

## E-commerce and Information and Communication Technologies in Greek firms

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### Abstract

*In this article we explore the evolution and potential determinants of the adoption of Information and Communication Technologies (ICT) and e-commerce by Greek firms. Utilizing data from the annual surveys on the "Use of Information, Communication and Electronic Commerce Technologies" undertaken by the Hellenic Statistical Authority (ELSTAT) for the 2008-2016 period, we examine the evolution of key indicators of ICT and e-commerce (use of personal computers-PCs, internet access, website availability, reception of electronic orders) over time. In addition, with the use of econometric analysis we investigate the role of ICT infrastructure, human capital and firm characteristics (size, industry, location) in e-commerce adoption and we identify factors that may hinder firms' e-sales. According to our findings the vast majority of Greek firms use PCs and have internet access; however, the dissemination of e-commerce appears to be still rather limited. Econometric results show that investments in infrastructure and human capital appear to be particularly important for e-commerce adoption. Also, small firms, firms belonging to trade and services sectors, as well as enterprises located in the Greek periphery seem to have an increased probability of being engaged in e-commerce activities.*

**Keywords:** e-commerce, Information and Communication Technologies (ICT), barriers to e-commerce

### 1. Introduction

Information and Communication Technologies (ICT) have changed, in a radical way, the majority of business activities, creating huge opportunities and mul-

iple benefits for enterprises at the regional, national and international level. From a business perspective, the gains of integrating and using ICT refer to cost savings, organizational effectiveness, improvement of services to customers and suppliers, and access to new business opportunities and market information; these gains are usually translated in terms of innovation, productivity, competitiveness and growth (Arvanitis, 2005; Ghobakhloo et al., 2011; Tan et al. 2010).

More specifically, e-commerce, as a form of ICT application, can significantly improve firms' efficiency in their daily activities and transactions, increase information flows and open new cross-border distribution channels, which can contribute to firms' internationalization (Ongori and Migiro, 2010). On the other hand, as in the case of general purpose technologies, integrating and using e-commerce technologies entails a series of adaptation costs (e.g., employee training, licensing, organizational restructuring and upgrading existing facilities). These costs need to be taken into consideration, especially in the case of SMEs, which face increased constraints with respect to financial capital as well as human and other resources (Ghobakhloo et al., 2011; Tan et al., 2010).

The issue of ICT adoption has attracted much attention in the international literature, with a significant number of studies undertaking survey-based research considering firms of different sizes, industries and/or countries, as well as different technology types (Bayo-Moriones and Lera-López, 2007; Fabiani et al., 2005; Kurnia et al., 2015; Hollenstein, 2004; Dholakia and Kshetri, 2004). In Greece, the relevant studies are rather limited. Particularly, Spanos et al. (2002), using survey data from 91 leading companies with an average firm size of 515 employees, identify significant relationships between ICT adoption and some changes in strategy, organizational structure, management systems and human capital skills. Moreover, Papastathopoulos and Beneki (2010), using survey data for 54 Greek SMEs, show the existence of a statistically significant relationship between ICT investments and both ICT-organizational forms and ICT strategy. Chatzoglou et al. (2010), also based on survey data from 278 employees in Greek SMEs, ex-

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amine personal computer acceptance patterns using a structural equation model.

In addition, the results from logistic regressions for 100 Greek SMEs participating in a questionnaire-based survey undertaken by Pontikakis et al. (2006) highlight the role of previous experience in the adoption of internet-enabled personal computers. Finally, very recently, Giotopoulos et al. (2017) utilize data from a large-scale survey on 3,500 Greek SMEs to explore the role of firms' technological competencies, human capital of workforce and internal organization in ICT adoption. Econometric analysis shows that innovation and R&D activities and collaborations, well-educated and skilled workers, decentralized decision-making and visionary leadership increase the likelihood of adopting new technologies in SMEs.

