To what extent firms are using e-commerce? Some evidence for the EU-27

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Draft: March 2009

Abstract

One of the most significant economic trends of recent years is the growing use of the Internet for conducting business, and in particular to purchase and sell online without temporal or spatial restrictions. In this context the aim of this paper is to explore both the adoption of e-commerce and the extent of its use across EU-27 firms. We analyze in parallel the factors driving online buying and selling. The intensity of adoption is examined by looking at the percentage of sales and purchases, respectively, made online. Our results show that the decision to adopt e-commerce depends mainly on the perceived impact ICT adoption would have for the firm. Furthermore, size, absorptive capacity, market environment, and competitive pressures are positively correlated with adoption. Our results also throw some light on the cross-country diffusion of e-commerce. The substantial differences in adoption rates are mainly explained by income levels. In addition, countries that are more open to trade tend toward higher e-commerce diffusion.

Key words: e-commerce, Internet, diffusion, European Union, probit models

1. Introduction

One of the most significant economic trends of recent years is the growing use of the Internet for conducting business. E-commerce, which can be defined as the sale or purchase of goods or services, whether between businesses, households, individuals, governments, and other public or private organisations, conducted over computer-mediated networks (OECD, 2005)[1], has opened up huge possibilities for businesses to expand their markets. In this sense, e-commerce allows to complete transactions with continuously decreasing time restrictions or geographical barriers. It allows sellers to access narrow markets segments that are widely distributed while buyers can benefit by accessing global markets with larger product availability from a variety of sellers at reduced costs. Improvement in product quality and the creation of new methods of selling existing products are also benefits derived from e-commerce.

In spite of the remarkable diffusion of e-commerce in the last few years, recent figures show large differences in adoption across firms, sectors and countries. According to Eurostat, the share of enterprises having received order online along 2008 differed significantly between the 27 Member States of the European Union (EU-27) with the United Kingdom (32%), the Netherlands (27%) and Ireland (25%) having the highest percentages. In Bulgaria, Hungary, Italy, and Romania (27%), less than 5% of enterprises have sold over the Internet. Furthermore, e-commerce adoption appears to be less likely among small-and-medium-size enterprises, and among those firms belonging to industries with a low proportion of skilled-workers and low levels of engagement in research and development activities.

Within this context, a vast theoretical and empirical literature on technology diffusion has been developed in order to identify the factors that explain such differences in the adoption rates of information and communication technologies in general and e-commerce in particular. In this sense, “rank models” of technology diffusion (for instance) emphasize differences among firms with respect to the profitability potential of technology adoption arising from the heterogeneity of firms. For “epidemic models”, the main elements of the of technology diffusion are information spillovers from users to non-users. At the empirical level, most research refers to the United States, Australia, and OECD countries; meanwhile the references to

[1] This definition corresponds to the OECD broad definition of e-commerce. The narrow definition only considers the transactions conducted over the Internet.

the Europe Union are quite limited. Furthermore, cross-country studies are still relatively scarce.

The aim of this paper is to explore both the adoption of e-commerce and the intensity of this adoption across EU-27 firms. In particular, we analyze in parallel the factors driving e-selling and e-purchasing. The intensity of adoption is examined by looking at the percentage of sales and purchases, respectively, made online.

Next section reviews the main determinants of ICT diffusion in general and e-commerce in particular at firm-level. Then, we present the data and the methodological framework for our analysis. Finally, we discuss results and draw some concluding remarks.

2. Factors driving ICT and e-commerce diffusion at firm-level

The last few years have seen a growing interest in explaining the diffusion of ICT and its applications such as e-commerce, e-banking, and e-learning, among others.

A key reason to understand why e-commerce has grown so quickly is its significant impact on business costs and productivity (OECD, 2000). In general, an online store is less expensive to maintain than a physical one because it is always "open", has a global market, and has fewer variable costs. In this sense, electronic commerce allows both reducing capital needs (through lowering inventory requirements, for instance), and saving labour (e.g., through the automation of internal transactions) or at least, substituting it for specific skills (sales or purchasing staff, service men...). Furthermore, e-commerce reduces significantly the distribution costs for those products that can be electronically delivered such as financial services, software, and travel. It also allows firms to move much of customer support online, so that clients can access databases or smart manuals directly, which significantly cuts the costs of this service for the enterprise. In addition, e-commerce may increase the efficient use of inputs in general (through speeding up internal processes, detecting inconsistencies between orders, receipts and invoices more easily, lowering transaction costs at the interface with users and suppliers…). Moreover, e-selling may increase product quality in various ways (customization, variety, convenience, etc.) or support the development of new market segments, whereas e-purchasing should improve the knowledge of (alternative) sources of inputs and ease the access to suppliers. In other

cases, e-commerce may be necessary to keep up to market standards, even if it not more than preserving or improving the firm's image and market appearance.

