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Internet Use by Businesses in Old and New EU Member Countries

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Summary

In recent years, the potential use of information and communication technologies (ICT) and, more particularly, the Internet as an instrument of change, and economic development and growth has attracted considerable attention. Whereas much of the policy discussion has focused on the promotion of the use of the Internet by households, business and governments, the empirical evidence of the determinants of the Internet take-up in various countries is still relatively limited. So far, a number of country-specific studies have examined the determinants and benefits of ICT use by businesses, but there is very limited empirical evidence on the reasons for the observed wide cross-country differences in Internet take-up by businesses. In the present study we use data from the recently e-Business Survey 2003 to examine why Internet usage by businesses in the 25 EU Member States differs.

[1] The views and opinions expressed in this paper are those of the authors only. The results presented in this paper are preliminary and should not be quoted without permission of the authors.

1. Introduction

Much has already been written in recent years about the so-called "new economy" and the Internet. However, in the economic literature, the focus so far has been mainly on the potential impact of ICT (information and communication technologies) on output and productivity[2] and to a much lesser extent on the specific economic impact of Internet[3].

Yet, at the policy level, the potential use of ICT and, more particularly, of the Internet as an instrument of change and economic development and growth has attracted considerable attention. Much policy discussion in various international and domestic fora has been devoted to the development of policies promoting the use of the Internet by households, business and governments, and many governments throughout the world have by now adopted explicit policies targeting the domestic development of Internet.

In this study we use data from the recently released e-Business Survey 2003 to examine how Internet take-up and usage varies across the 25 EU Member States.

The structure of the paper is as follows. In section 2, we discuss briefly the growth in Internet. Next, in section 3, we review the literature on the cross-country determinants of Internet take-up and usage. We then present briefly, in section 4, the data used in the present study and, in section 5, we set out the model used in the empirical analysis. The estimation results are reported in Section 6. Finally, section 7 provides some concluding remarks.

2. Internet

Internet has seen an explosion of its number of users in recent years. The number of hosts computers connected to the Internet has grown from fewer than 200,000 in 1990 to over 20 million today.

Businesses have benefited enormously by the introduction of the Internet. The World Wide Web allows rapid access to huge amounts of information of commercial value, and posting of information to the web on a home page allows a firm or individual to advertise its products or services at relatively low cost. In addition, one of the principal uses attached to

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[2] For a good overview of the on-going debate on the likely impact of ICT on productivity see, for example Brynjolfson and Hitt (2000), Gordon (2000), Jorgensen (2001), Nordhaus (2001),Stiroh (2001), and OECD (2004).

[3] In fact, the literature on the likely social impact of the Internet, i.e. the debate on the digital divide within countries and among countries, appears to exceed by far the literature on the likely economic impact. Litan and Rivlin (2001) provide a good overview of the likely economic impact of the Internet.

the Internet, the electronic mail, has allowed cheap communications among companies sharing not only written messages but also documents, images or software.

The degree of penetration of the Internet has not been, however, uniform across countries. Geographically, industrialised countries have connected rapidly, whereas connection has been slower in many emerging and developing countries. Amongst the industrialised countries, the expansion of Internet has been exceptional in the US, and, to a somewhat lesser extent, in a few European countries.

Overall, there exist noticeable differences in the connectivity rates of European countries.[4] Whether such differences can be explained by country-specific economic factors, the degree of development of the telecommunications sector, or the characteristics of the industrial sectors and businesses, is critical for the formulation of policies aimed at reducing, in the coming years, the digital divide between members of the enlarged European Union.

The empirical evidence on the determinants of cross-country differences in Internet take-up is rather limited. Overall, we are aware of only a few multivariate studies examining in detail potential factors explaining the different Internet take-up rate across the world. Beilock and Dimitrova (2003), Chinn and Fairlie (2004) and Kiiski and Pohjola (2002) focus on the determinants of Internet diffusion world-wide; Hargittai (1999) on the OECD countries; Muller and Salsas (2003) on Western and Central and Eastern Europe; Clarke (2001) on Central and Eastern Europe; Dasgupta (2001) on developing countries; Conte (2001), and Roycroft and Anantho (2003) on Africa; and Estache et al. (2002)[5] on Latin America. Of note is the fact that the object of most of these studies is country-wide Internet usage with no real distinction being made between Internet usage by households and businesses.

