Telematics and Informatics 34 (2017) 1322–1332

Contents lists available at ScienceDirect

Telematics and Informatics

journal homepage: www.elsevier.com/locate/tele

Why do firms adopt cloud computing? A comparative analysis based on South and North Europe firm data

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ARTICLE INFO

Article history:
Received 3 February 2016
Accepted 11 May 2016
Available online 25 June 2016

JEL classification:
O31

Keywords:
Cloud computing
Technology adoption

ABSTRACT

In this paper we empirically investigate and compare to what extent Northern and Southern European firms view cloud computing (CC) as a means of: (a) ICT investment reduction; (b) supporting and facilitating product/service innovation and process innovation; (c) experimenting with and exploiting new ICT; and (d) supporting and facilitating electronic innovation collaboration. This is done by estimating econometrically a model of CC adoption propensity containing measures of the four main adoption motives mentioned above besides further variables that are associated with technology adoption and a series of controls for firm size, sector and country affiliation. Our study is based on a dataset collected through the e-Business W@tch Survey of the European Commission from 556 European firms from the glass, ceramic and cement sectors. These findings indicate that Southern European firms are mainly oriented towards 'first-level' cost (and especially investment) reduction related benefits from CC as well as from new emerging ICT, while on the contrary Northern European firms are mainly oriented towards 'second-level' transformation related benefits from CC, which are associated with support and facilitation of innovation and external collaboration.

1. Introduction

The European North-South divide has been one of the most important and widely debated problems of Europe for long time (Aiginger, 2013a, 2013b; Landesmann, 2013). The countries of the European South (often referred to as the 'European Periphery') have for decades lower levels of economic and technological development, productivity and performance, and also higher levels of unemployment, than the countries of the European North. The Southern European counties are characterised by some fundamental weaknesses associated with the size and structure of manufacturing, deficits in innovation and education, deficits with respect to the exploitation of economy globalization and the restructuring of the public sector. They have a larger share of low-skill and a small share of high-skill industries; hence, the technology-driven industries are much smaller in comparison with the Northern European counties, and also declining. European periphery countries did not use the advantage of globalization despite being located by the sea and despite a history of global trade connections. It is because of these weaknesses (besides institutional problems) that economic performance differed across European countries, particularly between Northern and Southern countries, in the recent crisis (Aiginger, 2011). Though there has been a convergence

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http://dx.doi.org/10.1016/j.tele.2016.05.013
0736-5853/

between the European North and South for some time, recently, due to the economic crisis, this trend has stopped, and on the contrary a divergence is observed (Aiginger, 2013a, 2003). It is widely recognized that in order to overcome this negative situation, and achieve a gradual convergence between these two regions, it is important not only to cut wages and public expenditure in the European South (which has been the dominant approach so far), but also to make wider and better use of new technologies and boost innovation, aiming at the increase of productivity and growth.

Cloud computing (CC) is one of the most important, innovative and disruptive new information and communication technologies (ICT), which changes radically the way firms access and use ICT for supporting their activities. CC is defined 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, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (NIST, 2009). The idea is that part of the ICT support services required by firms are delivered not by their internal ICT units, but by external providers on an on-demand basis over the Internet, and users pay for the service as an operating expense, based on the real use of it, without having to make significant initial hardware and software investments, and also without having to incur operation, support and maintenance costs (Armbrust et al., 2010; Marston et al., 2011; Venters and Whitley, 2012).

In this paper we empirically investigate and compare Northern and Southern European firms with respect not to the 'quantity' of CC use, but to its 'quality': their CC adoption motivations and orientations. In particular, we investigate and compare to what extent Northern and Southern European firms view CC as a means of: (a) ICT investment reduction; (b) supporting and facilitating product/service innovation and process innovation; (c) experimenting with and exploiting new ICT; and (d) supporting and facilitating electronic innovation collaboration. Furthermore, this investigation is not based on the descriptive analysis of firms' managers' subjective perceptions concerning the usefulness of CC along the abovementioned four dimensions; it adopts a more "objective" approach, based on the estimation of a probit model the propensity for CC adoption, which is explained by the four main motives mentioned above (ICT investment reduction; product/service innovation and/or process innovation; interest in some new emerging ICT (data warehousing and data mining, mobile services); and having external collaborations for the development of innovations) separately for these two geographic regions and the pooled data of both regions. The estimated model contains further variables that are associated with technology adoption and a series of controls for firm size, sector and country affiliation. Our study is based on a dataset collected through the e-Business W@tch Survey of the European Commission from 556 European firms from the glass, ceramic and cement sectors.

