

Auteur: Leila BEN  
AOUN-PELTIER, STATEC  
et Maria Rosalia  
VICENTE, University of  
Oviedo

## **E-commerce diffusion: exploring the determinants of the adoption and extent of usage at firm-level**

### **Abstract**

In the last years great attention has been paid to understand the factors driving ICT diffusion at firm-level. However, most studies have focused on the analysis of the adoption of the new technology and there is no much evidence on the intensity of use of ICT by firms. Within, this context this paper attempts to throw some light on such issue by presenting a joint-analysis of the adoption and extent of usage of e-commerce among Luxembourgish firms. In particular, the two sides of e-commerce are analyzed: e-purchasing and e-selling. Results show that competitive pressures together with absorptive capacity and infrastructure are the main drivers of adoption. Regarding intensity, human capital and the type of competition faced by firms are key determinants. Additionally, there is some evidence that the Internet helps to overcome distance barriers only to a certain extent.

**Keywords:** e-commerce, Information and Communication Technologies (ICT), technology diffusion, Internet

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### Résumé

Ces dernières années les déterminants de la diffusion des TIC au niveau de l'entreprise ont fait l'objet d'une grande attention des études économétriques. Cependant, la plupart des études se sont limitées à l'analyse de l'adoption des nouvelles technologies et on recense peu d'études sur l'intensité de l'utilisation des TIC par les entreprises. Dans ce contexte, la présente étude propose une analyse jointe de l'adoption et de l'ampleur de l'utilisation du commerce électronique par les entreprises au Luxembourg. Par ailleurs, étant données leurs natures différentes, nous étudierons distinctement les achats en ligne et les ventes en ligne. Les résultats montrent que les pressions concurrentielles en collaboration avec la capacité d'absorption et les infrastructures TIC présentent dans les entreprises sont les principaux moteurs de l'adoption. En ce qui concerne l'intensité, le capital humain et le type de concurrence rencontré par les entreprises sont des facteurs déterminants. En outre, l'étude montre qu'Internet aide à surmonter les obstacles liés à la distance mais seulement dans une certaine mesure.

## 1. INTRODUCTION

The growing use of e-commerce, which can be defined as the sale or purchase of goods or services conducted over the Internet<sup>1</sup> (OECD, 2009a), has become one of the most important economic trends of the last years. In particular, e-commerce has provided both consumers and businesses with a powerful tool to face the restrictions posed by the economic crisis.

On the one hand, many consumers are using the Internet in order to cut down their expenditures (OECD, 2009b). According to Frontier Economics, consumers can get savings of even a 17% by buying products such as electronics, computers and clothes online (European Commission, 2009). On the other hand, e-commerce has allowed firms to expand their markets and generate new business opportunities.

Aware of the importance of e-commerce, the new digital agenda for the European Union has set some strategic targets in this field: by 2015, 50% of European citizens should be buying online, 20% of them will carry out cross-border online transactions, and 33% of small-and-medium enterprises should be buying/selling online (European Commission, 2010). In order to achieve such goals, it becomes crucial to understand the process of diffusion of e-commerce.

A proper assessment of the spread of any new technology requires paying

attention to two main elements: firstly, to the adoption of the new technology by firms, and, secondly, to the intensity or sophistication of its usage. Nonetheless, data limitations have lead most research to focus on adoption (Baptista, 1999; Hall, 2004), while literature on technological intensity is much smaller (Fuentelsaz et al., 2003; Battisti and Stoneman, 2005; Battisti and Iona, 2009). In fact, few studies analyze jointly adoption and intensity (Battisti et al., 2004, 2007, 2009; Hollenstein and Woerter, 2008), showing evidence for Swiss and British firms.

In this context, the aim of this paper is to contribute to this latter stream of the literature by analyzing the factors driving both the adoption of e-commerce and the extent of its usage across a sample of Luxembourgish firms. Next sections describe the data and the conceptual framework. Then, we present the models and the specification of variables. These are followed by the analysis of the results and some concluding remarks.