The present article contributes to the literature related to ICT and, more specifically, e-commerce adoption using and analyzing data from a large sample of Greek firms. The Greek case appears to be of interest due to the adverse economic conditions that businesses have faced during at least the last 8 years and also due to the limited exploitation by firms of opportunities and possibilities arising from the new technologies. In this respect, Europe's Digital Progress Report (EDPR) for the year 2017 (European Commission, 2017) once again classifies Greece in the group of countries with low performance, along with Romania, Bulgaria, Italy, Croatia, Poland, Cyprus, Hungary and Slovakia.

Given the above, many scholars and policy makers highlight the significant role that new technologies can perform in Greece, on its way to rebalancing and economic recovery (Giotopoulos et al., 2017; Kontolaimou, 2015). In this context, we examine the development of key indicators of ICT and e-commerce over time, and we also explore the role of ICT infrastructure, human capital and firm characteristics (size, industry, location) in e-commerce adoption by Greek firms with the use of econometric analysis. In addition, we identify factors that may hinder the implementation of such technologies, operating as significant barriers to firms' e-sales in Greece.

The article is structured as follows: Section 2 presents the evolution of basic indicators of ICT and e-commerce adoption over time. Section 3 describes the data, the variables and the econometric model used. Estimation results are presented and discussed in Section 4. The last section concludes and provides some relevant policy implications.

## 2. Evolution of ICT and e-commerce adoption by Greek firms

The data used to capture the evolution of ICT and e-commerce adoption over time, as well as to conduct the econometric analysis, are derived from the survey "Use of Information, Communication and Electronic Commerce Technologies (ICT)", which is carried out by ELSTAT on an annual basis. It should be noted that the questionnaires sent by ELSTAT to firms vary each year, with only a certain number of questions being common to all the years under investigation. Moreover, the survey is addressed to firms with at least 10 employees; therefore the sample does not include micro enterprises.

As far as the adoption of ICT by Greek firms is concerned, three key factors are examined: computer usage, internet access and the existence of a company's home page or website. The data are derived from the annual surveys that took place during the period 2008-2016. Regarding e-commerce adoption, it is examined whether the company received orders for products or services through a website or specific applications (apps) during the previous year of the survey.<sup>1</sup>

Table 1 presents the number of firms that responded to the ELSTAT survey, as well as the number and percentage of companies that use PCs. The percentage of firms using PCs ranges between 93% and 97% during the period 2008-2016. It is noteworthy, that the low-

**TABLE 1 Number and percentage of firms using PCs**

Year	No of firms	No of firms using PCs	% of firms using PCs
2008	1,906	1,855	97%
2009	2,981	2,858	96%
2010	3,123	3,019	97%
2011	2,547	2,480	97%
2012	2,080	2,003	96%
2013	3,100	2,942	95%
2014	3,295	3,128	95%
2015	2,654	2,472	93%
2016	3,010	2,820	94%

1. Manually typed e-mails are excluded.

**TABLE 2 Percentage of firms that use PCs and have access to the Internet, have a website and receive electronic orders (e-commerce)**

Year	Internet	Website	E-commerce
2008	98%	73%	10%
2009	97%	71%	9%
2010	99%	72%	12%
2011	99%	78%	11%
2012	99%	75%	10%
2013	98%	76%	12%
2014	99%	77%	12%
2015	99%	79%	9%
2016	99%	81%	12%

est percentages, 93% and 94%, are observed in the last two years of the period under examination; that is in 2015 and 2016, respectively.

Almost all firms using PCs have access to the Internet during the period 2008-2016, as shown in Table 2. This percentage ranges from 97% to 99%, and since 2010 it has remained stable at 99%, with the sole exception of 2013. In addition, a large percentage of firms using PCs also have a website or a homepage (Table 2). This percentage ranges from 71% to 81%. It should be noted, that the average percentage of firms using PCs and having a website is 74% for the sub-period 2008-2012, while the corresponding average, for the sub-period 2013-2016, is 78%. Therefore, there seems to be an increasing trend in the number of companies that have a website.

The percentage of firms using PCs and having received electronic orders appears to be relatively stable over the period under consideration, ranging between 9% and 12%, as shown in Table 2. Considering the average percentage of firms that received electronic orders during the two sub-periods, 2008-2012 and 2013-2016, we observe that it remains stable at 11%. Therefore, there seems to be no clear trend of increase or decrease, as far as the adoption of e-commerce is concerned, during the period under examination.