This paper consists of six sections. In the following Section 2 a relevant literature review is presented, while in Section 3 our research hypotheses are developed. Then in Section 4 the data, the model specification and the econometric method of this study are described. In Section 5 the results are presented and discussed. The final Section 6 summarizes the conclusions and suggests future research directions.

2. Literature review

Considerable empirical research has been conducted concerning the factors affecting CC adoption by firms. Most of it has been based on the Technology, Organization and Environment (TOE) theory (Tornatzky and Fleischer, 1990; Baker, 2011), which identifies three groups of factors that affect the adoption of technological innovations in general by firms: technological (=perceived characteristics of the technological innovation), organizational (=firm's characteristics) and environmental (=characteristics of firm's external environment) factors (Low et al., 2011; Mangula et al., 2014; Hsu et al., 2014; Oliveira et al., 2014; Gutierrez et al., 2015). For each group a number of CC related factors are determined and the importance of their effects on adoption CC are statistically tested.

In particular, Low et al. (2011) examine the effect of a set of technological factors (relative advantage, complexity and compatibility), organizational factors (top management support, firm size and technology readiness) and environmental factors (competitive pressure and trading partner pressure) on CC adoption. They concluded that perceived relative advantage, top management support, firm size, competitive pressure and trading partner pressure have statistically significant effects on CC adoption.

Mangula et al. (2014) similarly examine the effect of technological factors (relative advantage, compatibility, complexity, trialability, observability), organizational factors (organizational readiness, top management support) and environmental factors (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 a positive correlation with SaaS adoption, while complexity has a negative correlation with it.

Hsu et al. (2014) examine the effect of perceived benefits and business concerns (technological factors), IT capability (IT personnel and budget – organizational factor) and external pressure (environmental factor) on CC adoption intention; they found that the first three of these factors are significant determinants of CC adoption.

Oliveira et al. (2014) examine the effects of three CC characteristics from a technological innovation perspective (relative advantage, complexity and compatibility), three organizational context characteristics (top management support, firm size, technological readiness) and two environmental context characteristics (competitive pressure, regulatory support). They found that relative advantage, technological readiness, top management support and firm size have positive effects on CC adoption, while complexity has a negative effect. Another similar study has been conducted by Gutierrez et al. (2015),

who examined the effects of a set of technological factors (relative advantage, complexity and compatibility), organizational factors (top management support, firm size, technological readiness) and environmental factors (competitive pressure, trading partners pressure) on CC adoption. They concluded that competitive pressure, complexity, technology readiness and trading partner pressure have a significant influence on the adoption of CC services.

Furthermore, there are CC adoption empirical studies that are based on the synthesis of other theoretical frameworks. The study of Benlian et al. (2009) developed a SaaS adoption model by combining three theoretical foundations: transaction cost theory (including in their model the application specificity and perceived uncertainty), resource-based view of the firm (including application strategic value and inimitability) and theory of planned behaviour (including the attitude towards SaaS and also social influence). It has concluded that social influence, adoption uncertainty and application strategic value are the most consistent SaaS adoption drivers across all application types.

The study of Saya et al. (2010) formulated a four layers structural equation CC adoption model, based on the institutional theory and the real options theory. It reached the conclusion that institutional influences (e.g., from government, customers, suppliers, competitors, strategic partners, industry and trade organizations, professional bodies) affect organizations perceptions about the technological characteristics of CC (perceived accessibility, scalability, cost effectiveness and lack of security), and through them affect the perceptions on the provided real options by CC adoption (concerning ICT applications growth, abandonment and deferral) and finally the intention to adopt CC.).

Benlian and Hess (2011) having as theoretical foundation the theory of "reasoned action" in combination with previous research on ICT outsourcing and application service provision (ASP), examine the effects of perceived SaaS opportunities (cost advantages, strategic flexibility, focus on core competencies, access to specialised resources and quality improvements) and SaaS risks (performance, economic, strategic, security and managerial ones) on the intention to increase the level of its adoption. They have concluded that the perceived cost advantages have the strongest positive effect, followed by strategic flexibility and the quality improvement, while the security risks have the strongest negative effect, followed by the performance, economic and strategic risks.

Wu et al. (2013) conducted a study of CC adoption factors having as theoretical foundations the innovation diffusion theory (DOI) proposed by Rogers (2003) and the "information processing view" (IPV) of the firm. They concluded that business process complexity and also applications compatibility have negative effects on CC adoption intention, while entrepreneurial culture and applications functionality have positive effects.