## 2. DATA

The data used in this study is the result of merging the two following datasets: the 2007 Survey on Information and Communication Technologies (ICT) Usage and e-Commerce in Enterprises<sup>2</sup> and the 2006 Community Innovation Survey, both for the case of Luxembourg (STATEC, 2006, 2007). While the former dataset contains information about ICT adoption and use, the later focuses on innovation (as defined in the Oslo Manual) and, in

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<sup>1</sup> This corresponds to the narrow to OECD "narrow" definition on e-commerce. The "broad" definition considers transactions conducted over computer-mediated networks.

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<sup>2</sup> Firms from financial sector are not concerned by the e-commerce part of the survey and, hence, do not appear in the analysis

particular, it includes valuable data on the type of competition faced by firms, which is a key factor to explain technological diffusion as indicated by Porter (1990). The merge of these two

datasets covers firms with at least 10 employees in manufacturing and services, except for financial activities. This leads to a sample size of 300 firms (1,091 firms if weighted).

**Table 1a. Adoption of e-commerce (order and selling via Internet) by sector and size class among Luxembourgish firms. Year 2006**

	Order %	Sell %		Order %	Sell %
<b>NACE</b>			<b>Size</b>		
Industry	27.2	11.9	10-49	39.4	15.2
Trade	32.4	20.8	50-249	35.0	16.3
Business services	74.2	11.7	250 and more	62.1	42.3
Total	39.4	16.5		39.4	16.5

Note: Intensity refers to the percentage of Internet orders/sales in relation to the total firm's purchases/sales. These rates only take into account those firms engaged in buying/selling online.  
Source: Own using data from STATEC (2007).

Table 1a and 1b show some figures on the use and intensity rates of e-commerce (ordering/selling via the Internet) among Luxembourgish firms. The first thing to notice is that e-commerce is still not a common practice for firms, especially in what regards selling online: only 16.5% of firms sell online compared to 39.4% buying online. By firm size, the highest percentages of e-commerce adoption are found for large firms (250 employees or more). Nonetheless, the percentage of small firms (39.4%) buying online is

higher than that related to medium-sized ones (35%). By industry, business services and trade present the highest figures of firms buying and selling online, respectively.

Regarding intensity, the general picture shows that the differences between the two types of e-commerce tend to disappear. Among those firms involved in e-commerce, Internet orders/sales represent a low percentage of their total purchases/sales. For 30% (respectively 25%) of firms involved on e-purchasing (resp. e-selling) the turnover extract from this technology represent less than 1%.

**Table 1b. Intensity rates of e-commerce (order and selling via Internet) among firms in Luxembourg. (2006)**

	Order %	Sell %
≥1%	69.6	74.7
≥2%	62.2	65.8
≥5%	46.9	50.7
≥10%	31.4	25.6
≥50%	8.3	13.3

Source: Own using data from STATEC (2007).

Table 2 reveals the main barriers to use e-commerce as identified by firms. Hence, the greatest obstacles to order via Internet are related to both legal uncertainties (contracts, terms of delivery and guarantees) and an insufficient supply of goods and services online. In the case of those firms already buying online, legal matters are their

major concern. For selling online, firms identify two main problems: on the one hand, their products may not be adequate to be sold online; and on the other hand, their clients do not want to use e-commerce.

**Table 2. Barriers to e-commerce (order and selling via Internet) among firms in Luxembourg. Year 2006**

<b>Barriers to buy online</b>	Full sample	Only firms involved in e-buying
Some providers have abandoned online selling	10.9%	16.4%
The supply of goods and services online is too small	27.3%	25.8%
Payment security is not guaranteed	22.5%	27.2%
Uncertainty about the legal context of e-commerce	27.7%	36.6%
<b>Barriers to sell online</b>	Full sample	Only firms involved in e-selling
You have decreased your offer of products sold on the Internet	5.4%	4.0%
You encounter logistical problems	12.5%	12.1%
Payment security is not guaranteed	20.8%	18.9%
Some customers made orders online, but abandoned this system	6.2%	23.8%
Uncertainty about the legal context of e-commerce	19.8%	28.6%
Your goods and services may not be sold online	61.9%	33.4%
Some clients do not wish to use e-commerce	41.6%	71.5%

Source: Own using data from STATEC (2007)

### 3. CONCEPTUAL FRAMEWORK

Diffusion is generally defined as the process by which innovations spread over the economy (OECD and Eurostat, 2005). Understanding the reasons that lead firms to adopt innovations (either new technologies, products or processes) has become one of the major issues for economists since the seminal work of Griliches (1957).