### 3. Data, variables and the econometric model

The econometric analysis makes use of data on 5,664 firms that participated in the most recent surveys of ELSTAT for years 2015 and 2016, which were available at the time of our research.<sup>2</sup> The analysis is based on these two years to consider the most recently available data and also to take advantage of the similarity of the questionnaires used (many common questions) in the respective surveys.

Table 3 presents firm distribution in our sample per size, sector and location. Firms are classified in three size groups, namely small, medium and large, according to the EU respective definitions. As already mentioned, the specific ELSTAT surveys address enterprises with at least 10 employees. Also, firms of our sample are classified in four sectors, i.e. manufacturing; services; retail and whole trade; energy and construction, based on the European Commission's NACE classification of economic activities.

As shown in Table 3, the majority of the examined firms are small (62%) and operate in the services (38%) and manufacturing (33%) sectors. Moreover, regarding regional distribution, almost half of the firms under study appear to have their base in the region of Attica, while the region of Central Macedonia follows with a percentage of 14.5%. The remaining Greek regions exhibit one-digit percentages, implying the significant concentration rate of firms in the largest urban centers of the country (Athens and Thessaloniki). Generally, we can argue that the firm distribution reported in Table 3 reflects to a large extent, the structural and demographic attributes of the Greek economic activity.

Based on related international literature (Haller and Siedschlag, 2011; Taylor and Murphy, 2004), we define the dependent variable of electronic sales in our model as follows:

**Electronic sales (Esales):** The firm reports whether it received orders for products/services via website or special applications ('apps') during the year preceding the survey. It is a binary (0/1) variable taking the value of 1 in case of a positive answer, and 0 otherwise.

The independent (explanatory) variables we use refer to ICT infrastructure, human capital, firm size, sector of economic activity and firm location. Related studies have systematically investigated and emphasized the role of human capital (Fabiani et al., 2005; Lucchetti and Sterlacchini, 2004; Martins and Oliveira, 2008), as

2. Firm coding in the specific ELSTAT surveys does not allow the identification of common firms across the surveys; as a result, the construction of a panel dataset taking into account the time dimension was not possible.

**TABLE 3 Firm distribution per size, sector and location**

	Number of firms	Percentage (%)
<i>Size</i>		
Small (<50 employees)	3,514	62.04
Medium (50-249 employees)	1,528	26.98
Large (250 or more employees)	622	10.98
<i>Sector</i>		
Manufacturing	1,892	33.40
Retail & whole trade,	1,163	20.53
Services	2,172	38.35
Energy and construction	437	7.72
<i>Location</i>		
Attica region	2,822	49.82
Central Macedonia	825	14.57
Rest of Greece	2,017	35.61
Total	5,664	100

well as demographic factors (Tan et al., 2010; Dholaria and Kshetri, 2004; Bayo-Moriones and Lera-López, 2007) in ICT adoption. In addition, following existing empirical studies (Hollenstein, 2004; Ghobakhloo et al., 2011), we include in our model a set of variables to capture potential obstacles that firms face in receiving and executing client electronic orders. More specifically, we examine the following variables:

**Employees with internet access (Interempl):** The firm reports the number of employees who used PCs with internet access in the context of their work during the year preceding the survey. It is a continuous variable expressed in a natural logarithmic form.

**Website availability (Website):** The firm reports whether it has a website. It is a binary (0/1) variable taking the value of 1 in case of a positive answer, and 0 otherwise.

**Training ICT specialists (Training):** The firm is asked whether it provided training to ICT specialists to develop/upgrade their ICT skills during the year preceding the survey. It is a binary (0/1) variable taking the value of 1 in case of a positive answer, and 0 otherwise.

Regarding barriers to electronic sales, enterprises that participated in the survey were asked to note in a given list all factors that constrained or hindered e-sales via website or 'apps' during the year preceding the survey. Based on firms' answers we constructed the following binary variables:

**Unsuitability of products/services (Products):** It takes the value of 1 in the case where the firm considers its goods or services not suitable for sales via website, and 0 otherwise.

