HARD AND SOFT ICT CAPITAL AND CLOUD COMPUTING BENEFITS

Research full-length paper

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Abstract

The Cloud Computing (CC) is a new innovative model of sourcing the information and communication technologies (ICT) services required by firms for supporting their activities, so it is necessary to investigate the level of benefits that CC offers to firms, as well as their determinants. However, limited empirical research has been conducted in this direction. Our paper contributes to filling this research gap. It formulates a set of research hypotheses concerning the effects of firm's 'hard ICT capital', and also some types of firm's 'soft ICT capital', on the benefits offered by CC, having as theoretical foundation the 'resource-based view' theory. These research hypotheses are tested using data collected through a survey from 115 Greek firms, from which CC benefits regression models are estimated. It has been concluded that the sophistication of firm's ICT infrastructure (an overall measure of firm's hard ICT capital) has a positive impact on CC benefits. Furthermore, three of the examined types of soft ICT capital have been found to impact positively CC benefits: the information systems (IS) interconnection/integration capability, the ICT strategic planning and alignment capability, and the internal relationship between firm's ICT unit and business units. Our findings reveal some aspects of firm's ICT capital that affect the generation of value from this new innovative CC paradigm, which can be useful to CC service providers, and also management and ICT firms' practitioners and consultants.

Keywords: cloud computing, hard ICT, soft ICT, ICT capabilities.

1 Introduction

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

Relevant literature argues that CC has the potential to offer important advantages and benefits to firms, which are associated mainly with ICT costs reduction, as well as support and promotion of firm's innovation activity (Etro, 2009; Brynjolfsson et al., 2010; Benlian and Hess, 2011; Marston et al., 2011; Venders and Whitley, 2012; Bernman et al., 2012; Hoberg et al., 2012; Willcocks et al., 2013; Willcocks et al., 2014; Müller et al., 2015). However, there has been limited empirical research in this direction, in order to understand to what extent these expected benefits are realized by firms, and which

factors determine the magnitude of them (an outline of this research is provided in 2.1). As CC is a new innovative paradigm for the provision of the ICT services required by firms for supporting their activities, it is important to conduct empirical research on the real business value it generates (i.e. to what extent it reduces ICT costs, or supports firm's innovations in its processes, products and services), as well as it's the factors affecting it, e.g. various internal factors associated with firm's characteristics, or external factors associated with its environment, or even factors concerning the relationship between the firm and its CC services providers; for this research initially we can use as starting point the findings of the extensive previous literature on the determinants of ICT outsourcing outcomes and success – see comprehensive reviews in Lacity et al., 2010, 2016 and 2017 - adapting them to the specificities of CC, and gradually proceed to the examination of other factors specific to CC. The findings of this research can be useful to CC service providers (in order to provide guidance to their clients for increasing the business value they obtain from CC), as well as to management and ICT firms' practitioners and relevant consultants (in order to design appropriate actions for the maximization of the business value firms obtain from CC).

Our paper contributes to filling this research gap. It formulates a set of research hypotheses concerning the effects of firm's 'hard ICT capital', as well as some types of firm's 'soft ICT capital', on the benefits offered by CC. Previous information systems (IS) literature has revealed the importance of different types of hard and soft ICT capital that firms develop (including both ICT resources and capabilities) in order to support their activities, as well as their business impacts, and their effects on various dimensions of firm's performance, in the 'classical' on-premises paradigm (Feeny and Willcocks, 1998; Bharadwaj, 2000; Wade and Hulland, 2004; Ravichandran and Lertwongsatien, 2005; Loukis et al., 2009; Gu and Jung, 2013; Arvanitis et al., 2013) (see section 2.2 for more details). So we extend this literature for the new innovative CC paradigm of providing ICT support of firm's activities, by examining the impact of hard ICT capital as well as some types of soft ICT capital on the business benefits generated by CC. This is in line with the findings of previous ICT outsourcing research (see reviews in Lacity et al., 2010, 2016 and 2017) that client firm characteristics are important determinants of ICT outsourcing outcomes and benefits (as the use of CC is a specific form of ICT outsourcing). Our research hypotheses are then tested using data collected through a survey from 115 Greek firms, from which CC benefits regression models are estimated, leading to interesting conclusions.

This paper is organized as follows. Section 2 includes the background of the study, while in Section 3 our research hypotheses are formulated. Section 4 describes the data and method of this study. The results are presented and discussed in Section 5, while in the final section 6 conclusions are summarized and future research directions are proposed.