The basic approach to analyze diffusion are epidemic models which state that diffusion

is the result of the spread of information over time from the users of the new technology to the non-users. The essential ideas in these models are, then, that firms learn about the new technology from those which are already users and do not get that information at the same time. Such assumptions lead to a path of diffusion similar to an S-curve. At first, when the technology shows up in the market, some firms will start using it and will transmit their experience to other firms, which in turn might become users as well. As more and more firms use the new technology,

the spread of information accelerates and the diffusion speeds up. Ultimately the market will reach its saturation point, and the diffusion rate will decrease (Karshenas and Stoneman, 1995; Baptista, 1999; Geroski, 2000).

An alternative to the epidemic approach are those models that put emphasis on diffusion as the result of firms' decision-making process on whether to adopt the new technology and the intensity of the usage. These models hence focus on the factors that determine the benefits a firm can get from the new technology. There are three leading models in this approach. Rank models (also known as probit models) consider that the benefits derived from technology adoption and use depend on firm major characteristics (size, workforce' skills, whether the firm carries out innovation activities, among other features) (Karshenas and Stoneman, 1995; Geroski, 2000). Then, stock and order-effects consider that the benefits from the new technology depend on the number of previous adopters and on the order of adoption, respectively. Hence, the more number of firms already using the technology and the later adoption takes place, the lower the benefits a firm can get. The underlying assumption in these models is that, despite the uncertainty involved in new technologies, there are first-mover advantages (Karshenas and Stoneman, 1995).

Although these four approaches could be specified separately, several authors have integrated them into the same model in order to better understand the diffusion process of a new technology (Karshenas and Stoneman, 1995; Battisti et al., 2004, 2007, 2009; Hollenstein and Woerter, 2008). Such integrated model will be the approach used in this paper.

#### 4. MODEL AND VARIABLES SPECIFICATION

The modelization of the adoption and the extent of usage of e-commerce among Luxembourgish firms requires two equations. In the first equation, the dependent variable is a dummy one related to whether a firm is using e-commerce or not; hence, the estimation of a probit model will be appropriate.

Assume that e-commerce adoption is determined by an unobserved latent variable  $S^*$ , where  $S^* = Z'\gamma + e$  (1),

only  $S$  is observed, which equals 1 if  $S^* > 0$ , implying that a firm chooses to adopt e-commerce; and  $S$  equals zero otherwise.  $Z$  is the vector of explanatory variables reflecting rank, epidemic, stock and order effects, and  $e$  is the error term. Assuming that  $e$  is normally distributed, the data are described by the following probit model<sup>3</sup>:

$$\text{Prob}(S=1) = \Phi(Z'\gamma) \quad (2)$$

where  $\Phi$  is the cumulative normal distribution function.

In the second equation, the dependent variable reflects the share of e-commerce in total business turnover ( $Y$ ); the continuous nature of this variable leads to the following regression model:

$$Y = X'\beta + u \quad (3)$$

where  $X$  is the vector of variables that explain the extent of use e-commerce, and  $u$  is the error term (Wooldridge, 2006).

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<sup>3</sup> In order to correct for the endogeneity of the variable "innovator" we have performed a Biprobit model where e-activity and innovation are simultaneously explained. From these results we constructed the Inverse Mills ratio in order to correct the selection bias in the second equation but the IMR was not significant so we drop it and estimate the biprobit first and the OLS equation separately.

Tables 3 and 4 show the definition of the variables and some descriptive statistics, respectively. Following Hollenstein and Woerter (2008) e-selling and e-buying are analyzed as two separate processes but the same set of explanatory variables is used (except for some variables that were dropped from the intensity equations due to the small number of observations). The choice of the variables is well-based on the literature of ICT diffusion (Battisti et al., 2004, 2007, 2009; Hollenstein and Woerter, 2008), and reflect rank, epidemic, stock and order effects.