**High cost (Cost):** It takes the value of 1 in the case where the firm considers the costs of introducing web sales too high compared to the benefits, and 0 otherwise.

**Problems related to payments (Payment):** It takes the value of 1 in the case where the firm notes problems related to payments as a barrier to web sales, and 0 otherwise.

**Problems related to ICT security or data protection (Security):** It takes the value of 1 in the case where the firm notes problems related to ICT security or data protection as a barrier to web sales, and 0 otherwise.

**Problems related to the legal framework (Legal):** It takes the value of 1 in the case where the firm notes problems related to the legal framework as a barrier to web sales, and 0 otherwise.

To account for firm size, we included in our model two dummies, i.e. *medium* and *large* (as defined above), considering small firms as the reference group. Also, we included sector dummies which show whether the enterprise operates in *trade*, *services* or *energy and construction*, defining manufacturing as the reference category in the econometric analysis. Finally, we took into account firm location, that is whether the enter-

prise is based in a highly urbanized region, by creating a binary variable (*location*) which takes the value of 1 in the case where the firm reports the region of Attica or Central Macedonia as its base, and 0 otherwise.

Given the above, the model to be estimated can be written as:

$$\begin{aligned}
 Esales_i = & b_1 Inerempl_i + b_2 Website_i + \\
 & + b_3 Training_i + b_4 Products_i + b_5 Cost_i + \\
 & + b_6 Payment_i + b_7 Security_i + b_8 Legal_i + \\
 & + b_9 Location_i + \mathbf{kS}_i + \mathbf{rI}_i + u_i
 \end{aligned} \quad (1)$$

where the dependent variable  $Esales_i$  stands for the electronic sales of firm  $i$ . The explanatory variables  $Inerempl_i$ ,  $Website_i$ ,  $Training_i$  and  $Location_i$  denote employees with internet access, website availability, training provided to ICT specialists and location of firm  $i$ , respectively.  $Products_i$ ,  $Cost_i$ ,  $Payment_i$ ,  $Security_i$  and  $Legal_i$  refer to the barriers to e-sales reported by firm  $i$ , namely unsuitability of products/services, the high cost, payment problems, ICT security problems and legal framework problems, respectively. Vectors  $\mathbf{S}_i$  and  $\mathbf{I}_i$  represent size and industry (sector) dummies, respectively. Finally,  $u_i$  is the error term for firm  $i$  and  $\mathbf{b}$ ,  $\mathbf{k}$  and  $\mathbf{r}$  denote the vectors of coefficients to be estimated.

As described above, the dependent variable  $Esales_i$  is a binary (dichotomous) variable, i.e:

$$Esales_i = y = \begin{cases} 1, & \text{if the firm receives client orders via} \\ & \text{website or 'apps'} \\ 0, & \text{if the firm does not receive client} \\ & \text{orders via website or 'apps' 'apps'}. \end{cases}$$

In the case of dichotomous dependent variables the analysis undertaken concerns primarily the probability:

$$p(\mathbf{x}) = P(y = 1|\mathbf{x})$$

where  $\mathbf{x}$  denotes the vector of the explanatory variables. We can use a function  $F$  (usually called a link function) to express our model, i.e.

$$P(y = 1|\mathbf{x}) = F(\mathbf{x}\mathbf{b} + u). \quad (2)$$

assuming that  $0 < F(\mathbf{z}) < 1$ , for all real values  $\mathbf{z}$ .

Equation (2) is a general formulation which can accommodate both Probit and Logit models which are

used to estimate equation (1). The Probit model uses the standard normal distribution for the specification of  $F$ , while the Logit model uses a standard logistic distribution. Both models are estimated using the maximum likelihood estimation method. In non-linear models, like Probit and Logit, the estimated coefficients are not interpreted in the same way as in the case of linear regression models. The estimators in these models inform us about the statistical significance of each variable, but not about the size or magnitude of the relevant effect. Thus, for comparison and interpretation reasons we also estimated the average marginal effects of the variables of interest on the probability  $p(\mathbf{x}) = P(y = 1|\mathbf{x})$ .