2 Literature Review

2.1 Cloud Computing Benefits

The potential of CC to offer significant business benefits to firms has been extensively analysed in previous literature (Etro, 2009; Armbrust et al., 2010; Brynjolfsson et al., 2010; Iyer and Henderson, 2010; Iyer and Henderson, 2012; Marston et al., 2011; Venters and Whitley, 2012; Willcocks et al., 2013; Berman et al., 2012; Müller et al., 2015). These most important of these potential benefits are cost reduction, conversion of related capital investments to operating costs, rapid and low cost development of technological support required for process, product and service innovations, scalability, ubiquitous access, provision of flexible cost-effective computing capacity for supporting firm's growth, and rapid and low cost access to new technologies (e.g. business analytics, mobile) and high level ICT-related skills. Venters and Whitley (2012) distinguish between three main types of business benefits offered by CC: efficiency, simplicity (of use and understanding) and creativity/innovation. More recently Mueller et al. (2015) propose a similar but more detailed typology of the benefits that CC can offer to firms, which includes three main types of benefits, with each of them being elaborated

into several sub-types: the first type of benefits is termed 'business efficiency support' (including costs reduction and business efficiency improvements); the second is termed 'business effectiveness improvements' (including enhanced intra-enterprise collaboration, business integration and common ICT infrastructure, and focus on core competencies); the third type of CC benefits is termed 'innovation - business transformation' (including business growth through innovation, agility, business partner collaboration).

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

2.2 Hard and Soft ICT Capital

Previous IS research has revealed that firms in order to exploit ICT for supporting their activities develop not only various types of 'hard' ICT capital (e.g. ICT equipment, software, networks, etc.), but also various types of 'soft' ICT capital (e.g. ICT human resources and skills, ICT procedures, processes and in general organization) as well; in this direction there has been long and extensive research which identifies and analyses the different types of hard and soft ICT capital that firms develop, and examines their business impact, in the on-premises paradigm. (Mata et al., 1995; Feeny and Willcocks, 1998; Bharadwaj, 2000; Wade and Hulland, 2004; Ravichandran and Lertwongsatien, 2005; Loukis et al., 2009; Gu and Jung, 2013; Arvanitis et al., 2013; Loukis and Charalabidis, 2013). Most of the latter empirical research on the business impacts of different types of hard and soft ICT capital has as theoretical foundation the 'resource-based view' (RBV) of the firm (Wernerfelt, 1984; Barney, 1991; Barney and Clark, 2007). This theory argues that performance differences among firms are due to differences in their resources and capabilities: firms that are able to accumulate resources that are valuable,

rare, non-substitutable, and difficult to imitate, or to use their resources in order to develop capabilities that have these characteristics, will achieve higher performance and finally competitive advantage over competitors. So the main idea of the above empirical studies is that most ICT hardware, packaged software and network technological components that firms use are not rare and difficult to imitate, as they are available to all firms (e.g. competitors), so they cannot be a source of higher performance and finally competitive advantage. However, appropriate customizations as well as combinations can be made of such ICT technological components, as well as combinations of them with other firm's resources and capabilities (e.g. various human resources and skills, knowledge resources, procedures and processes, etc.), which can be highly valuable and at the same time rare and difficult to imitate, leading to higher firm's performance; for the development of such combinations highly important are firm's ICT human resources and skills (both technological and business ones), as well as ICT procedures and processes (e.g. for co-operating with ICT users or potential users), and ICT related capabilities in general.

In this section we review some representative theoretical and empirical studies on ICT hard and soft capital (concerning both ICT resources and capabilities). Mata et al. (1995) in order to investigate the potential of ICT to create sustainable competitive advantages examine four basic 'attributes' of ICT at firm level: proprietary technologies, technical ICT skills, managerial ICT skills and access to capital. From an extensive theoretical analysis, based on the RBV of the firm, they conclude that only the managerial ICT skills are likely to provide sustainable competitive advantage; on the contrary the ability of technologies (even proprietary ones) to provide sustainable competitive advantage was assessed as low and continuously eroding. Feeny and Willcocks (1998) identified three general IS capabilities that firms should develop, concerning the definition of IS vision associated with their general business vision, the design of IS architecture, and the delivery of IS services: furthermore they elaborated them into nine more specific IS capabilities: leadership, business system thinking, relationship building, architecture planning, making technology work, informed buying, contract facilitation, contract monitoring and vendor relationship development. Bharadwaj (2000) investigated empirically the effect of hard ICT capital, as well as some types of soft ICT capital, on a variety of profit and cost related performance measures, based also on an RBV perspective. He found that superior 'ICT resources', which consist of 'ICT physical infrastructure', 'human ICT resources' and 'ICT-enabled intangibles' (including ICT-enabled knowledge assets, customer orientation, synergy between organizational divisions) result in superior performance in the abovementioned measures of performance. Wade and Hulland (2004) from a literature review identified eight types of ICT resources and capabilities that firms require in order to exploit the potential of ICT: one of them corresponds to hard ICT capital (IS infrastructure), while the other seven correspond to soft ICT capital (IS technical, development and operations skills, IS-business partnerships and planning, and market responsiveness and external relationships management).