Given all these, a firm will choose to adopt e-commerce when it perceives that doing so will have a high (positive) impact on its business functions in any of the above mentioned ways.

Nonetheless, the decision to adopt e-commerce will also depend on the potential obstacles and barriers to the adoption and use of this technology, such as unfavourable financial conditions, human capital restrictions, or uncertainties with respect to its performance. In this sense, empirical evidence has shown that firms experimenting economic or financial difficulties are less likely to invest in and adopt new technologies (Bocquet et al., 2007).

Firm's absorptive capacity is another major determinant of ICT adoption in general and of e-commerce in particular. This capacity refers to firm's ability to evaluate, assimilate, and apply new knowledge. The endowment with human and knowledge capital is the main factor involved in such capacity. Thus, firms with a high level of human capital exhibit a higher propensity to use information technology and its applications (Black and Lynch, 2001; Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000). Moreover, research and development activities (R&D), as an element of firm's absorptive capacity, are also important for technology adoption. Both Cohen & Levinthal (1989) and Lal (1999) showed that firms' innovative activity facilitates the successful use of external knowledge in general and of new technologies in particular.

Firm's (technological) experience may also be important for new technology adoption and use. However the theoretical arguments are not conclusive. On one hand, if firm's age is considered as a proxy for experience, older firms will be more likely to adopt a new technology such as e-commerce. On the other hand, the younger firms might well prove more ready to embrace it and carry out the company reorganization that goes along with it due to lower adjustment costs. Experience can also arise from the use a predecessor of a specific technology embodying constituent elements of later applied (Colombo and Mosconi, 1995; McWilliams and Zilberman, 1996; Arvanitis and Hollenstein, 2001; Windrum and de Berranger, 2002). In the case of e-commerce, experience in transactions based on other types of networks, in particular Electronic Data Interchange (EDI), is expected to foster adoption and intensive use of e-commerce. However, there could also be an effect working in the opposite direction: switching

from EDI to Internet-based e-commerce involves learning and sunk costs which may hamper firms to take up the new technology. Nevertheless, some previous evidence (Bertschek and Fryges, 2002; Hollenstein and Wörter, 2004) points to a positive net effect on e-commerce.

Firm size is another of the most commonly studied determinants of technology adoption (Fabiani et al., 2005; Geroski, 2000; Hall, 2003), exerting a positive impact on it. There are several reasons why larger firms tend to be more technology intensive. Starting with the classical contribution of Schumpeter (1912), various other authors have seen a positive relation between size and the adoption of a new technology since larger firms are in a better position to appropriate the returns from adoption and have greater funds available to invest in the new technology, thus showing a greater capacity to absorb the new technologies. Moreover, many technologies, like the Internet and its applications, are scale-enhancing and, therefore, larger firms adopt them sooner because they capture economies of scale more quickly. Nonetheless, the impact of size of the intensity of use is not clear: while some authors found that small firms, once adopted the new technology, are at least as quickly as larger rivals to use it (Fuentelsaz et al. 2003), other have found a positive effect of size (Battisti and Stoneman, 2003; Hollenstein, 2004a, 2004b).

The diffusion of e-commerce may also be affected by market conditions, and particularly by the competitive pressures firms are exposed to. As Porter (1990) points out competition enhances the incentives to innovate and adopt new technologies. Thus, firms in a competitive environment are more likely to adopt those innovations and technologies that can enhance their decision making, strengthen their performance, and therefore, gain an edge over competitors, than those operating in a more sheltered environment.