More in particular, the following elements are considered in order to take account of rank effects:

- Firm size, which usually exerts a positive impact over adoption, since large firms have more resources and are in a better position to take advantage of the scale economies derived from the new technology. However, its impact on the extent of usage is not yet clear (Hollenstein and Woerter, 2008; Battisti et al., 2007; Giunta and Trivieri, 2007; Haller and Siedschlag, 2010).
- Human capital, measured by workers with a college/university degree and IT specialists. The effect is expected to be positive since the adoption of a new technology requires the firm to have a workforce with the appropriate skills to use it (Brynjolfsson and Hitt, 2000; Black and Lynch, 2001; Fabiani et al., 2005; Battisti et al., 2009).
- Absorptive capacity, indicated by firm's innovative activities, has been shown to be positively associated with the adoption of new technologies (Hollenstein and Woerter, 2008; Arduini et al., 2010).
- ICT infrastructure, also expected to have a positive effect since any firm willing to adopt e-commerce needs some basic ICT infrastructure such as a PC and an Internet connection (Hollenstein and Woerter, 2008).
- Age of the firm, which could either have a positive or negative influence depending on whether age indicates experience or less flexibility to changes than a younger firm (Bayo-Moriones and Lera-Lopez, 2007; Giunta and Trivieri, 2007).
- A variable related to whether the firm belongs to a group of enterprises. In this case, a positive effect is expected because multinational firms are able to spread the cost of the new technology among more units (Haller and Siedschlag, 2010).
- Geographical market served by the firm, which association with ICT is not clear yet. Although firms operating in international markets might be more likely to use ICT because of the potential of these technologies to reduce transaction costs and to give visibility to the firm, the uncertainties about cross-border online trade and consumers' distrust might hamper the use of ICT (Fabiani et al., 2005; Giunta and Trivieri, 2007; Hollenstein and Woerter, 2008).

- A series of variables related to the type of competition faced by the firm. Usually firms in highly competitive markets tend more to adopt new technologies than those in sheltered environments in order to gain an advantage over rivals (Porter,1990).

**Table 3. Variables description**

<b>Dependent variables</b>	<b>Description of the variables</b>
E-buying adoption	Firm ordered products/services via the Internet (excluding manually typed e-mails) (yes/no)
E-selling adoption	Enterprise received orders via the internet (excluding manually typed e-mails) (yes/no)
E-buying intensity	Percentage of Internet orders in relation to the total purchases (in monetary terms, excluding VAT)
E-selling intensity	Percentage of the total turnover resulted from orders received via Internet (in monetary terms, excluding VAT)
<b>Independent variables</b>	
<b>Rank effects</b>	
Group	Firm belongs to a group of enterprises (yes/no)
Age	Number of years since the firm was created
Size	Number of workers
Employees with a degree	Percentage of employees with a college or university degree
IT / ICT Specialists	Firm employs IT/ICT specialists (yes/no)
ICT infrastructure	Number of ICT infrastructure owned by the firm, considering the following options: LAN, intranet, extranet, visio/video conference, and project group-management system
“Grande region” market <sup>a</sup>	Market in which the firm sells its products (yes/no). <i>Reference category: National market</i>
European market <sup>b</sup>	
Rest of the world market	
F1 <sup>c</sup> -Service to customers & products quality	Factors defining firm’s competitive environment. These variables are the results from a factor analysis performed on 13 questions. See the Annex for more information.
F2-Fast technological change	
F3-Competition & forecasting difficulties	
F4-Publicity and product diversity	
Innovation	Firm introduced product, process or/and organizational innovations during 2004-2006 (yes/no)
Services	Firm belongs to the service sector (yes/no)
<b>Epidemic, Stock and Order effects</b>	
Adoption of e-buying in sector j	Percentage of firms buying online in sector j
Adoption of e-selling in sector j	Percentage of firms selling online in sector j

<sup>a</sup> Grande Region market is: Lorraine, Sarre, Rhénanie-Palatinat, Wallonie, except Luxembourg (considered as national market).

<sup>b</sup> European market is. Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden and United Kingdom.