In sum, there is considerable heterogeneity in the theoretical approaches as they are used in the information systems management literature, even if there is some overlapping among them. Hence, there is a need for a unifying framework for analysing technology diffusion processes. We try to satisfy this need by utilizing a theoretical framework that is widely used in economics. Further, there is a lack of empirical studies of the association between CC adoption and various aspects of firm's strategy and operation, which would provide valuable insight into CC adoption motivations and orientations of firms. Also, there is a lack of comparative studies in this respect between geographic regions or countries, from such a 'quality' related perspective, rather than a 'quantity' related one. This study contributes to filling these research gaps by empirically investigating and comparing Northern and Southern European glass, ceramic and cement sector firms with respect to their CC adoption motivations and orientations.

3. Conceptual background and research hypotheses

Our general theoretical framework builds on the adoption model of Battisti et al. (2009). According to this model the first use of a new technology is determined by five categories of variables: firstly, a vector of characteristics of a firm and its environment reflecting so-called "rank effects", i.e. relative advantages that might make the technology adoption beneficial for the firm;[1] secondly, factors that reflect motives for adopting a certain technology, i.e., "inducement effects";[2] thirdly, the extent of usage of a technology to capture inter-firm "stock and order effects" (i.e., market-intermediated externalities);[3] fourthly, "epidemic effects" (i.e., learning and non-market intermediated externalities) reflecting either a firm's own earlier experience of similar technologies or experience gained through the observation of other firms that use the new technology; fifthly, the expected adoption costs that have to be lower than the expected benefits in order to adopt the new technology.

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

[1] Rank effects could lead to differing returns to adoption and consequently to different adoption behaviour (Davies, 1979; Ireland and Stoneman, 1986).

[2] The original model in Battisti et al. (2009) does not include explicitly a variable for inducement effects. We expanded the model to take into account also this important factor in accordance with Arvanitis and Ley (2013).

[3] Stock and order effects refer to externalities either due to early-mover advantages (order effect) or lower adoption costs due a larger number of firms utilizing a technology (stock effect) (Battisti et al., 2009). For more information on inducement effects see, e.g., Binswanger (1974).

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

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

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

Our second research hypothesis concerns the association between the adoption of an innovation-oriented strategy and the propensity for CC adoption. Changes in customers' needs and preferences, emergence of new technologies and strong competition make it necessary for firms to make innovations in their products and services, and also in their internal production and administrative processes, which have become today highly important for the competitiveness and even for the survival of firms. However, these innovations (both product/service and process ones) usually necessitate the development of complex supporting ICT infrastructures. This can be costly (requiring considerable capital investments), risky (since if the innovation is not successful its supporting ICT infrastructure will become to a large extent useless, leading to waste of significant financial resources), and also can take too much time (which is quite negative in the rapidly changing and highly competitive modern economy). CC can alleviate the above problems: it can reduce the cost of the required ICT infrastructure for supporting an innovation (and make it an operational expense, without having to make ICT investments), reduce the implementation time (as the required CC services can be rapidly activated and customized), and also reduce the risk (since if the innovation is not successful the CC services used for supporting it can be simply terminated). Extant CC literature has emphasized that it can provide benefits associated not only with the ICT cost reduction, but also with the support and facilitation of innovations as well, as CC enables the rapid development of their required supporting ICT infrastructures, at a low cost, without requiring ICT capital investments (Brynjolfsson et al., 2010; Marston et al., 2011; Venters and Whitley, 2012; Berman et al., 2012). So, we expect that firms adopting an innovation-oriented strategy will have a strong propensity to adopt CC. Thus, our second hypothesis is:

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

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

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

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

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

4. Data, model specification and estimation method

4.1. Data

In this study we used firm level data collected through the "e-Business Survey 2009" survey, conducted by the e-Business Market W@tch (www.ebusiness-watch.org) under the auspices of the European Commission. The survey was based on a questionnaire that contained questions on the use of various types of ICT, ICT skills, ICT investment, and also innovation activity. The data come from 676 firms of the glass, ceramic and cement sectors from six European countries: Germany, France, UK, Italy, Spain and Poland. For this study we used only the data from the first five of these countries, with the first three belonging to the European North, and next three belonging to the European South, while the Polish data were not used (as Poland belongs to the Easter European region, which has quite different economic characteristics). The dataset used in this study contained 556 observations, 3 of them had to be dropped due to missing values for important variables.