In this paper, we seek to expand the current stock of knowledge on the determinants of Internet use by focusing on the determinants of Internet take-up and use by businesses in the enlarged European Union and Norway.

[4] For example, according to the latest Eurostat (2004) data, Internet usage in 2003 by individuals varied from 16% of all individuals in Greece to 77% in Finland among the EU15. Among SMEs, the Internet usage ranged from 71% in Portugal to 98% in Denmark and Finland. In contrast, Internet usage by larger firms was high, typically higher than 95% and varied little across the EU15.

[5] Although the paper provides estimation results of a model of Internet-use worldwide, its primary focus is on Latin America.

3. Overview of the Literature of the Determinants of Internet Usage

Although there is some limited literature on the determinants of the Internet take-up in various countries, we are not aware of any cross-country studies that examine in detail the potential factors of different Internet penetration in businesses.

Previous studies on Internet take-up highlight a country's income (GDP per capita or a similar measure) as one of the factors explaining the variation in Internet usage across countries. Other socio-economic factors that have been conjectured as playing an important role are the size of the population, income inequality, the overall education level of the population, or the relative size of the urban population, although the empirical estimates do not so far provide strong evidence that these are major factors.

The state and quality of the overall telecommunications infrastructure is also often viewed as a key factor explaining different Internet take-up rates across countries. According to some studies, the number of telephone lines and the cost of local calls appear to be a relevant factor. A country's openness (trade, FDI, etc) to other countries seems also a robust predictor of Internet penetration, especially in the emerging and developing countries.

The degree of competition in the telecommunications sector also appears to play a critical role. This is not surprising in light of the more general literature on telecommunications that finds generally a solid link between the level of development of telecommunications and competition in the sector.[6]

In line with standard consumer demand, the costs of Internet access are also often expected to be a key determinant of Internet usage. However, as the Internet costs data are very limited, especially for non-OECD countries, this hypothesis has not yet been robustly tested.

Finally, some authors have also used the number of personal computers in a country as determinant of Internet usage. The use of such a variable, however, can be problematic as it is not a priori obvious which variable is the truly exogenous one. In the case of countries having taken the Internet recently, it is possible that, in fact, it is the availability of Internet that determines the decision to acquire a personal computer and that, hence, the causality is reversed.

[6] See for example Spiller and Cardilli (1997) and Wallenstein (2001).

4. Data

In this section we describe the data we are using in our analysis.

The study collates data from different sources. Our principal source of information is the e-Business Survey 2003[7] that collected information on business Internet usage, business ICT indicators and other basic company data. We also use country-specific data such as GDP, trade, foreign direct investment and an index of education from the World Bank, WTO, UNCTAD, and the UNDP Human Development Report. We complete the information on a country's state of the telecommunications sector by using the number of Internet users from the International Telecommunication Union (ITU), and an indicator of the state of liberalisation of the telecommunications sector.[8]

The geographic area covered by our study is the 25 Member States European Union plus Norway. Complete data are available for Austria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, and the United Kingdom.

The e-business survey of enterprises covers the following sectors: Business services, Chemicals, Crafts & Trade, Electronics, Health services, ICT services, Retail, Textile, Tourism, and Transport.

Our final sample is constituted of 120 observations.

The last year for which data are available varies across the data sources used in our analysis. The data from the e-Business Survey refers to 2003, whereas the last available year for the rest of data is 2002, with the exception of the education index that is available only for 2001. Therefore, because of data constraints, the empirical estimation of our model will use data from different years. We believe, however, that this will not bias the results for reasons that we discuss in the next section.

The full description of the variables and their descriptive statistics can be found in the Annex.

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[7] This survey was carried out by e-Business W@tch in November 2003 for the European Commission Enterprise Directorate General. Further information on the survey can be found at http://www.ebusiness-watch.org/.

[8] In the case of the Central European countries, this indicator is the telecommunications transition indicator produced by the EBRD and in the case of the other countries it reflects our own assessment of the state of liberalisation of the telecommunications sector (see Annex for further details).