<sup>c</sup> The Community Innovation Survey includes several questions to characterize the level and kind of competition in a firm’s main market. In order to summarize all this information, a factor analysis was run (Hair et al., 1995) identifying the following four competition-related factors: (1) the impacts of service to customers and products quality; (2) the fast technological change; (3) the intensity of competition and the difficulty in forecasting competitors’ actions; and (4) the impacts of publicity and product diversity (See the Annex for more details of the factor analysis performed).



Following a standard practice in the literature when dealing with cross-sectional data, epidemic effects are measured together with stock and order effects by the rates of the e-commerce adoption (Battisti et al., 2007; Hollenstein

and Woerter, 2008). The sign of the estimated coefficients will indicate the net effect of these forces: if the sign is positive, then epidemic effects overcome stock and order influences; if the sign is negative, just the opposite effect is taken place.

**Table 4. Summary statistics**

Variables	N	Weight	Mean	Std. Dev.	Min	Max
Group	300	1 091	0.386	0.487	0	1
Age	300	1 091	15.063	16.344	-1	191
ln (Size)	300	1 091	3.404	0.947	2.30	8.04
Employees with a degree (%)	300	1 091	26.721	32.055	0	100
IT/ICT specialists	300	1 091	0.238	0.426	0	1
ICT infrastructure	300	1 091	2.133	1.163	0	5
“Grande Region” market <sup>a</sup>	300	1 091	0.275	0.447	0	1
European market <sup>b</sup>	300	1 091	0.078	0.268	0	1
Rest of the world market	300	1 091	0.019	0.138	0	1
F1-Service to customers & products quality	300	1 091	-0.029	1.036	-2.91	1.82
F2-Fast technological change	300	1 091	-0.019	0.999	-2.55	2.46
F3-Competition & forecasting difficulties	300	1 091	-0.063	1.030	-2.89	2.14
F4-Publicity and product diversity	300	1 091	0.022	0.999	-2.31	2.09
Innovation	300	1 091	0.618	0.486	0	1
% of Turnover from e-selling	300	1 091	2.851	13.349	0	100
% of Turnover from e-buying	300	1 091	6.776	17.557	0	90
Adoption of e-buying in sector j (%)	300	1 091	0.168	0.061	0.05	0.21
Adoption of e-selling in sector j (%)	300	1 091	0.424	0.138	0.34	0.69

<sup>a</sup>Grande Region market is: Lorraine, Sarre, Rhénanie-Palatinat, Wallonie, except Luxembourg (considered as national market).

<sup>b</sup>European market is. Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden and United Kingdom.

Two main issues arise in the estimation of equations (2) and (3). On the one hand, there could be some sample selection bias in the estimation of equation (3) since it only uses data from those firms already involved in e-commerce. However, the several checks performed indicated the absence of such bias. On the other hand, the inclusion of innovation as an explanatory variable raises some

endogeneity concerns. In absence of appropriate instruments for this variable, innovation and e-commerce adoption were estimated as a bivariate probit (Arendt and Holms, 2006). In the case of intensity, dropping the innovation variable was considered the best solution due to the non-availability of instruments and the small number of observations.