The data were collected through interviews using computer-aided telephone interview technology. The decision-maker in the enterprise targeted by the survey was normally the person responsible for ICT within the enterprise. Alternatively, particularly in small firms, the managing director was interviewed. The survey took into consideration only enterprises that used computers. The sample drawn was a random sample of enterprises from the respective sector population in each of the countries considered, with the objective of fulfilling minimum strata with respect to size class per country-sector cell. The response rate, i.e. the number of completed interviews divided by the net sample of contacts established with eligible enterprises, was typically about 15–20%, with, however, big differences in some of the countries. Table A.1 in the Appendix presents the composition of the dataset used in the present study by country and sector. 59.4% of all firms come from Northern Europe, 40.6% of them from Southern Europe; about 50% of all enterprises come from the cement sub-sector. Table A.2 contains standard descriptive statistics (mean; standard deviation) for all variables in our model (see also Table 3), while Table A.3a, Table A.3b and Table A.3c show the correlations among model variables for all firms, and separately for the sub-sample of firms from Northern Europe and Southern Europe, respectively. A short inspection of these tables demonstrates that none of the correlation coefficients is larger than 0.26, thus practically excluding problems of multicollinearity in our estimates.

4.2. Model specification

As dependent variable we used the propensity for CC adoption, which is constructed as a binary variable with the value 1, if firms report relevance of CC for their activities and 0, if they report that CC is not relevant for them. As independent variables we used, first, four binary variables referring to the four different motivations for adopting CC (ICT investment reduction; product/service innovation and/or process innovation; interest in new emerging ICT – data warehousing, data mining, and mobile services; and electronic (i.e., supported by ICT) external innovation collaboration). These four variables measure *inducement effects* that are specific for CC (see Section 3). Further, we control for other factors that could influence the CC propensity: (a) some firm characteristics (firm size, firm being part of an international enterprise group, exporting, earlier experience with other ICT outsourcing activities); (b) environmental factors (intensity of price competition at the main market), both groups of variables reflecting *rank effects*; and (c) experience with CC of other firms in the firm-specific market environment (net effect of *stock, order and epidemic effects*; see Section 3). Finally we control for sector and country affiliation in order to reduce the possibility of omitted variable bias (and control for *adoption costs*; Section 3). Table 3 shows in detail how the model variables were constructed. Our model can be formally expressed as follows:

Table 1
Cloud computing propensity by country.

Cloud computing propensity		Very or partly relevant (%)	Not relevant (%)
South (N = 226)	Italy	21.8	78.2
	Spain	16.0	84.0
North (N = 327)	UK	4.7	95.3
	France	12.8	87.2
	Germany	4.4	95.6

Table 2
Motives for adopting cloud computing; percentage of firms.

		ICT investment reduction	Product innovation	Process innovation	Interest in data mining, ware-houses	Interest in mobile services	Electronic collaboration
South (N = 226)	Italy	30.7	39.6	38.6	32.7	13.9	13.9
	Spain	30.4	36.0	44.0	26.4	13.6	13.6
North (N = 327)	UK	14.1	34.4	40.6	9.4	26.5	7.8
	France	20.9	20.9	24.4	22.1	41.9	11.6
	Germany	16.7	36.1	39.4	17.2	33.9	9.4

Table 3
Definition of the variables.

Variables	Definitions
Dependent variables	
CLOUD_PROP	Relevance of cloud computing; binary variable: 1: very relevant, partly relevant; 0: not relevant
Independent variables	
Inducement effects	
ICT_INVEST_RED	Impact of the economic crisis on ICT investment plans or on ICT projects; binary variable: 1: yes, no ICT or e-business projects were cancelled or significantly downsized or yes, ICT or e-business projects were cancelled or significantly downsized; 0: no impact
INNO	Introduction of product or process innovations in the past 12 months; binary variable: 1: yes; 0: no
INNOPC	Introduction of process innovations in the past 12 months; binary variable: 1: yes; 0: no
NEW_ICT_TECH	Relevance of service-oriented architectures and/or data warehouses; data mining and/or mobile services such as mobile commerce and remote access technologies; binary variable: 1: yes; 0: no
COLLAB_ELC	Use of software applications other than E-mail to collaborate in the development of new products or processes; binary variable: 1: yes; 0: no
Rank effects	
OUTS	Outsourcing of ICT services in the past12 months; binary variable: 1: yes; 0: no
EXPORT	International market as most important sales market; binary variable; 1: yes; 0: no
INTER	Part of a multinational enterprise; 1: yes; 0: no
PCOMP	Importance of price competition in the main market; 3-level ordinal variable: 0: not important; 1: quite important; 2: very important
Medium-sized	50–249 employees
Large	250 employees and more
Stock, order, epidemic effects	
EP	Percentage of firms reporting relevance of cloud computing in one of 15 sub-markets (3 sectors in 5 countries)
Subs-sector dummies	Ceramics, cement (reference: glass)
Country dummies	France, Italy, Spain, United Kingdom, Germany