Ravichandran and Lertwongsatien (2005) developed and estimated a model that relates the quality of firm's main IS resources (ICT infrastructure (= firm's basic platform, network, applications and data) sophistication, IS human capital (=IS personnel skills and knowledge concerning technologies and firm's operation) and IS partnerships (both internal ones, between firm's ICT unit and business units, and external ones, between the ICT unit and the ICT vendors)) at a first layer, with the most important IS capabilities (for IS planning, development and operation) at a second layer, the resulting ICT support provided for the main business functions at a third layer and finally the financial performance; they found that all first layer IS resources have positive effects on the IS capabilities of the second layer, with the effect of the IS human capital being the strongest. Gu and Jung (2013) investigate empirically the effects of firm's ICT resources (ICT infrastructure, ICT personnel technological skills and business expertise, ICT internal and external relations) on firm's ICT capabilities (concerning ICT planning, business process change, ICT acquisition, IS development, operation and users' support), and then the effect of the latter on firm's IS-enabled business processes performance and finally IS-enabled overall performance. All their hypotheses have been supported by the collected data, indicating the importance of ICT resources for the development of ICT capabilities, which affect positively

the performance of firm's business processes, as well as its overall performance. Arvanitis et al. (2013) empirically investigate the effects of four types of soft' ICT capital (ICT personnel, ICT training of the ICT personnel and the users, existence of ICT unit) on firm's innovation performance. They found that three of them (ICT personnel, ICT training of the ICT personnel and the users) impact positively both process and product/service innovation. Loukis and Charalabidis (2013) focus on the hard ICT capital, and investigate empirically the effect of a technological property of it, its interoperability (defined as its compliance with some widely used IS interoperability standards), on the four important perspectives/dimensions of firm's business performance proposed by the balanced scorecard approach (financial, customers, internal business processes, learning and innovation). It has been concluded for all the examined types of IS interoperability standards that their adoption increases considerably the positive impact of firm's ICT infrastructure on all the above four perspectives/dimensions of business performance.

In conclusion, there has been extensive research for the identification and analysis of the different types of hard and soft ICT capital (including both ICT resources and capabilities) that firms develop, as well as their business impact (e.g. their effects on various dimensions of business performance), for the existing on-premises paradigm of providing ICT support of firms' activities. However, quite limited research has been conducted concerning the business impact of these types of firm's hard and soft ICT capital for the new CC paradigm (see previous section). Our study contributes to filling this important research gap, by investigating empirically the effects of an measure of firm's overall hard ICT capital (sophistication of firm's ICT infrastructure), as well as five types of firm's soft ICT capital (ICT personnel, IS interconnection/integration capability, ICT strategic planning and alignment capability, internal relationship between firm's ICT unit and business units, and external relationship with firm's ICT vendors), on the magnitude of the benefits generated by CC.

3 Research Hypotheses

In order to formulate our research hypotheses we focused on some of the main types of hard and soft ICT capital (both ICT resources and capabilities) mentioned in the previous section 2.2, for which there are arguments or/and previous literature support concerning a possible impact on the magnitude of the benefits obtained from the use of CC services. The common theoretical foundation of our research hypotheses is the 'resource-based view' (RBV) of the firm (Wernerfelt, 1984; Barney, 1991; Barney and Clark, 2007) (outlined in the first paragraph of previous section): the CC services used by a firm are easily and rapidly available to other firms as well, so they are not rare and inimitable. However, some types of both hard as well as soft ICT capital that firms possess enable making complex combinations and integrations of many different CC services (possibly from different providers), and also with elements of firm's 'on-premises' ICT infrastructure, which can be highly valuable, and at the same time more rare and difficult to imitate, leading to higher levels of CC benefits. For these types of hard and soft ICT capital we have developed the following research hypotheses.

3.1 Hard ICT Capital

Our first research hypothesis concerns the effect of firm's ICT infrastructure overall sophistication on the magnitude of CC benefits. Firms having highly sophisticated ICT infrastructures have extensive experience concerning the efficient and effective use of ICT for supporting their activities, which will enable them to select and exploit better the most appropriate and cost effective CC services in order to: a) reduce the cost of the existing electronic support of their activities (e.g. by using IaaS and PaaS services for hosting some of the existing applications, or by using SaaS for replacing some older and/or bespoke applications with more modern standard software packages); b) also provide additional electronic support of their activities (e.g. by using SaaS for the electronic support of activities not currently supported, or minimally supported, providing for the latter more support functionalities); c) experiment with new technologies initially, and then exploit the most appropriate and valuable ones for the

firm at a larger scale, without need for relevant investments; d) respond rapidly and at low cost to various changes/challenges in its external environment (i.e. enhance its 'agility'); and e) support the rapid and low cost introduction of products/services innovations (new products/services or significantly improved ones), as well method/process innovations (new methods/processes or significantly improved ones). The above will result in higher levels of benefits from CC for firms having higher ICT infrastructure sophistication and therefore more experience of electronically supporting their activities. Previous empirical research has found a positive effect of firm's ICT infrastructure sophistication on its propensity to adopt CC (Loukis et al., 2017). From a RBV theory perspective, CC services per se, as mentioned above, are not rare and difficult to imitate, as they are available to all firms; however, a highly sophisticated ICT infrastructure provides many opportunities for complex combinations and integrations of various elements of it with external CC services (enabling extensive exchange of data and functionality combination) (Ragowsky et al., 2014; Willcocks et al., 2014), which can be quite valuable, and at the same time more rare and difficult to imitate, resulting in high levels of benefits, concerning both efficiency improvement, as well as agility enhancement and innovation support. For the above reasons our first research hypothesis is:

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

3.2 ICT Personnel

While our first research hypothesis H1 concerns the effect of firm's hard ICT capital on CC benefits, the next three research hypotheses H2 to H4 are dealing with the soft ICT capital: the effects of three different types of firm's 'ICT human capital' on CC benefits. The role and importance of firm's human capital for innovation has been extensively researched both theoretically and empirically in previous innovation literature (Vandenbussche et al., 2006; Lopez-Garcia and Montero, 2012; Arvanitis et al., 2016). This research has revealed that the human capital of a firm is its "engine of innovation", as it embeds firm's internal knowledge capital, which is critical for its innovation activity. Also, the human capital is a critical determinant of firm's 'Absorptive Capacity' (ACAP), defined as its ability to absorb, assimilate and exploit external knowledge and technology, which is highly important for innovation (Cohen and Levinthal, 1989 and 1990; Camisón and Forés, 2010). As CC constitutes a radical innovation concerning the ICT support of firm's activities, we expect that firm's relevant ICT human capital will be important for its success. Firm's ICT personnel, possessing extensive knowledge on one hand about firm's existing ICT infrastructure, its strengths and weaknesses, as well as the needs for extensions and improvements of it, and on the other hand about firm's business processes and activities, can play an important role in absorbing, assimilating and exploiting external knowledge about the existing CC services and providers; and also in selecting and exploiting better the most appropriate and cost effective CC services. The above enable achieving high quality electronic support of firm's existing activities and business processes, as well as agility enhancement and innovation (in processes, products and services), at a low cost. Therefore if a firm has sufficient size of ICT personnel (so that, beyond fulfilling their everyday duties, they have time to deal systematically with CC), this can increase the benefits obtained from CC services usage. Previous empirical research has found a positive effect of firm's ICT personnel on its innovation activity (Arvanitis et al., 2013), as well as on its propensity to adopt CC (Loukis et al., 2017). From an RBV theory perspective, the existence of sufficient ICT personnel is necessary for the identification and implementation of the abovementioned (in research hypothesis 1) possible highly valuable combinations and integrations of appropriate CC services, and also with firm's 'on-premises' ICT infrastructure (since ICT personnel have a deep knowledge of it), which are rare and difficult to imitate, leading to higher levels of CC benefits. So our second research hypothesis is:

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

3.3 IS Interconnection/Integration Capability

The following two research hypotheses, H3 and H4, focus on the effects of two types of ICT human capital, which concern specific ICT skills and resulting capabilities, on the benefits obtained from CC. So our third research hypothesis H3 concerns the effect of firm's IS interconnection/integration capability on CC benefits. The adoption of CC by a firm changes significantly the composition of the tasks of its ICT unit: the systems development, administration and support related tasks decrease, while the systems interconnection/integration related tasks increase and become more significant (Willcocks et al. 2013; Willcocks et al., 2014; Ragowsky et al., 2014). Extensive interconnection/integration is required between the remaining on-premises IS and various external CC services used (usually from many different providers, and having different technological bases, data structures, security mechanisms), so that they can exchange data and functionality with the required security levels. Ragowsky et al. (2014), based on opinions expressed by Chief Information Officers (CIOs) of USA firms, conclude that the role of the CIO is evolving from providing and supporting internal ICT services, toward a 'Chief Integration Officer' one, with main focus on the the integration of externally acquired standardized hardware and software (used for developing their internal ICT infrastructure), and also external CC services, retaining quality and performance control. According to the above CIOs opinions, the main reason for this increasing importance of integration is that 'Firms that adopt public cloud infrastructure without significant integration to other systems will lose a potentially valuable source of organizational differentiation. It is only through integration to the rest of the organization that the firm can differentiate its internal routines and hope to gain advantage from these IT systems'. So firms having high capabilities of rapid internal implementation (by their own ICT staff personnel) of various interconnections/integrations of different IS, so that there is interoperability of them (i.e. one IS can use data and functionality of other IS), will be better prepared to cope with the above integration related challenges that CC poses, reap more benefits from it. From an RBV perspective, this IS interconnection/integration capability is particularly important for the rapid and reliable implementation of the abovementioned possible complex and highly valuable combinations and integrations of multiple external CC services, and also with firm's 'on-premises' ICT infrastructure, which are rare, difficult to imitate, and provide significant efficiency, as well as agility and innovation oriented benefits. Therefore our third research hypothesis is:

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

3.4 ICT Strategic Planning and Alignment Capability

The fourth research hypothesis H4 concerns the effect of firm's ICT strategic planning and alignment capability on CC benefits. Previous IS research has extensively dealt with the importance and the impact of ICT strategic planning and alignment in the on premises paradigm of electronic support of firm's activities (Chen et al., 2010; Galliers, 2011; Leidner, et al., 2011). The development of an ICT strategic plan, which defines firm's directions and plans concerning the investment in, deployment, use, and management of ICT, is highly important for generating high business value from the use of ICT; if there are weaknesses in this area ICT investment might offer limited benefits, even lower than their cost. Furthermore, extensive research on ICT strategic alignment has revealed that if firm's ICT strategic plans are connected and aligned with its overall strategies, then the business value it will obtain from ICT will be much higher (Chan and Reich, 2007; De Haes and Van Grembergen, 2009; Wu et al., 2015). We expect that a firm having high ICT strategic planning and alignment capability will have experience and skills, as well as a positive tradition, in this area, so it will adopt a similar strategic approach with respect both to selection and the use of CC services. In particular, firm's ICT strategic plan will include a strategy as to which IS will remain on-premises, and which will be based on external CC services. The firm instead of making an uncoordinated and fragmented use of CC services, which address short terms problems and needs of specific business units (which very often happens – see Willcocks et al. 2013; Willcocks et al., 2014), with minimal integration between them, and also with the on-premises IS, will define in its ICT plan a complete set of CC services to be used in

order to support firm's strategic directions, address its weaknesses, leverage its strengths, seize external opportunities and cope with external threats. Having the above higher level business objectives as a guide for the selection and exploitation of CC services will lead to higher levels of benefits from CC, concerning the improvement of efficiency as well as flexibility (especially for firms experiencing highly dynamic external environment), exploitation of strategic new technologies and support of innovations. From an RBV theory perspective a high ICT strategic planning and alignment capability constitutes a sound basis for the design of strategically founded combinations/integrations of CC services, appropriate combinations/integrations of them with elements of the internal on-premises IS, as well as unique internal resources and capabilities; such combinations/integrations can be highly valuable, and at the same time quite rare and difficult to imitate, leading to higher levels of benefits. So our fourth research hypothesis is:

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

3.5 Internal ICT Relationship

The final two research hypotheses, H5 and H6, concern the effects of another form of soft ICT capital, the ICT relational capital, internal and external, on the benefits obtained from CC. Previous IS literature has revealed the importance of the internal ICT relationship between the personnel of firm's ICT unit and the personnel of its business units (who use ICT for supporting their activities) for the effective exploitation of ICT in the firm, and the generation of high levels of business value from it, in the 'classical' on-premises paradigm (Feeny and Willcocks, 1998; Ravichandran and Lertwongsatien, 2005; Gu and Jung, 2013). We expect that this will hold to an even larger extent for the case of the exploitation of the CC, as it requires a quite different set of tasks to be performed by the firm, in which the weight of the business related tasks is increased, while the weight of the technology related tasks is reduced, in comparison with the on-premises paradigm. In particular, the business oriented tasks include the evaluation of the numerous existing relevant CC services on offer in the market from a business perspective, the selection of the most appropriate ones from this perspective, and then their optimal business exploitation, possibly through interconnection/integration between different CC services, and also with the on-premises IS. The technology oriented tasks include the evaluation of the existing relevant CC services from a technological perspective (e.g. concerning the specific technologies and platforms they are based on, their security mechanisms, their reliability, their availability, as well as their integration capabilities), the selection of the most appropriate ones from this perspective, and then the implementation of the required integrations of them, and their technological monitoring (e.g. with respect to their availability, response time, etc.). The above indicate that close co-ordination and co-operation is required, between firm's business units (responsible for performing the former business oriented tasks) and the ICT unit (responsible for performing the latter technology oriented tasks), for a successfully exploitation of CC by the firm, and the realization of high levels of benefits from it. The existence of a good internal ICT relationship between the ICT unit of the firm and its business units creates high levels of mutual understanding, trust and inter-dependence between them, and in general a tradition of co-operation, and also establish (formal or informal) mechanisms and procedures for this; these are expected to lead to and facilitate a close and effective cooperation between them for the effective exploitation of CC in the firm as well, resulting in higher levels of CC benefits, concerning improvements of efficiency as well as agility, and support of innovation. From a RBV perspective this ICT internal relationship can be the best source of ideas for valuable, rare and difficult to imitate combinations and integrations of many different CC services (possibly from different providers), and also with elements of the internal on-premises IS, based on the combination of the business related knowledge of the business units and the technological knowledge of the ICT unit; this can lead to the generation of more CC benefits. So our fifth research hypothesis is:

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

3.6 External ICT Relationship

Our last research hypothesis concerns the effect of the external ICT relationship between the firm and its ICT vendors on CC benefits. Previous IS literature has revealed the importance of this external ICT relationship, for the effective exploitation of ICT by the firm, and the generation of high levels of business value from it, in the 'classical' on-premises paradigm (Feeny and Willcocks, 1998; Ravichandran and Lertwongsatien, 2005; Gu and Jung, 2013). We expect that this will hold to an even larger extent with CC, as in this paradigm the CC providers have a much bigger role in the electronic support of firm's activities than the ICT providers in the on premises paradigm. The development of a good and deep relationship with CC providers, characterized by extensive information and knowledge exchange, mutual understanding, trust and positive attitude to solving problems and resolving any disputes aiming at mutual benefit and satisfaction (towards 'win-win' directions), and avoiding opportunistic behaviours, will result to higher levels of CC benefits. The information and knowledge provided by CC providers allows a better selection and customization of CC services for supporting the current needs of the firm, as well as the future ones (e.g. for responding to various changes and challenges in firm's external environment, enhancing its agility, and for supporting innovations in firm's processes, products and services); furthermore, the provision of extensive technological information and knowledge by the CC providers about their services will enable the design and implementation of valuable integrations between them, and also with appropriate elements of our on-premises IS. A recent empirical study by Garrison et al. (2015) found that firm's relationships with CC services providers have a strong positive impact on CC success and firm performance (see section 2.1 for more details). The existence of good ICT external relationships between the firm and its ICT vendors creates on one hand a tradition of close and constructive co-operation with them, extensive exchange of information and knowledge, as well as a positive attitude towards solution of problems or resolution of possible disputes that might appear, and on the other hand a general capability and possibly specific mechanisms and procedures for effectively managing these relationships; these will facilitate a good and deep cooperation with CC providers as well, leading to the abovementioned increase of CC benefits. From a RBV perspective, establishing a good and deep cooperation with CC providers leads to better supports by them, enabling deeper discovery and exploitation of the capabilities of their CC services, and effective solution of possible problems; also it enables better customization of the services, leading to better adaptation of them to firm's specific needs, processes and activities; and finally a better combination and integration of different CC services (possibly from different CC providers), and also with appropriate elements of our on-premises IS, as well as unique internal resources and capabilities. These will allow a more valuable exploitation of CC, which is rare and difficult to imitate, leading to higher levels of CC benefits. So our sixth research hypothesis is:

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

4 Data and Method

For this study we have used firm-level data collected from Greek firms through a survey, which has been conducted in cooperation with ICAP S.A. (www.icap.gr), one of the largest business information and consulting companies in Greece. As our starting point we used the original large sample of Greek firms of ICAP, which to the best of our knowledge is the best and largest source for firm data in Greece. From it we constructed an intermediate smaller sample, with about 50% of the firms of the initial sample, including 3308 firms, and the same composition by industry and size with the original sample. To these firms of the intermediate sample we sent a questionnaire we developed, including a large number of questions concerning background information of the firm, ICT resources and capabilities, cloud usage and benefits, and innovation activity. The initial version of the questionnaire was developed by the authors, was then reviewed by three questionnaire development experts from ICAP S.A., and based on their remarks the final version of it was formulated. For this study we used part of its questions, which are shown in the Appendix. Finally, we received completed questionnaires from

363 firms (188 small, 131 medium and 41 large ones), having a response rate of about 11%. For this study we used data from 115 of these firms which are using cloud computing (59 small, 41 medium and, 15 large).

It should be noted that the original sample of ICAP is not representative of the composition of Greek firms by industry. The Greek economy contains thousands of small and very small enterprises in trade, particularly retail trade, tourism, particularly in catering, and in construction. The ICAP focuses on the most technologically developed part of the Greek economy: its sample concentrates on manufacturing (30.7% of sample firms) and some modern service industries (computer services, business services and transport/communication; 13.7% of sample firms), still keeping a high percentage of trade and tourism firms (49.5% of sample firms), while the intermediate sample has a similar composition by industry. In the sample we used in this study (respondent firms using cloud computing) there is a similar representation of manufacturing (26.9%) and even higher representation of modern service industries (43.1%). Therefore our sample structure concentrates on the most technologically developed part of the Greek economy.

In order to test our research hypotheses H1 to H6 five linear regression models (model 1 to 5) were estimated using the aforementioned data, having the following specification:

$$CC\_BEN_i = b_o + b_1*ICTI\_SO_i + b_2*SOFT\_ICTC + b_3*D\_SIZE_i + b_4*D\_SECT_i + e_i \quad \text{(for firm i)}$$

In all these models dependent variable is the CC benefits (CC_BEN), which assesses the magnitude of the benefits obtained by the firm from the use of CC. As it is the most multidimensional of all our variables it has been measured though a six items scale developed based on previous literature on the benefits offered by CC (Marston et al., 2011; Venders and Whitley, 2012; Müller et al., 2015); they assess to what extent the use of CC services by the firm has provided six main potential CC benefits mentioned by the above relevant literature (using a 5-levels Lickert-type scale 1-5, where: 5 = to a very large extent, 4 = to a large extent, 3 = to a moderate ex-tent, 2 = to a small extent, 1 = not at all or to a very small extent): reduction of cost of firm's electronic support, improvement of its quality, use and exploitation of new technologies, electronic support and facilitation of products/services innovations, electronic support and facilitation of methods/processes innovations, improvement of firm's agility/adaptability. A Principal Component Analysis was performed for the above six variables, which gave one factor that was used as our dependent variable.