5. The Model

The model of the determinants of business Internet usage is based on the existing literature of the determinants of Internet usage. It includes basic industry-specific economic indicators (**B**), indicators of the state of each county's telecommunications infrastructure (**T**), and indicators related to each country's socio-economic characteristics (**S**). In addition, we have included one dummy variable indicating whether the country is a new EU Member State (ACC), and dummies for each one of the industrial sectors. We estimate several versions of equation (1) defined for each country *i* and sector *j* as follows:

$$y_{ij}, = \alpha + \boldsymbol{\beta}_1' \mathbf{B}_{ij} + \boldsymbol{\beta}_2' \mathbf{T}_i + \boldsymbol{\beta}_3' \mathbf{S}_i + \delta_1 \mathrm{ACC}_i + \text{sector dummies}_j + \varepsilon_{ij} \ , \qquad (1)$$

where:

y_{ij} is the percentage companies in country *i* and sector *j* having Internet access (weighted by employment).

B is a column vector of business-specific economic indicators comprising the sector average number of employees (in logs), the percentage of companies having more than 50 employees, and the percentage of companies using computers (as percentage of employment).

T is a column vector of telecommunications infrastructure variables including Internet hosts per 100 inhabitants, estimated Internet users per 100 inhabitants, and the telecommunications liberalisation indicators. We label dindi3 a dummy variable that equals 1 when the value of the telecommunications liberalisation indicator takes a value of 3 or 3+ (substantial progress has been achieved in commercialisation and regulation), and 0 otherwise. Similarly we label dindi4 a dummy variable reflecting ratings 4 and 4+ (complete commercialisation or implementation of an effective regulation).

S is a column vector of socio-economic indicators that comprises GDP per capita (in logs), imports of goods and services as a percentage of GDP, foreign direct investment as a percentage of gross fixed capital formation, and the Human Development Indicator education index.

The sector dummies are defined as 1 if the observation belongs to the sector, 0 otherwise. The sectors include Business services, Chemicals, Crafts & Trade, Electronics, Health services, Retail, Textile, Tourism, and Transport. The omitted sector in the regression models is ICT services.

Finally, $\boldsymbol{\beta}_1, \boldsymbol{\beta}_2$ and $\boldsymbol{\beta}_3$ are column vectors of the parameters for the variables in **B**, **T**, and **S**, respectively, δ_1 is the parameter associated with the new Member State dummy variable, and ε_{ij} is an error term.

The precise data definitions and data sources are provided in the Annex together with their descriptive statistics.

As we have already noted in the previous section, the availability of data varies across data sources. For the telecommunications infrastructure variables (**T**) and socio-economic variables (**S**) data are available until 2002 (except for the education index that is only available to 2001), whereas the data from the e-Business survey that includes basic company economic indicators (**B)** are available for 2003 only.

We believe that using data from different years will not invalidate our results for the following reasons. First, yearly variations in the variables in **S** and **T** are small, and therefore we do not expect substantial differences in parameter estimates to arise from using 2002 data instead of 2003 data. This also applies for the education index for which data is only available to 2001. Second, and more importantly, by using data lagged one period for the infrastructure and socio-economic variables we are in fact imposing a structure that is appropriate for our exercise as we wish to avoid any reverse causality from Internet use to any of our explanatory variables[9]. Our approach is akin to using instrumental variables approach.

6. Empirical Results

In our empirical work, we focus both on access by businesses to the Internet, and the various uses of Internet by businesses. We first report the results of our detailed analysis of the determinants of a) Internet access. Next, we report the estimation results of a model seeking to explain variations among businesses in b) use of e-mails, c) use of the World Wide Web, d) having a web site, and e) selling through the Internet or other online distribution.

6.1 Analysis of Businesses Internet Access

We have estimated different versions of the model proposed by equation (1). Our first specification includes only sector-specific variables, our second specification includes only

[9] For example Clark and Wallsten (2004) find that greater Internet use stimulates exports.

country-specific variables, and our third model includes only telecommunications-infrastructure variables. All three models include also a constant term and a dummy variable for New EU Member States (ACC). We experimented with additional specifications allowing for each variable a different parameter for the group of New EU Member States. However, none of the interaction parameters were statistically significant, except that of the variable "Percentage of companies using computers". The different models did not pass homoskedasticity tests, therefore we estimated standard errors using a robust procedure. The estimation results are provided in the first three columns of Table 1.