$$CC_i = b_0 + b_1 ICT\_INVEST\_RED_i + b_2 INNO_i(INNOPC_i) + b_3 NEW\_ICT\_TECH_i + b_4 COLLAB\_ELC_i + b_5 OUTS_i + b_6 EXPORT_i + b_7 INTER_i + b_8 PCOMP_i + b_9 Medium - sized_i + b_{10} Large_i + b_{11} EP_i + sector\ dummies + country\ dummies + e_i$$

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

5. Results

5.1. Descriptive analysis

In Table 1 we show the share of firms reporting that CC is "very relevant" or "partly relevant" for their activities for each of the five countries examined in this study. We remark that in the glass, ceramic and cement sectors of the examined Southern

Table 4
Probit estimates for the binary variable CLOUD_PROP.

Indep. variables	Southern Europe	Northern Europe	All firms
Inducement effects			
ICT_invest_red	0.582***	0.245	0.412***
	(0.230)	(0.246)	(0.164)
INNOPC		0.507*	
		(0.298)	
INNO	0.197		0.208
	(0.228)		(0.172)
NEW_ICT_TECH	0.941***	0.249	0.683***
	(0.274)	(0.282)	(0.191)
COLLAB_ELC	0.121	0.967***	0.468**
	(0.292)	(0.315)	(0.218)
Rank effects			
OUTS	0.340	0.514*	0.340*
	(0.272)	(0.303)	(0.196)
EXPORT	−0.649*	−0.103	−0.425*
	(0.362)	(0.312)	(0.234)
INTER	0.400	0.300	0.304
	(0.383)	(0.328)	(0.239)
PCOMP	−0.033	0.302	0.066
	(0.187)	(0.206)	(0.134)
Medium-sized	−0.256	0.324	−0.059
	(0.248)	(0.271)	(0.185)
Large	0.262	−0.185	0.151
	(0.380)	(0.410)	(0.270)
Stock, order, epidemic effects			
EP	0.040*	0.033	0.024**
	(0.023)	(0.023)	(0.012)
Controls			
Sector dummies	Yes (2)	Yes (2)	Yes (2)
Country dummies	Yes (1)	Yes (2)	Yes (4)
Const.	−2.763***	−3.802***	−2.899***
	(0.755)	(0.804)	(0.458)
N	226	327	553
Pseudo R^2	0.188	0.267	0.218
Wald Chi2	42.2***	58.5***	71.2***

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

Europe countries there is a higher share of firms considering CC as very relevant or partly relevant than in the examined Northern Europe countries. A possible explanation of this might be that the economic problems of the European South limit the financial resources of firms, and this increases their propensity to use CC for reducing the ICT costs and especially ICT investments; however, a clearer picture on this can be formed by examining the model estimates, which are discussed in the following paragraphs of this section.

In Table 2 we present the share of firms reporting that the various motivations for using CC are "very relevant" or "partly relevant" for them (see also Table 3) for each of the five countries examined in this study. We remark that in the European South the percentage of firms of these sectors adopting an ICT investment reduction strategy is much higher than in the European North, due to the existing economic problems that reduce demand and sales. Further, we find in Southern Europe higher percentages of firms introducing innovations, having electronic external innovation collaboration and being interested in data warehousing/mining.

5.2. Econometric analysis

Table 4 shows the probit estimates for the sub-samples of the firms in Southern Europe (column 1) and in Northern Europe (column 2) as well as for the entire sample (all firms; column 3).[4] The main focus is on the variables for the four different motivations related to our research hypotheses.[5] For the firms from Southern Europe seem to be relevant the motive of

[4] All model variables (with the exception of the competition variable PCOMP) are dummy variables; for this reason we refrain here from calculating marginal effects. Given the cross-sectional character of our data we refrain from interpreting our estimated coefficients as causal effects; we see them as conditional correlations that give important hints with respect to the validity of our hypotheses.