Also, all five models included as an independent hard ICT capital variable the degree of sophistication of firms' ICT infrastructure (ICTI_SO), which has been calculated as the average of five 5-levels Likert–type variables (using the abovementioned scale), assessing the extent of using an Enterprise Resource Planning (ERP) system, a Customer Relationship Management (CRM) system, a Supply Chain Management (CRM) system, a Business Intelligence/Business Analytics (BI/BA) system and a Collaboration Support (CS) system. Also all models include as independent variables two dummy variables: one size dummy (D_SIZE), in order to capture the effects of firm size on CC benefits, which was based on firm's number of employees in full-time equivalents, taking value 1 for small-sized firms with less than 50 employees, 2 for medium-sized firms with 50 to 249 employees and 3 for large-sized firms with 250 or more employees; and another sector dummy (D_SECT), in order to capture the effects of firm sector on CC benefits, taking value 0 for service sectors firms and 1 for manufacturing or construction sectors firms.

Finally each of the five models included as independent variable one soft ICT capital variable, corresponding to one of the relevant research hypotheses H2-H6. Because there were high levels of correlation among these soft ICT capital variables it was not possible to include all of them in one regression model, as this would lead to multi-collinearity problems, resulting in unreliable estimations of regression coefficients (Greene, 2011). The first of these variables is a measure of firm's ICT personnel (ICT_PERS), and is equal to the number of firm's ICT employees as a percentage of firm's total number of employees. The other four soft ICT capital variables assess in a 5-levels Likert-type scale firm's IS interconnection/integration capability (INTEGR_CAP), ICT strategic planning and alignment capa-

bility (ICT_STRAL_CAP), internal ICT relationship (between the ICT unit and the business units) (INT_REL) and external ICT relationship (between the firm and its ICT vendors) (EXT_REL).

5 Results and Discussion

The estimates of the five models described in the previous section are shown in Table 1. For each independent variable the standardized regression coefficient is shown; statistically significant coefficients at the test levels of 1% and 5% are shown in bold. We can see that the effect of our overall measure of hard ICT capital, the ICT infrastructure sophistication, on CC benefits is positive and statistically significant; therefore research hypothesis H1 is supported. With respect to the five soft ICT capital variables, three of them have positive and statistically significant effects on CC benefits: the IS interconnection/integration capability, the ICT strategic planning and alignment capability and the internal ICT relationship; so research hypotheses H3, H4 and H5 are supported. On contrary the size of ICT personnel and the external ICT relationship do not have statistically significant effects on CC benefits; so research hypotheses H2 and H6 are not supported. We remark that among the examined types of ICT capital the capability for ICT strategic planning and alignment has the strongest positive impact on CC benefits (standardised coefficient 0.323); it is followed by the hard ICT capital (average standardised coefficient over the five models 0.229). Lower are the effects of the internal ICT relationship (standardised coefficient 0.201) and the IS interconnection/integration capability (standardised coefficient 0.177). Finally, we can see that the size dummy has a negative statistically effect on CC benefits, while the sector dummy does not have a statistically significant effect.

Independent Variable	Model 1	Model 2	Model 3	Model 4	Model 5
D_SIZE	**-0.168**	**-0.233**	**-0.259**	**-0.236**	**0.229**
D_SECT	-0.096	-0.113	-0.100	-0.117	-0.136
ICTI_SO	**0.261**	**0.236**	**0.148**	**0.237**	**0.262**
ICT_PERS	0.116				
INTEGR_CAP		**0.177**			
ICT_STRAL_CAP			**0.323**		
INT_REL				**0.201**	
EXT_REL					0.087

Table 1. Cloud Computing benefits regression models

The above results indicate that four out of the six examined types of ICT capital that firms develop can contribute to generating higher benefits from this innovative CC model of sourcing ICT services. The capability for developing ICT strategies and plans, which are connected with the overall strategies and plans of the firm (ICT strategic alignment), seems to have the strongest positive effect on CC benefits among all types of ICT capital examined in this study. Previous IS literature has highlighted the importance of ICT strategic planning in the on premises model of electronic support of firm's activities and alignment, and its positive impact on the business benefits firms gain from ICT usage (Chen et al., 2010; Galliers, 2011; Leidner, et al., 2011), which increases significantly if it is strongly connected and aligned with firm's overall strategic directions (ICT strategic alignment - Chan and Reich, 2007; De Haes and Van Grembergen, 2009; Wu et al., 2015). Our findings indicate ICT planning connected with business planning has a positive impact of the benefits gained from this new CC model as well. The existence of this important capability leads to a less fragmented and uncoordinated exploitation of CC, and more strategic one, aiming to support firm's strategic plans, address its weaknesses, leverage its strengths, as well as to facilitate and support seizing external opportunities and coping with external threats. This leads to a more strategically focused use of external CC services, and also a more sophis-

ticated one, which makes highly valuable, and at the same time rare and difficult to imitate combinations and integrations of CC services from many different vendors, and also with elements of firm's internal on-premises IS, and in general with important or even unique resources and capabilities of the firm, leading to higher levels of benefits from CC.