## 5. RESULTS

**Table 5. Determinants of e-commerce diffusion among Luxembourgish firms. Year 2006**

	Adoption		Intensity	
	e-Buying mfx	e-Selling mfx	e-Buying	e-Selling
Group	-0.069**	-0.011	-6.751**	-10.717**
	(-0.034)	(0.021)	(2.439)	(3.336)
Age	-0.002	-0.001	-0.081	0.085
	(-0.001)	(0.001)	(0.079)	(0.073)
Ln (employment in 2006)	-0.008	-0.003	-1.648	1.607
	(-0.019)	(0.011)	(1.294)	(1.548)
Employees with a degree	-0.001	-0.001**	0.145***	0.519***
	(-0.001)	(0.001)	(0.036)	(0.062)
Specialist IT / ICT	0.112	-0.023	6.939**	-17.262***
	(-0.079)	(0.015)	(2.286)	(4.696)
ICT infrastructure	0.052**	0.028**		
	(-0.025)	(0.014)		
“Grande region” market (a)	0.043	-0.036		
	(-0.061)	(0.023)		
European market (b)	0.038	-0.010	-0.079	41.654***
	(-0.05)	(0.023)	(2.486)	(3.797)
Rest of the world market	0.002	-0.055**		
	(-0.123)	(0.025)		
F1_Service to customers & products	0.007	-0.011	5.142***	-7.834***
	(-0.017)	(0.009)	(1.024)	(1.670)
F2_Fast technological change	0.035*	0.001	-0.329	10.958***
	(-0.02)	(0.009)	(1.211)	(2.081)
F3_Competition & forecasting difficulties	-0.037*	-0.021**	1.151	10.458***
	(-0.02)	(0.010)	(1.002)	(2.221)
F4_Publicity and product diversity	0.012	0.011	10.015**	11.369***
	(-0.022)	(0.013)	(1.102)	(1.745)
Innovation	0.444***	0.376***		
	(-0.128)	(0.068)		
Adoption of e-buying in sector j	0.225			
	(-0.188)			
Adoption of e-selling in sector j		0.304		
		(0.300)		
Services	0.076*	0.027	6.074	7.605
	(-0.045)	(0.026)	(3.157)	(4.780)
N	1091	1091	416	166
Log likelihood	-1165.47	-1005.56		
R <sup>2</sup>			0.3044	0.7039

Note: This table reports in the adoption equation : Marginal Effects (mfx) are calculated at the mean of continuous variables and value 0 for the discrete variables. And in the Intensity equation the coefficients. Below them, standard errors are in brackets. . \*\*\*, \*\*, and \* indicate significant at the 1, 5, and 10 percent levels, respectively.

<sup>a</sup>Grande Region market is: Lorraine, Sarre, Rhénanie-Palatinat, Wallonie, except Luxembourg (considered as national market).

<sup>b</sup>European market is. Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Ireland, Latvia, Liechtenstein, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovenia, Slovakia, Switzerland, Turkey, Spain, Sweden and United Kingdom.

Source : ICT 2007 & CIS 2006, STATEC

Table 5 shows the results from the estimation of the adoption and intensity equations for both e-selling and e-buying online. Regarding adoption, the first things to draw attention on are the non-significant impacts of firm size and human capital. These two factors do not suffice to explain e-commerce adoption among Luxembourgish firms as previously observed by Battisti et al. (2007) in the United Kingdom. In contrast, ICT infrastructure and innovation really make a difference for adoption. Results indicate that innovative firms and those which have high levels of ICT equipment are more likely to buy/sell online than those that do not carry out any innovation and have lower levels of infrastructure. It is also observed that firms belonging to a group are less likely to use e-commerce, although this effect is only significant for e-buying.

Adoption is explained as well by the competition context faced by firms. Results show that a highly competitive environment, in which forecasting rivals' actions is difficult, tends to hamper the adoption of both types of e-commerce. However, the fast technological change in the market exerts a positive and significant influence on the adoption of e-buying. In the particular case of e-selling, market distance has a significant and negative impact on adoption: firms selling out of Europe are less likely to use the Internet to trade than those selling nationally. This finding suggests that the Internet help to overcome distance barriers only to a certain extent.

The positive signs, shown by the coefficients of the rates e-commerce adoption in the sector the firm belongs to, indicate that epidemic effects are stronger than the negative influences of stock and

order effects. However, the net effect is not significant.

As regards intensity, firm size keeps being non-significant while human capital becomes a relevant factor to explain the extent of use of e-commerce among Luxembourgish firms. Results show that firms with a high proportion of workers graduated from college/university tend to use online commerce more intensively than those with lower percentages of educated workforce. However, the impact of IT specialists differs by type of e-commerce: positive for e-buying but negative for e-selling. Such a result might be pointing out the different nature of these two types of e-commerce and, in particular, the more complexity of e-purchasing compared to e-selling: the former might require dealing with complex systems to integrate with suppliers, while the latter requires, in its most basic form, just a website.

Belonging to a group keeps exerting a negative influence over e-commerce. Note the negative and significant coefficients of the group variable on the intensity equations. A possible reason for this negative association could be related to the fact that firms, that are part of a group, might be using other types of electronic commerce than that related to Internet, which is the focus of this paper.