Nonetheless, in those cases when competitors have already adopted the technology, the firm is also likely to adopt it in order to catch up with competitors. This same idea of adopting because others have already done it, is stated in both epidemic and network models of technology diffusion. Thus, the epidemic models stress that firm's propensity to adopt a new technology is positively influenced by the level of diffusion in the economy as a whole, or by the proportion of adopters in its industry due to information spillovers from users to non users and from intensive users to less intensive users in technology adoption (Karshenas and Stoneman, (1995). Furthermore,

network externalities highlight that the value of a new technology depends on how many other users there are (Shapiro and Varian, 1999): thus, the number of users of e-commerce, the higher the incentive for a firm to use this trade channel as well.

Another factor to be considered is the market in which the firm operates. E-commerce has the potential to decrease the impact of geographical locations and distances (Freund and Weinhold, 2004) by reducing transaction costs, and especially international transactions costs. The empirical literature has revealed a positive relationship between the presence of international markets and ICT, since internationalization implies growth in competitiveness and market size.

Finally, research has also shown that the industry in which the firm operates has an important influence on ICT adoption (Giunta and Trivieri, 2007). In contrast to Solow's famous remarks "you can see computers everywhere but in productivity statistics" (Solow, 1987), ICT are in fact heavily concentrated in the service sector. E-commerce, as an application of these technologies, is very likely to be used more intensively by service firms. Furthermore, e-commerce's most significant impact will be on those sectors that primarily transmit information or produce it, since electronically delivered products (such as software, travel services, entertainment, and finance) are leading products e-commerce. Nevertheless, it is important to bear in mind that ICT are general purpose technology (Bresnahan and Trajtenberg, 1995), which implies that all sectors might be able to benefit from its use and the use of its applications.

3. Methodology and data

Methodology

In the economic analysis of the extent of e-commerce, we assume that its intensity is determined by an unobserved latent variable,

$$Y_i^* = X_i'\beta + u_i \quad (1),$$

for firm i, i=1, …, N. Only Y_i is observed with the following structure:

$$Y_i = \begin{cases} 1 & \text{if } Y_i^* \le \mu_1 \\ 2 & \text{if } \mu_1 < Y_i^* \le \mu_2 \\ 3 & \text{if } \mu_2 < Y_i^* \le \mu_3 \\ 4 & \text{if } \mu_3 < Y_i^* \le \mu_4 \\ 5 & \text{if } Y_i^* > \mu_4 \text{ and } \mu_1 \le \mu_2 \le \mu_3 \le \mu_4 \end{cases} \quad (2)$$

The variable of theoretical interest Y_i^* is a continuous unobserved index of the extent of e-commerce. The observed rating categories, Y_i, are assumed to represent an ordered partitioning of this continuous scale where, Y_i is the observed rating category for the ith firm, β is a vector of coefficients, X_i is a vector of explanatory variables for the ith firm, u_i is the error term and the μ_js are threshold parameters.

Assuming that u_i is normally distributed, the data are described by the following ordinal probit model:

$$\begin{aligned} P(Y_i = 1) &= \phi(\mu_1 - X_i'\beta) \\ P(Y_i = 2) &= \phi(\mu_2 - X_i'\beta) - \phi(\mu_1 - X_i'\beta) \\ P(Y_i = 3) &= \phi(\mu_3 - X_i'\beta) - \phi(\mu_2 - X_i'\beta) \quad (3) \\ P(Y_i = 4) &= \phi(\mu_4 - X_i'\beta) - \phi(\mu_3 - X_i'\beta) \\ P(Y_i = 5) &= 1 - \phi(\mu_4 - X_i'\beta) \end{aligned}$$

where ϕ is the cumulative normal distribution function.

The analysis of e-commerce intensity only makes sense for those firms that have already engaged in e-commerce. Since our data comes from a sample of the full population, if we restrict our analysis only to those who have adopted e-commerce, sample selection bias will be introduced. To avoid this, a two-stage estimation procedure is adopted (Heckman, 1979; Greene, 1992): we estimate a first equation to determine whether a firm has adopted e-commerce, and a second equation to explain the

intensity of e-commerce (measured as share of this activity of firm's total business volume), given that the firm has engaged in buying/selling online.

Thus, similar to (1) we assume that the adoption of e-commerce is determined by an unobserved latent variable,

$$C_i^* = Z_i'\gamma + \varepsilon_i \quad (4),$$

where only C_i equal to 0 or 1 is observed, Z_i is a vector of explanatory variables and ε_i is the normally distributed error term. From this model we calculate the inverse Mill's ratio or lambda (λ), which added as an explanatory variable to (1) allows controlling for selectivity bias. If the lambda is significant, the sample selection bias is present but has been corrected.