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

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

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

On the contrary, the size of firm's ICT personnel does not seem to affect CC benefits. This indicates that what matters for the generation of benefits from CC is not the mere employment of ICT human resources, but the development based on them of some critical ICT capabilities for ICT strategic planning connected with overall strategic directions, for building good and productive internal ICT relationships with firm's business units, and for interconnecting/integrating external and internal technological components. Also, we found that the external ICT relationship with ICT vendors does not affect the benefits generation from CC. This indicates that the external co-operation capabilities that

these relationships develop in a firm, as well as the specific mechanisms and procedures (formal or informal) for managing effectively these relationships, are not very much transferable to (useful for) the development and management of the relationships with the CC service providers: this probably happens because the nature and the subject of the relationships with ICT vendors are quite different from the ones with the CC service providers.

6 Conclusions

There have been high expectations about the potential of this new innovative CC model of sourcing ICT services to offer important advantages and benefits to firms, which are associated mainly with ICT costs reduction, and enhancement of firm's agility as well as innovation activity. However, limited empirical research has been conducted in order to understand to what extent these expectations are realized, what are the magnitudes of the benefits that firms really obtain from CC services usage, and which factors affect them (so that appropriate interventions can be designed for increasing CC benefits). This paper contributes to filling this important research gap. It formulates a set of research hypotheses concerning the effects of firm's 'hard ICT capital', and also some types of firm's 'soft ICT capital', on the benefits generated by CC. It has as theoretical foundation the RBV theory. It basic idea is that some types of both hard as well as soft ICT capital that firms possess enable a more sophisticated and valuable CC exploitation; in particular, they enable the design and implementation of complex combinations and integrations of many different CC services (possibly from different providers), and also with elements of firm's 'on-premises' ICT infrastructure, which can be highly valuable, and at the same time more rare and difficult to imitate, which lead to higher levels of CC benefits. This seems to be confirmed by our analysis. Our research hypotheses have been tested using data collected through a survey from 115 Greek firms, from which CC benefits regression models have been estimated. From these models it has been concluded that the sophistication of firm's ICT infrastructure (an overall measure of firm's hard ICT capital) has a positive impact on the benefits obtained from CC. Furthermore, three out of the five examined types of soft ICT capital have been found to impact positively the benefits that CC generates: the information systems (IS) interconnection/integration capability, the ICT strategic planning and alignment capability, and the internal relationship between firm's ICT unit and business units. Our findings reveal some aspects of firm's ICT capital that affect the generation of value from this new innovative CC paradigm.

Our study has interesting implications for research and practice. With respect to the former it extends the research that has been conducted concerning the effects of various types of firm's hard and soft ICT capital (both resources and capabilities) on different aspects of its performance, which concerns the classical on-premises model, to the CC model of sourcing ICT services required by firms, using a sound theoretical foundation: the RBV theory. Furthermore, it contributes to the development of a 'theory of CC business value', based on the unique combination of different (commoditized and widely available) CC services, and also with firm's internal resources and capabilities (both technological and non-technological ones). With respect to practice the findings of our research can be useful to CC service providers, in order to provide guidance to their clients for increasing the business value they obtain from CC; also, they can be useful to management and ICT firms' practitioners, as well as relevant consultants, in order to design appropriate interventions for the maximization of the business value firms obtain from CC.

This study has two main limitations. First, it has been based on data collected from one country (Greece); so it is necessary our research questions/hypotheses to be investigated in other national contexts as well. Second, it does not discriminate between different types of hard ICT capital, as we investigate the effects on CC benefits of one relevant independent variable, which is an overall measure of firm's hard ICT capital (ICT infrastructure sophistication); so it is necessary to examine the effects of different types of hard ICT capital on CC benefits. Furthermore, it would be interesting to investigate the effects of other types of firm's soft ICT capital (e.g. various ICT related capabilities) on the benefits generated from CC.

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Appendix: Questions Used

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

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

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

INTEGR_CAP	Capability of rapid internal implementation (by the ICT staff of your firm) of various interconnections/integrations of existing	1 2 3 4 5

	applications, so that there is interoperability of them (= one application can use data and functionality of other applications)	5
INT_REL	Good relationship, cooperation, mutual understanding and trust between the ICT personnel of your company and the personnel of its business units who use ICT	1 2 3 4 5
EXT_REL	Good relationship, cooperation, trust and exchange of information with ICT suppliers (of hardware, software, networks), and provision of sufficient support by them for solving all your relevant problems	1 2 3 4 5
ICT_STRAL_CAP	Capability for developing ICT strategies and plans which are connected with the overall strategies and plans of the firm (ICT strategic alignment)	1 2 3 4 5

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

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

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

Number of firm's employees : _____