[5] Wald chi2 tests for the difference of the coefficients of ICT_INVEST_RED and NEW_ICT_TECH in the equation for Southern Europe as well as for the difference of the coefficients of INNOPC and COLLAB_ELC in the equation for Northern Europe show no statistical significance at the 10% test level. So the effects of the motives that are statistically significant appear to be of similar magnitude in both regions.

ICT invest reduction and the motive of the interest for emerging technologies, but not the innovation and the collaboration motives.[6] The respective findings for the Northern European countries are quite opposite to those for South Europe: relevant are in this case the innovation motive, particularly for process innovation, and the collaboration motive, which is related to the innovation motive. So we find two different patterns of motives for the two European regions. With respect to our hypotheses the results are in a way complementary to each other: H1 and H3 appear to be valid for Southern Europe but not for Northern Europe and H2 and H4 seem to be valid only for Northern but not for Southern Europe. For three of the four motives examined in this study we find positive and statistically significant coefficients in the estimates for all firms. As we have seen, behind this overall finding hides much heterogeneity with respect to the southern and northern part of the European Union.

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

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

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

6. Conclusions

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

However, the main contribution refers to the empirical findings. One of the most important problems of Europe for long time has been the gap in economic and technological development and performance between the European North and the European South, referred to as the 'European North-South divide'. Though for some time a gradual convergence between these two regions was in progress, recently, due to the economic crisis, this has stopped, and on the contrary a new divergence has started. It is widely recognized that in order to reverse this negative trend and achieve a gradual convergence between these two regions, it is of critical important to make wider and better use of new technologies and boost innovation in the European South in order to improve its productivity. This study makes a contribution to this 'European North-South divide' debate, by empirically investigating and comparing European North and South with respect to the one of the most important, innovative and disruptive new ICT, the CC. This technology changes radically the way firms access and use ICT for supporting their activities, and also the economics of business computing as it enables the conversion of relevant capital investments (cap-ex) to operating costs (op-ex). In particular, we investigate and compare the "quality" (instead of the "quantity" usually examined by similar studies) of CC use (or planned use) by the Northern and Southern European firms. To his end, we examine to what extent they view CC as a means of: (a) ICT investment reduction; (b) supporting and facilitating product/service innovation and process innovation; (c) experimenting with and exploiting new ICT; and (d) supporting and facilitating external collaboration.

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

[6] We examined all three innovation variables (product innovation; process innovation and the combined variable product or process innovation in all three estimations. The variable for product innovation has not been significant in any estimate. For this reason we show here only the results for the combined variable (INNO) and the variable for process innovation (INNOPC). Due to high multicollinearity we avoided inserting both the product and the process innovation variable together in the estimated equations.

Table A.1
European glass, ceramics and cement industry: composition of the dataset by country and sub-sector.

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

Table A.2
Descriptive statistics.

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

These findings is indicate that Southern European firms are mainly oriented towards ‘first-level’ cost (and especially investment) reduction related benefits from CC as well as from new emerging ICT, while on the contrary Northern European firms are mainly oriented towards ‘second-level’ transformation related benefits from CC, which are associated with support and facilitation of innovation and external collaboration. The difficulty of financing investments in the problematic economic

Table A.3a
Correlation matrix of the model variables; South.

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

Table A.3b
Correlation matrix of the model variables; North.

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

Table A.3c
Correlation matrix of the model variables; all firms.

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

context of the European South, in combination with the longer and stronger tradition of the European North concerning the use and advanced exploitation of complex new technologies, are a possible explanation for these findings.

The results of this empirical study have interesting implications both for research and practice. With respect to research it makes a contribution to the existing body of knowledge concerning the impact of the national context of ICT adoption, focusing on a very important and disruptive ICT (the CC), particularly on motivations and orientations of CC adoption. With respect to practice, our conclusions can be useful for government agencies, both at national level and at European level, in order to formulate effective technology adoption and transfer policies, and also for CC services providers, in order to optimize their offerings in taking into account the specific characteristics and needs of each national market. Our study has two main limitations: its limited sectoral and national scope, and also the use of a rather broad dependent variable (propensity for CC adoption in general). So further research is required concerning the motivations/orientations of the adoption of various types of CC services (e.g. IaaS, PaaS, SaaS), in various sectorial and national contexts.

Appendix A

See Tables A.1, A.2, A.3a, A.3b and A.3c.

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