Our first model (Model 1) achieves a high fit (R-squared of 0.79) and shows that all the variables are statistically significant at a 5% level or better, except for the average number of employees. Models 2 and 3 show a very low goodness of fit (R-squared lower than 0.15) but indicate that socio-economic variables such as trade, education and telecommunications transition indicator are statistically significant. On the other hand, only the number of Internet hosts is a significant variable of telecommunications infrastructure.

In Model 4 we have included all the variables together with sectoral dummy variables. Our preferred model is Model 5 where we have excluded the per capita GDP and FDI variables, which were found to be statistically insignificant in Model 4. The final model has good statistical properties and an R-squared of 0.88.

The results of Model 5 show some important findings. Although previous studies have shown a strong positive relationship between per-capita GDP and rates of per-capita Internet usage (see for example Beilock and Dimitrova, 2003), we do not find such an effect for the businesses in our sample. Furthermore, the FDI variable is also not statistically significant, and only the trade variable appears as statistically significant and with a positive sign. This indicates that companies have a higher Internet usage in countries where the level of trade is high.

The telecommunications liberalisation indicators are statistically significant, positive and consistent with our expectations. Hence, in countries with a liberalisation indicator of 3 or 3+ have 9.8% more business with Internet access than in countries where the indicator is only 1 (the omitted category). Furthermore, in countries with an indicator of 4 or 4+ have 11.4% more business with Internet access. Following from this same argument we can also conclude that countries moving from a liberalisation indicator of 3 or 3+ to 4 or 4+ would increase the percentage of businesses having Internet access by 1.6% (11.4-9.8), on average.

The variable "Internet hosts" is statistically significant with a positive sign. This indicates that Internet access by business is greater in countries where there is a wider Internet diffusion. On the other hand, the variable "Internet users" is not significant.

The results for the set of company-specific variables are as follows. The average number of employees is not statistically significant in any of our models. The variable of the percentage of companies having more than 50 employees is significant with a positive coefficient. This suggests that business Internet access is related to the size of the company, i.e. larger companies (more than 50 employees) have a higher Internet access than smaller companies.[10] We have allowed a different slope for New EU Member States for the variable that measures the percentage of companies using computers[11]. The percentage of companies using computers has a positive and significant coefficient for Norway and countries in the EU. The coefficient of 1.6 indicates that a one percent point increase in the percentage of companies that use computers would, on average, increase by 1.6 percentage points the business with Internet usage. However, for the New Member States this coefficient is only 1.2 (derived as 1.6-0.4).

It is important to note that a one-percentage-point increase in businesses computers impacts businesses Internet usage by more than one percent. Hence, it seems that increasing the number of computers will encourage new potential users to connect to the Internet, but also existing ones will be persuaded to join. This suggests that some network externalities exist for Internet business use. Network externalities have typically been defined in the literature as a change in the benefit, or surplus, that an agent derives from a good when the number of other agents consuming the same kind of good changes. As computers increase in popularity, connecting them to the Internet will allow each business to derive greater benefit from Internet usage because the company will be able to interact with more users. The externality is lower in New Member States than the EU15+Norway, probably because the EU15+Norway have a larger number of users and a more developed Internet network that makes the potential externalities larger.

We have also included a dummy variable that allows for a different constant term for New Member States (ACC). This variable is statistically significant with a positive value. This means that New Member States have higher Internet business use than the level that the model would predict on the basis of the explanatory variables such as trade, education, etc.

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[10] This finding is consistent with the results of the recent Eurostat survey cited earlier, which shows that in the EU15 larger companies have a much higher Internet access rate than smaller companies.

[11] We also tried different slopes for other explanatory variables but they were not statistically significant.

This result suggests that, once all economic factors have been taken into account, there seems to be some dynamic at play that encourages countries with a lower Internet use to increase further their use, and thus bring about convergence towards the level in the EU15 Member States and reduce the gap between the two groups of countries.