Data

The data used in this study comes from the European e-Business Market Watch, which mission is to support the work of the European Commission's Enterprise and Industry Directorate-General in the field of ICT and e-business policies. In particular, our study uses data from the 2006 e-Business Survey and covers the 27 Member States of the European Union (European Commission and the Sectoral e-Business Watch, 2006).

The population scope of the survey was the set of all computer-using enterprises which were active within the national territory of one of the 27 Member States, and which had their primary business activity in one of the 8 following sectors, which covered manufacturing and services: Food and beverages, Footwear, Pulp and Paper, ICT Manufacturing, Consumer electronics, Shipbuilding and repair, Construction, Tourism, and Telecommunications.

A random sample was drawn, stratified by industry and firm size within each country. Data was gathered through a computer-aid telephone interview (CATI) in March and April 2006, with a final sample of about 10, 000 establishments[2].

Table 1 shows a complete description of the variables used in the econometric analysis.

[2] More details on survey methodology can be retrieved from http://www.ebusiness-watch.org.

Table 1. Description of variables

Dependent variables	**Description**
BUY	Dummy=1 if the firm uses the Internet or other computer-mediated networks to place orders for goods or services online (zero otherwise)
SELL	Dummy=1 if the firm allows customers to order goods or book services online from the website or through other computer-mediated networks (zero otherwise)
BUY_Q	Share of the total volume of firm's orders placed online. Answers on a five-point Likert scale. 1:Less than 5%; 2: Between 5% and 10%;3: Between 11% and 25%; 4: Between 26% and 50%; 5: More than 50%
SELL_Q	Share of the total volume of customers' orders or bookings received online. Answers on a five-point Likert scale. 1:Less than 5%; 2: Between 5% and 10%;3: Between 11% and 25%; 4: Between 26% and 50%; 5: More than 50%
Independent variables	**Description**
IMPACT	Scores from a principal component factor analysis of the expected impact of ICT on seven business functions as assessed by firms on a four-point Likert scale (from 1: no impact to 4: high impact)
FINAN_CONSTR	Dummy=1 if the turnover of the company has decreased in the last year (zero otherwise)
EDUC	Percentage of employees with a college or university degree
INN_PT	Dummy=1 if the firm has launched any new or substantially improved products or services during the past 12 months (zero otherwise)
INN_PC	Dummy=1 if the firm has introduced any new or significantly improved internal processes (for example for producing or supplying goods and services) during the past 12 months (zero otherwise)
SIZE (10-49)	Dummy=1 if the firm has 10-49 employees (zero otherwise)
SIZE (50-249)	Dummy=1 if the firm has 50-249 employees (zero otherwise)
SIZE (250 and more)	Dummy=1 if the firm has 250 or more employees (zero otherwise)
COMPET	Dummy=1 if the firm thinks that ICT have increased the competition in its sector (zero otherwise)
AGE	Period of creation. 1= before 1981; 2=between 1981 and 1996; 3= between 1997 and 2002; 4=after 2002
EDI	Dummy=1 if the firm has used Electronic Data Interchange (EDI) (zero otherwise)
MARKET_NAC	Dummy=1 if national market is the most significant for the firm (zero otherwise)
MARKET_INT	Dummy=1 if international market is the most significant for the firm (zero otherwise)
CUST_BUS	Dummy=1 if the firm's primary customers are other business (zero otherwise)
CUST_PS	Dummy=1 if the firm's primary customer is the public sector (zero otherwise)
CUST_MX	Dummy=1 if the firm has no primary customers (it's a mixed) (zero otherwise)
R_COMP *	Dummy=1 if the firm decided to engage in e-business because its competitors also engaged in (zero otherwise)
R_ADV *	Dummy=1 if the firm decided to engage in e-business because it did believe that e-business would help to get an edge over its competitors (zero otherwise)
GDP	Gross Domestic Product per capita as an index (European Union-27=100)
OPENNESS	Imports and exports of goods as a percentage of Gross Domestic Product
PRICE	Price of national calls (€/10 minute call)

Note: * These variables are only available for those firms who considered that e-business constituted a significant part or at least some part of the way the company operated at the time of the survey. Country and industry dummies are not included in the table for space considerations. The Appendix includes a full description of the factor analysis run to obtain the variable IMPACT.