Other important determinants of the intensity of use of e-commerce are related to the features that describe the competition context faced by firms. In the case of e-selling, the four considered factors are significant; for e-buying only two of them. Results then show that firms buy online intensively when they operate in markets where competition is mainly

driven by publicity and product diversity together with customer service and product quality. Nonetheless, this latter feature, competition defined by customer service and product quality, exerts just the opposite effect over e-selling: the more important customer service and product quality are, the less proportion of sales the firm will make online. Finally, it seems that online selling by Luxembourgish firms is mainly oriented to the European market.

## **6. CONCLUDING REMARKS**

This paper has attempted to contribute to the literature on ICT diffusion at firm-level, by analyzing not only the determinants of the decision to adopt e-commerce but also the intensity of online sales and purchases among those firms already using this technology. Results show that e-commerce adoption mainly takes place among innovative firms which have the adequate ICT infrastructure. Contrary to previous evidence, human capital and firm size do not play any role in adoption. It is also

interesting to note the negative influences of the intensity of competition and “being part of a group of enterprises” over the take-up of e-commerce. All this suggests that Internet commerce is still surrounded by a lot of uncertainty that makes firms prefer other types of electronic transactions. However, once firms have overcome the uncertainties about adoption they tend to use e-commerce intensively to compete with rivals. The non-significant evidence of epidemic effects seems a bit shocking in a small economy such as Luxembourg where firms are located next to each other and the likelihood of ‘contagion’ should be high. Results regarding intensity highlight the differences in the two sides of e-commerce: e-purchasing involves more complex systems that require higher skilled-workers compared to e-selling. In addition, it remains an unanswered question for firms the way they can use Internet to provide efficient services to customers.

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## ANNEX. FACTOR ANALYSIS

### A) Competition-related questions used in factor analysis (2006 Community Innovation Survey)

1.3 During the period 2004-2006, how would you describe the nature of the market you were operating in?

- i. No effective competition
- ii. Not very intense
- iii. Quite intense
- iv. Very intense

1.4 Please indicate to what extent the following characteristic are describing the competition context on your main market:

	High	Medium	Low	Not relevant
a. The actions of competitors are difficult to forecast				
b. Your position on the market is threatened by the arrival of new competitors				
c. The production's technologies and the services are changing quite quickly				
d. The products and services are rapidly old-fashioned (outdated)				
e. The products of your enterprise can be easily replaced by the products of your competitors				
f. Evolution of the demand is difficult to forecast				

1.5 Please indicate to what extent the following factors impact the competition on your main market:

	High	Medium	Low	Not relevant
a. The price				
b. The quality of goods and services				
c. Technological advance				
d. The service and the adaptation of customers wishes				
e. The diversity of the products' package				
f. Publicity and design				

### B) Results from factor analysis

**Table B1. Some measures of the appropriateness of factor analysis**

<b>Bartlett test of sphericity</b> (H0: variables are not intercorrelated)	Chi-square	892.950
	Degrees of freedom	78
	p-value	0.000
<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</b>	KMO	0.778

**Table B2. Results from factor analysis**

	<b>Eigenvalue</b>	<b>Explained Variance (%)</b>	<b>Cumulative Explained Variance (%)</b>
Factor1	3.66	28.14	28.14
Factor2	1.60	12.27	40.41
Factor3	1.25	9.59	50.01
Factor4	1.07	8.26	58.27
Factor5	0.95	7.28	65.55
Factor6	0.84	6.48	72.03
Factor7	0.67	5.17	77.20
Factor8	0.66	5.07	82.27
Factor9	0.55	4.24	86.51
Factor10	0.52	3.97	90.48
Factor11	0.49	3.76	94.24
Factor12	0.40	3.11	97.36
Factor13	0.34	2.64	100.00

**Table B3. Rotated Factor Loadings**

	Factor1	Factor2	Factor3	Factor4
Q1.3			0.7485	
Q1.4a			0.7171	
Q1.4b		0.5366		
Q1.4c		0.7423		
Q1.4d		0.6125		
Q1.4e		0.5465		
Q1.4f		0.6646		
Q1.5a			0.6155	
Q1.5b	0.7510			
Q1.5c	0.7601			
Q1.5d	0.8169			
Q1.5e				0.7280
Q1.5f				0.8784