The final model also includes sectoral dummies that were jointly statistically significant at better than 1% using a Wald test (F value 4.1).

Table 1: Estimated models

(dependent variable: Percentage of companies having Internet access)

	Model 1	Model 2	Model 3	Model 4	Model 5
Llgdp_cap		-0.96		-1.10	
		(0.94)		(1.43)	
Ltrade_gdp		6.31		2.45	2.47
		(2.48)*		(2.23)*	(2.54)*
Lfdi_in		0.01		-0.07	
		(0.22)		(1.40)	
DeLindi23		1.84		7.40	9.79
		(0.39)		(2.32)*	(3.52)**
DeLindi45		9.62		10.35	11.39
		(2.45)*		(3.51)**	(3.86)**
L2edu		-135.55		-106.51	-69.50
		(2.31)*		(2.35)*	(2.16)*
Li4211_cap			0.34	0.19	0.11
			(3.20)**	(2.43)*	(1.94)+
Li422_cap			-0.02	-0.01	-0.01
			(1.27)	(0.71)	(0.77)
dregion1	48.49	-10.45	-0.24	36.80	42.53
	(3.06)**	(2.84)**	(0.10)	(2.57)*	(2.93)**
lx1	0.13			-0.01	-0.14
	(0.25)			(0.02)	(0.20)
g1	0.05			0.13	0.13
	(2.49)*			(3.06)**	(3.24)**
a1	1.71			1.51	1.57
	(11.35)**			(10.86)**	(11.55)**
dregion1_a1	-0.48			-0.4	-0.44
	(2.98)**			(2.78)**	(2.96)**
Constant	-77.67	208.07	90.01	27.84	-11.29
	(5.19)**	(3.76)**	(53.81)**	(0.62)	(0.36)
Sector dummies	No	No	No	Yes	Yes
				(3.90)**	(4.11)**
Observations	120	120	120	120	120
R-squared	0.79	0.15	0.03	0.88	0.88

Note: Robust absolute t statistics in parentheses except for sector dummies where F test of joint significance is used. + significant at 10%; * significant at 5%; ** significant at 1%.

6.2 Analysis of Internet-use Variables

Next we have re-estimated our preferred model with a number of Internet-use variables documented in the 2003 eBusiness Watch survey.

In Table 2 we show Model B that is estimated using the "Percentage of companies using E-mail" as dependent variable; Model C uses the "Percentage of companies using the World Wide Web"; Model D uses the "Percentage of companies having a web site"; and Model E uses the "Percentage of companies selling on the Internet or through other online distribution". In addition, for comparative purposes, we have included Model A that reproduces Model 5 ("Percentage of companies having Internet access").

The overall results are the following. The "Percentage of companies using E-mail" can be broadly explained with the same variables as those of Model A (R-squared of 0.86). In addition, almost all the same variables are statistically significant and show a coefficient of a similar magnitude. The reason for this is that having Internet access and using E-mail are probably highly related , i.e. companies having one have also usually the other. Therefore, because both variables are highly correlated (see Table 9), they show similar estimation results.

The estimation results of the model explaining the "Percentage of companies using the World Wide Web" show some differences relative to the original Model A. The coefficient of the trade variable is much higher than in Model A suggesting that World Wide Web usage is higher in countries with higher trade. The variable company size (percentage of companies having more than 50 employees) is significant with a positive coefficient, and the percentage of companies using computers has a positive and significant coefficient. This variable, however, does not seem to be different for New Member States (the interactive term is not statistically significant). Furthermore, everything else being equal, New Member States show a higher usage of the World Wide Web than the EU15+Norway (the variable dregion1 is statistically significant). Finally, the degree of liberalisation of the telecommunications does not seem to have any effect.

The estimation results of the model for the variable "Percentage of companies having a web site" show that variations in the presence of a company web site is related to the size of the company and the percentage of companies using computers. However, the percentage of companies using computers is not statistically different for New Member States (the interactive term is not statistically significant). Finally, the variable measuring Internet hosts is also statistically significant.