Besides this firm-level information, some macroeconomic variables were considered in order to take account of cross-country variation. Research has shown that the uneven diffusion of ICT across countries mirror to some extend social and economic disparities. Hence countries with lower income and lower educational attainment tend to show lower rates of ICT access and use when compared with higher income and higher education countries (Beilock and Dimitrova, 2003; Caselli and Coleman, 2001; Hargittai, 1999; Pohjola, 2003; Vicente and López, 2006a). In particular, Chinn and Fairlie (2007) find that the income per capita differential accounts for the single most important component of the digital divide between countries, but it is not the only component. As shown by Vicente and López (2006b) other factors such as knowledge capital and openness are important as well. Data was derived from Eurostat (2007).

4. Results

The results of our estimations are presented in Table 2, which shows the estimated coefficients based on probit models: Models 1-2 and 4-5 include the full set explanatory variables at firm level, and country dummies which coefficients are not shown in the table due to space considerations. Models 3 and 6 include some macroeconomic variables to take account of cross-country variation instead of using the dummies.

A first interesting point to note is that while some variables exert a similar effect on the adoption on e-buying and e-selling, there are certain variables which impact differently on these two activities.

Among the variables with similar effect, we must highlight that the proxy for the perceived impact of ICT adoption is significant and positive. Therefore, those firms who expect a high impact of ICT on business functions have a higher propensity to adopt e-commerce, and especially e-buying (note that its gets a coefficient of about 0.23 in model 1 compared to the coefficient of 0.17 for e-selling in model 4). On the contrary, the financial constraints derived from a decrease in last year's turnover reveal as a non-significant obstacle to e-commerce. We also find that firm's size matters for adoption: bigger firms are more likely to adopt than the smallest.

Table 2. The adoption of e-commerce. Probit Estimates

	Buying online			Selling online		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
IMPACT	0.234***	0.246***	0.226***	0.168***	0.187***	0.155***
FINAN_CONSTR	-0.050			-0.162		
EDUC	0.005**	0.005**	0.005**	-0.001		
INN PT	0.170			0.183**	0.205***	0.162**
INN PRC	0.458***	0.534***	0.475***	0.092		
SIZE (10-49)	0.290*	0.294*	0.255	0.155		
SIZE (50-249)	0.581***	0.547***	0.672***	0.379***	0.294***	0.373***
SIZE (250 and more)	0.566***	0.550***	0.587***	0.241*	0.199*	0.196*
COMPET	0.098			0.395***	0.426***	0.401***
AGE	0.049			-0.050		
EDI	0.012			0.273**	0.272**	0.364***
GDP			0.006***			0.002**
OPENNESS			0.014***			0.004*
PRICE			-0.048			-0.075
Industry dummies	Consumer electronics (+) ***			Ship building and repair (-)*** Tourism (+)***		
Constant	-0.343	-0.147	-1.452***	-0.902***	-0.906***	
Log pseudolikelihood	-4075.125	-4124.669	-4105.680	-4304.145	-4646.132	-4591.749
Wald Chi2	265.18***	267.93***	156.46***	310.18***	323.96***	214.23***

Note: *** Significant at the 1% level; ** significant at the 5% level and significant at the 10% level. For the estimation of the model we have considered micro firms (with less than 10 employees) as reference group in what regards to size. Models 1-2 and 4-5 include country dummies which coefficients are not shown in the table due to space considerations. The table only shows the significant industry controls.

With regard to the variables with differential impact, results show that while firm's absorptive capacity stimulates the adoption of e-commerce, its various dimensions have diverse effects on e-buying and e-selling. Thus, firms with a larger proportion of college/university workers are more likely to purchase online, however this effect is not significant for online selling. Furthermore, while process innovation significantly matters for e-buying, product innovation is the relevant activity for e-selling. We also find that competitive pressures are only significant for selling online, stimulating the take-up of this activity. Likewise, the use of EDI has a significant positive effect on e-selling. However, age as a proxy for firm's experience is not significant either for buying or selling online.

