrastructures or take advantage of new emerging ICT; or b) adopt product/service innovation strategy (especially in firms adopting ICT-based product/service innovation strategy, which are already using ICT applications in order to support the design, or/and implementation or/and market launch of product/service innovations); or c) have highly sophisticated and costly administration support ICT infrastructures. Furthermore, our results indicate that CC is perceived as quite advantageous in small firms that: i) adopt process innovation strategy (especially in firms adopting ICT-based process innovation strategy, which are already using ICT applications in order to support the design or/and implementation of process innovations); or ii) have highly sophisticated and costly production support, e-sales, or e-invoicing ICT infrastructures. On the contrary, CC is perceived as less suitable for firms having complex and firm-specific processes due to wide geographical scope of activities or internationalization. Also, our results provide interesting insights concerning the different roles that ICT personnel can play with respect to CC adoption, which seem to depend on firm size, and also their corresponding impact on CC adoption.

The above shed light on the main aspects of CC value/usefulness that firms perceive: for firms of all sizes CC allows overcoming the limitations posed by existing ICT reduction strategies, by using CC in order to make necessary upgrades of their ICT infrastructures and take advantage of new emerging ICT, without having to make investments; also CC enables rapid and low cost provision of the ICT support required for product and service innovations, as well as reduction the costs of highly sophisticated administration support ICT infrastructures. Furthermore, there are some additional aspects of CC value/usefulness that are perceived only by small firms: CC enables the rapid and low cost provision of the ICT support required for process innovations, as well as the reduction the costs of highly sophisticated production support, e-sales and e-invoicing ICT infrastructures.

Our study has interesting implications for research and practice. With respect to research, it contributes to the existing empirical literature on CC adoption factors, by investigating the effects of a wide set of firm's characteristics, related to four important aspects of a firm (strategy, processes, personnel and technology), which had not been dealt with previously. It opens a new stream of CC adoption research, which investigates the effects of wider range of firm's characteristics on the adoption of CC by firms. Furthermore, it provides a theoretical foundation for this research, by elaborating the organizational perspective of the TOE theory, based on Scott-Morton' theoretical framework on firm's main elements. Our study uses the latter theoretical framework, in order to elaborate/enrich the former theory (with respect to its organizational perspective), and then based on this elaboration/enrichment it formulates its research hypotheses, which are tested using firm-level data; therefore our study, using the terminology of the seminal paper of Colquitt and Zapata-Phelan (2007), combines both 'theory building' and 'theory testing'. With respect to practice, our findings provide interesting insights concerning the characteristics of the firms in which the CC is perceived as more appropriate and beneficial (so they are more likely to adopt CC), or less suitable, as well as the main aspects of CC value/usefulness perceived by firms, which are useful to both CC services providers and users (or potential users). In particular, they are useful for CC services provider firms, in order to focus their marketing efforts on firms' segments (from strategy, processes, personnel and ICT infrastructures viewpoint) that are more likely to adopt CC, fine tune their existing services for them, and also enhance them in order to make them more attractive for firms' segments currently exhibiting low propensity to adopt CC, and provide new forms of value. For instance, our findings indicate that SaaS providers should improve the capabilities of their services for supporting complex firm's processes (e.g. due to wide geographical scope of activities, or

internationalization, or other reasons), as well as firm-specific processes, by enabling extensive customization. Also, our findings can provide guidance to CC provider firms for the development of new CC services that support additional kinds of strategies, processes and ICT infrastructures/functions, for which CC is currently perceived by firms as less appropriate and beneficial. Furthermore, our findings are useful for CC user firms (or potential CC user firms), in order to make better decisions concerning the adoption of CC, as well as the ways of using it. Taking into account the abovementioned main aspects of CC value/usefulness, which have been identified by our study, firms can start with less risky uses of CC (e.g. use CC for reducing the cost of a specific ICT infrastructure), and then based on the acquired experience they can proceed to more risky uses of CC (e.g. use CC for supporting innovations).

The main limitation of this study is that it has been based on data from only three European manufacturing sectors, which are rather conservative in terms of adoption of new ICT and innovative business practices in general, so its findings may have been influenced to some extent by this particular sectoral and national context. Also, it does not distinguish between the adoption of different categories of CC services (IaaS, PaaS, SaaS). So, further research is required concerning the effect of wider sets of firm's characteristics on its propensity to adopt different categories of CC services in various sectoral contexts (having different attitudes towards technological and business innovation) as well as national contexts (having different levels of economic and technological development as well as culture). Furthermore, at the 'theory-building' level, the proposed elaboration of the organizational perspective of the TOE theory can be further developed and elaborated (e.g. by using more detailed theoretical frameworks for each of the five main firm's elements proposed by the Scott-Morton's framework, or even use the other conceptualizations of firm's main elements reviewed in 2.2).

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