The estimation results of the last model, the "Percentage of companies selling on the Internet or through other online distribution", are very different from those of the former models. The results indicate that the percentage of companies selling on the Internet is independent of the firm size and the percentage of computers. The variable "Internet hosts" is statistically significant and shows a positive sign. Surprisingly the variable "Internet users" has a negative sign, although its coefficient is small.

Table 2: Estimated models

	Model A	Model B	Model C	Model D	Model E
	a2	a6a	a6b	b1a	b21
Ltrade_gdp	2.47 (2.54)*	3.84 (3.00)**	6.62 (3.48)**	-0.84 (0.40)	0.82 (0.38)
deLindi23	9.79 (3.52)**	10.20 (3.34)**	3.11 (0.65)	-0.57 (0.09)	-3.55 (0.68)
deLindi45	11.39 (3.86)**	10.74 (3.12)**	2.78 (0.63)	7.23 (1.10)	-0.06 (0.01)
L2edu	-69.50 (2.16)*	-56.45 (1.30)	129.61 (1.86)+	90.85 (1.15)	39.80 (0.84)
Li4211_cap	0.11 (1.94)+	0.13 (1.60)	-0.02 (0.14)	0.44 (2.59)*	0.73 (3.26)**
Li422_cap	-0.01 (0.77)	-0.01 (0.84)	0.03 (1.80)+	-0.02 (0.88)	-0.04 (2.01)*
dregion1	42.53 (2.93)**	51.37 (2.54)*	42.09 (1.68)+	10.36 (0.34)	-21.20 (1.06)
lx1	-0.14 (0.20)	-0.07 (0.06)	0.17 (0.08)	-0.26 (0.12)	0.75 (0.59)
g1	0.13 (3.24)**	0.18 (3.57)**	0.27 (2.44)*	0.31 (2.58)*	0.03 (0.34)
a1	1.57 (11.55)**	1.81 (9.94)**	1.32 (5.40)**	0.89 (3.62)**	0.02 (0.09)
dregion1_a1	-0.44 (2.96)**	-0.53 (2.57)*	-0.32 (1.24)	-0.09 (0.28)	0.20 (0.90)
desector1	1.12 (0.83)	0.11 (0.06)	-3.77 (1.01)	-20.95 (4.29)**	-21.28 (5.50)**
desector2	-3.06 (2.92)**	-4.98 (3.00)**	-7.49 (2.04)*	-10.76 (2.81)**	-19.96 (4.77)**
desector3	1.69 (0.44)	0.25 (0.05)	-0.48 (0.06)	-28.47 (3.34)**	-22.16 (3.91)**

desector4	-2.19 (1.58)	-3.40 (2.00)*	-5.36 (1.46)	-13.25 (2.69)**	-17.50 (3.87)**
desector5	-4.12 (2.05)*	-6.81 (2.34)*	-7.99 (1.81)+	-29.91 (6.66)**	-25.91 (5.95)**
desector7	-0.34 (0.19)	-1.21 (0.54)	-8.98 (1.91)+	-21.96 (4.56)**	-15.77 (3.27)**
desector8	-2.94 (1.60)	-4.89 (2.13)*	-10.17 (2.44)*	-25.80 (6.04)**	-23.50 (6.53)**
desector9	5.00 (2.57)*	6.13 (2.39)*	4.75 (1.10)	4.93 (0.99)	9.45 (1.96)+
desector10	-2.48 (1.81)+	-4.76 (2.66)**	-12.55 (2.72)**	-14.53 (3.35)**	-22.72 (5.91)**
Constant	-11.29 (0.36)	-52.97 (1.26)	-192.74 (2.89)**	-109.51 (1.48)	-15.11 (0.32)
Observations	120	120	120	120	120
R-squared	0.88	0.86	0.71	0.82	0.74

Note: Robust absolute t statistics in parentheses except for sector dummies where F test of joint significance is used. + significant at 10%; * significant at 5%; ** significant at 1%.
Dependent variables: Model A "Percentage of companies having Internet access"; Model B "Percentage of companies using E-mail"; Model C "Percentage of companies using the world wide web"; Model D "Percentage of companies having a web site"; and Model E uses the "Percentage of companies selling on the Internet of through other online distribution".