We also see that the industry to which the firm belongs has a differential impact on e-buying and e-selling. In the former, only "consumer electronics" is significant with a positive sign while in the latter, "ship building and repair" and "tourism" are significant with a negative and a positive sign respectively. It is worth noticing that the

positive impacts are related to information-intensive sectors with electronic delivered products such as tourism.

Results also confirm that country characteristics matter in order to explain the diffusion of e-commerce. We find that income and openness have a positive significant effect on the likelihood of e-commerce take up, while the telecommunications costs have a negative effect, but it is not significant.

Table 3 shows the results for the intensity of e-commerce, given that the company has engaged in this activity. A first interesting point is that firm' size appears to be more correlated with the adoption of e-commerce as such than with the extent of such adoption. Thus, once we have controlled for size in the first equation, it is not statistically significant any more in the second equation. Nonetheless, workers' educational attainment still exerts a positive and statistically significant effect on both the intensity of e-buying and e-selling. The positive sign of this variable confirms that the higher proportion of workers with a college/university degree there is in a firm, the higher is the probability of top-level e-commerce intensity.

As happened with adoption, the impact of certain variables on intensity also differs significantly between e-buying and e-selling. Thus, results show that the type of market only matters for selling online. In particular, the more internationalised the firm is the higher is the probability of top-level online selling[3]. Furthermore, we find that the reasons for engaging in e-business also differ. In the case of buying online, "getting an edge over competitors" is the significant reason. While, for selling online, not only gaining a competitive advantage matters but also catching-up with competitors (the firm decided to engage in e-business because its competitors had also engaged in).

We also find that the type of customers is not significant for the intensity of e-selling. Nonetheless, it is worth noticing the negative sign of the variable related to the public sector: when public administrations are the main customer of the firm, the probability of top-level e-selling is lower than in the case of private consumers.

The results also show that the industries related to ICT are more likely to have a high intensity of e-commerce than other traditional sectors.

[3] The variables size of the market (national, international) and size of the firm are not included in the same model to avoid potential problems of multicollinearity.

Finally, the inverse Mill's ratio or λ is found to be significant at the 1% level in all the estimations. Such result indicates that sample selection bias is present but has been corrected. In general, λ captures the relationship between unmeasured factors affecting the likelihood of e-commerce and unmeasured factors explaining the proportion of trade done online. Hence the negative coefficient estimate of λ in the equations suggests that firms which do e-commerce are not as likely to have a large of a proportion of total business online. Such result might imply that electronic transactions still are a minority part of the total firm business, and that e-commerce works as a complementary trade cannel to the traditional ones.

Table 3. The intensity of e-commerce. Ordinal Probit Estimates

	Buying online			**Selling online**		
Variables	(1)	(2)	(3)	(4)	(5)	(6)
EDUC	0.010***	0.010***	0.009***	0.003**	0.003**	0.004**
SIZE (10-49)	0.124	0.086		0.059	0.042	
SIZE (50-249)	0.251	0.238		-0.197	-0.184	
SIZE (250 and more)	0.218	0.200		-0.133	-0.147	
MARKET_NAC			0.027			0.427***
MARKET_INT			0.125			0.716***
CUST_BUS				0.037	0.027	
CUST_PS				-0.259	-0.239	
CUST_MX				0.097	0.083	
R_COMP	0.133			0.216**		
R_ADV		0.319**	0.312**		0.324***	0.268**
Industry dummies	Telecommunications (+) ***			ICT manufacturing (+) ***		
Cut1	-0.124	-0.014	-0.244	-0.888	-0.758	-0.215
Cut2	0.333	0.449	0.217	-0.146	-0.012	0.552
Cut3	0.955	1.079	0.844	0.395	0.531	1.106
Cut4	1.375	1.501	1.266	1.069	1.206	1.795
λ (The inverse Mills' ratio)	-0.605***	-0.576***	-0.714***	-0.589***	-0.554***	-0.440***
Log pseudolikelihood	-6199.963	-6169.408	-6175.945	-3608.186	-3598.464	-3548.129
Wald Chi2	112.29***	120.01***	139.49***	62.40***	62.89***	93.63***

Note: *** Significant at the 1% level; ** significant at the 5% level and significant at the 10% level. The equations of e-buying and e-selling intensities have been estimated respectively joint with model 2 and 5 (Table 2). For the estimation of the intensity equations we have considered the following reference groups: micro firms (with less than 10 employees), regional market, and private clients as primary customers. Only the significant industry controls are shown in the table.