#### 4. Econometric analysis results

Table 4 presents the estimation results for the Probit and Logit models, as described above, referring to the factors that may affect the probability of realizing electronic sales. Notably, as can be deduced from Table 1, 372 enterprises that participated in both 2015 and 2016 surveys reported that they do not use PCs and, thus, did not proceed to the next sections of the questionnaire. In order to check for the existence of sample selection bias due to the exclusion of the specific observations from the analysis, we performed a two-stage regression based on the Heckman model (Heckman, 1979). The appropriate test in this setting showed that our estimations are not biased due to sample selection.<sup>3</sup>

As shown in Table 4, results from the two models are largely in agreement, with marginal effects in the Probit models being, in most cases, larger than the corresponding ones in the Logit model. We can say that both models perform rather well (based on the value of Pseudo-R<sup>2</sup> and the likelihood ratio-LR test), with model (2) exhibiting slightly higher goodness of fit (higher pseudo-R<sup>2</sup>).

In general, the results highlight the significance of ICT infrastructure and human capital for e-commerce adoption by the examined Greek enterprises. More specifically, we found that the higher the number of employees with internet access, the higher the probability of realizing e-sales. Accordingly, the significant marginal effects (in terms of both size and statistical significance) of *website availability* in both models indicate that firms with a website have an increased prob-

3. We first estimated a selection model with the *use of PCs* (yes/no variable) as a dependent variable and then our basic model with *Esale* as a dependent variable according to equation (1). The hypothesis of uncorrelated error terms between the two models could not be rejected ( $\chi^2 = 1.55$ , p-value=0.21), indicating the absence of sample selection bias in our estimations.

**TABLE 4 E-commerce determinants**

	Probit model (1)	Logit model (2)
Employees with internet access	0.017*** (0.003)	0.012*** (0.002)
Website availability	0.130*** (0.012)	0.114*** (0.012)
Training ICT specialists	0.015** (0.007)	0.012** (0.005)
Unsuitability of products/services	-0.115*** (0.008)	-0.093*** (0.007)
High cost	-0.064*** (0.008)	-0.056*** (0.007)
Problems related to payments	-0.034*** (0.007)	-0.032*** (0.006)
Problems related to ICT security or data protection	-0.010 (0.009)	-0.011 (0.007)
Problems related to the legal framework	-0.028*** (0.009)	-0.028*** (0.007)
Medium	-0.018** (0.008)	-0.013** (0.006)
Large	-0.027** (0.012)	-0.018* (0.009)
Trade	0.057*** (0.008)	0.043*** (0.007)
Services	0.053*** (0.007)	0.042*** (0.006)
Energy and construction	-0.030* (0.018)	-0.027* (0.016)
Location	-0.016** (0.007)	-0.012** (0.005)
Likelihood function	-1403.578	-1383.301
LR test ( $X^2$ )	809.16***	849.72***
Pseudo-R <sup>2</sup>	0.224	0.235
Number of observations	5,218	5,218

Notes: Average marginal effects are presented; standard errors in parentheses;

\* Statistically significant at the 10% significance level, \*\* Statistically significant at the 5% significance level, \*\*\* Statistically significant at the 1% significance level.

ability of e-commerce adoption (compared to those lacking a website). In addition, the estimated marginal effects corresponding to *training ICT specialists* imply that enterprises which invest in human capital by training employees specializing in ICTs are more likely to be engaged in e-commerce activities than those who do not.

Focusing on barriers to e-commerce, the results suggest that all examined factors impede firms' e-sales (negative and statistically significant corresponding marginal effects) with the exception of *problems relat-*

*ed to ICT security or data protection* which were found to have a negative but not statistically significant impact. More specifically, according to our findings, unsuitability of firms' products/services for e-sales (based on firms' perceptions), the high cost of implementation and use of e-commerce technologies compared to the benefits, problems related to payments and the legal framework seem to decrease the probability of e-commerce adoption by Greek firms.