5. Concluding remarks

The objective of this paper is to identify the factors that shape e-commerce diffusion, using cross-sectional data on the 27 Member States of the European Union.

We find that the decision to adopt e-commerce depends mainly on the perceived impact ICT adoption would have for the firm. A firm only chooses to adopt e-commerce when it perceives that doing so will provide new business opportunities and will have a major impact on its business functions.

In line with previous evidence, our results also show that firm's absorptive capacity and experience are major determinants of technology adoption. However, the impact is different on e-purchasing and e-selling. Regarding intensity, we observe the higher proportion of workers with a college/university degree there is in a firm, the higher is the probability of top-level e-commerce intensity.

Firm size is also positively correlated with adoption. Nonetheless, it is important to highlight that once the adoption has taken place, size is not relevant anymore for the intensity of usage. In some cases, smaller firms are the ones doing a higher of their transactions on line.

Moreover, market environment plays a key role to explain e-commerce diffusion across firms and sectors. In particular, we note that firms operating in bigger markets are more likely to have high intensities of e-selling compared to those in regional markets. However, these firms still face important barriers and obstacles to cross-border electronic transactions as recently pointed out in a just released report by the European Commission (2009).

Competitive pressures also matter for e-commerce diffusion. Furthermore, we find that the reason for high intensities of e-purchasing is related to gaining a competitive advantage, while for e-selling such motivation is combined with trying to keep up with competitors.

Although the type of clients of the firm is not a significant factor, it is worth noticing the negative sign of the public sector. Such result might be an indicator of too bureaucratic institutions in which new ways of making transactions are still not allowed (such as e-procurement) and all (invoices, orders...) needs to be in print with an official stamp.

Our results confirm previous evidences ICT diffusion across countries. Thus, the substantial differences in adoption rates are mainly explained by income levels. In addition, countries that are more open to trade tend toward higher e-commerce diffusion.

As a final point, we note that results show that despite the growing importance of e-commerce, electronic transactions still are a minority part of the total firm business, mainly working as a complementary trade cannel to the traditional ones.

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Appendix. Factor analysis on the perceived impacts of ICT

The e-Business survey included some questions about the expected impact of ICT (as assessed by firms) on the following seven business functions: administration and accounting, customer support, logistics, management and controlling, marketing, production, and research and development. The answers to these questions were on a four-point Likert scale from 1(no impact) to 4 (hight impact).

A principal component factor analysis was used to determine a small number of dimensions that summarized such information. Factor analysis is a multivariate technique that addresses the problem of analyzing the structure of interrelationships among a number of variables by defining a set of common underlying (Hair et al., 1995).

The appropriateness of factor analysis was gained by using the Bartlett test of sphericity and the Kaiser-Mayer–Olkin (KMO) measure of sampling adequacy. Bartlett tests the null hypothesis that the correlation matrix is an identity matrix, which implies that there is no correlation between the variables. The KMO measure requires values greater than 0.5 for a satisfactory factor analysis to proceed. Both measures, the Bartlett test with a statistical value of almost 29,800 and an associated probability of less than 1 percent and the KMO measure with a value over 0.9, suggested that the data structure was adequate for factor analysis.

The eigenvalue criterion, which states all factors having eigenvalues greater than 1 should be retained, led to the identification of just one factor which explained 64 percent of the variation in the original variables (Tables 3 and 4). Finally, computed factor scores were be included as an explanatory variable in the probit models.

Table 4. Results of factor analysis

Factor	Eigenvalue	Percent of variance	Cumulative percent of variance
1	4.476	63.943	63.943
2	0.557	7.960	71.903
3	0.514	7.348	79.251
4	0.429	6.130	85.381
5	0.353	5.049	90.429
6	0.341	4.873	95.302
7	0.329	4.698	100.000

Note: Extraction method: Principal Component Analysis.

Table 5. Factor matrix

Variables	Factor loadings
ICT impact on Management and controlling	0.820
ICT impact on Logistics	0.819
ICT impact on Customer support	0.816
ICT impact on Marketing	0.802
ICT impact on Production	0.784
ICT impact on Research and development	0.781
ICT impact on Administration and accounting	0.774

Note: Extraction method: Principal Component Analysis.