Moreover, the results referring to firm characteristics present particular interest. Regarding firm size, the

negative marginal effects of the size dummies show that medium-sized and large enterprises are less likely to realize e-sales in comparison to small firms (reference group). This finding may seem unexpected given the financial and other constraints that smaller firms usually encounter, making ICT and e-commerce adoption more difficult than for larger firms. However, a possible explanation could be provided on the basis of small firms' greater flexibility (relative to the larger ones) and the need to acquire a competitive advantage towards larger enterprises in order to survive. On the other hand, it must be noted that this result is consistent with existing empirical evidence from other countries on the existence of a negative relationship between firm size and ICT adoption (Bayo-Moriones and Lera-López, 2007; Dewett and Jones, 2001; Harris and Katz, 1991).

Focusing on the regional dimension, our estimations suggest that firms which operate either in the trade or the services sector have an increased probability of adopting e-commerce practices in comparison with manufacturing firms (reference group). Finally, the result regarding firm location appears to be of interest as well. In particular, the negative and statistically significant marginal effect of *location* on the dependent variable implies that firms located in the regions of Attica and Central Macedonia have decreased likelihood of engaging in e-commerce activities compared to firms in the rest of Greece. This finding potentially shows that firms of the Greek periphery that are located in relatively remote and difficult to reach areas, with a low urbanization degree (e.g. island regions), are more prone to the adoption of e-commerce practices since this could be a way to access more markets (domestic and international) and increase their competitiveness, given the adverse economic conditions in Greece during the last years. Moreover, the relatively large number of firms which operate in the tourism sector in these areas may also play a relevant role.

## 5. Conclusions

The digital transformation of the global production/business model has a significant economic impact. Digital entrepreneurship and e-commerce are identified as key drivers of productivity, employment, competitiveness and growth. Even though e-commerce is gaining ground internationally, Greece falls behind the majority of other EU member states. Therefore, the more extensive and rapid adoption of ICT by the Greek firms is of great importance, in order to take advantage of the opportunities that arise from the new technologies and e-commerce.

In this context, this article explores the evolution and the possible determinants of the adoption of ICT and in particular of e-commerce by Greek companies. Using data from the annual survey "Use of Information, Communication and Electronic Commerce Technologies (ICT)" conducted by ELSTAT, we examine the evolution of key ICT and e-commerce indicators (PC usage, internet access, website availability, electronic orders) over time. In addition, with the use of econometric analysis we investigate the role of ICT infrastructure, human capital and firm characteristics (size, industry, location) in e-commerce adoption. Moreover, factors that may hinder ICT adoption and obstruct Greek firms' e-sales are identified.

According to our findings, the vast majority of Greek firms use PCs and have internet access, while the number of firms that have a website is increasing. On the other hand, the spread of e-commerce in Greece is still quite limited and seems to have remained relatively stable over the period under examination. The econometric findings indicate that investing in ICT infrastructure and human capital is important for the adoption of e-commerce. As far as size is concerned, the results demonstrate that smaller companies are more likely to receive electronic orders compared to larger companies. In addition, firms operating either in the trade or the services sector have an increased probability of adopting e-commerce practices, in comparison with manufacturing firms. Moreover, the location of the firms seems to play an important role, since it was found that firms located in the regions of Attica and Central Macedonia have a decreased likelihood of engaging in e-commerce activities compared to firms located in the remaining regions of Greece. Moreover, it appears that Greek firms face significant obstacles as far as e-commerce is concerned. These barriers are associated with the unsuitability of firms' products/services for e-sales (based on firms' perceptions), the high cost of implementing and using e-commerce technologies, problems related to payments and problems related to the legal framework.

The results presented may be useful in the design and implementation of policies that will encourage and support ICT and e-commerce adoption. Given the importance of infrastructure and human capital for e-commerce, an effective government action plan could include specially designed actions for the technological upgrading of firms in order to develop e-business and e-commerce solutions, flexible training programs for ICT specialists, distance learning and mobility programs for exchanging and enhancing ICT skills at all levels of education and so on. Furthermore, barriers to e-commerce could be mitigated, at least to some

extent, through regional campaigns to inform and educate entrepreneurs about regulations, procedures, opportunities, and the potential medium-term and long-term benefits of e-commerce.

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