7 Conclusions

In this paper we study access by businesses to the Internet and the various uses of Internet by businesses. We first report the results of a detailed analysis of the determinants of a) Internet access, and next, we report the estimation results of several models that explain variations among businesses in b) use of e-mails, c) use of the World Wide Web, d) having a web site, and e) selling through the Internet or other online distribution.

In the first three Internet variables analysed ("Internet access", "use of e-mails, and "use of the World Wide Web") we have found that trade, company size (measured as the percentage of companies having more than 50 employees), and computer usage (measured as the percentage of companies using computers) are all significant variables with a positive coefficient. This indicates that companies have a higher Internet take-up in countries where

the level of trade is high, in sectors with larger companies, and in sectors with higher number of companies having computers. The degree of liberalisation of the telecommunications sector is also important for the first two variables and consistent with our expectations. Hence, more liberalisation brings higher "Internet access" and "use of emails".

In the last two variables analysed ("having a web site", and "selling through the Internet or other online distribution") we found that the number of Internet hosts was significant and with a positive coefficient, but not trade or the degree of liberalisation of the telecommunications sector. The company size and computer usage was significant and positive for explaining the percentage of companies "having a web site".

Finally, in all of the models except for "selling through the Internet or other online distribution" we found that, once all economic factors have been taken into account, there seems to be some convergence from countries with a lower Internet use towards the level in the EU15 Member States and hence reduce the gap between the two groups of countries.

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Annex

Data sources

The data used in this study were assembled from e-Business W@atch, International Telecommunication Union (ITU), the World Bank, the WTO, UNCTAD, the Human Development Report, and the EBRD.

The e-Business Survey was carried out in 2003 with enterprises which are active in the 25 EU Member States and Norway and which have as their primary business activity one of the sectors defined as per NACE Rev.1.[12]

Since 1994 the EBRD has been monitoring progress in transition across a number of dimensions of reform, including small-scale and large-scale privatisation. For each dimension, including telecommunications sector reform, a score is assigned once a year and reported in the annual *Transition Report*, published each year in November. The index ranges from 1 to 4+, where 1 indicates little or no progress in market-oriented reform, and 4+ indicates a standard similar to advanced market economies.[13] As noted earlier, the assessment of state of liberalisation of the telecommunications sector in the countries outside Central Europe was done by London Economics.

ITU provides several telecommunication indicators in its *World Telecommunication Indicators Database*. At the present time, there exists no perfect measure of Internet usage. However, the number of Internet hosts and the number of Internet users as published by the ITU are the most common source of Internet usage across countries.

The World Bank and the WTO publish data on GDP and trade in US$ for a wide number of countries. UNCTAD, in its World Investment Report 2003, publishes data for 1991-2002 on inward foreign direct investment as a percentage of gross fixed capital formation for several countries. Finally, the Human Development Report provides an education index.

A complete description of the variables used, with its sources, is shown in Table 3.

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[12] Methodological issues from the survey can be found in http://www.ebusiness-watch.org/images/stories/space/DMS2003_Methodology.pdf.

[13] Specifically the categories are defined as follows. Rating = 1: Little progress has been achieved in commercialisation and regulation. Rating = 2: Modest progress has been achieved in commercialisation. Rating = 3: Substantial progress has been achieved in commercialisation and regulation. Rating = 4: Complete commercialisation (including privatisation of the dominant operator) and comprehensive regulatory and institutional reforms have been achieved. Rating = 4+: Implementation of an effective regulation (including the operation of an independent regulator) has been achieved, with a coherent regulatory and institutional framework to deal with tariffs, interconnection rules, licensing, concession fees and spectrum allocation.

Table 3: Description of variables and sources

Variable name	Variable definition	Data source
a2	Percentage of companies having Internet access	eBusiness W@atch
a6a	Percentage of companies using E-mail	eBusiness W@atch
a6b	Percentage of companies using the world wide web	eBusiness W@atch
b1a	Percentage of companies having a web site	eBusiness W@atch
b21	Percentage of companies selling on the Internet or through other online distribution	eBusiness W@atch
lx1	Log of the average number of employees	eBusiness W@atch
g1	Percentage of companies having more than 50 employees	eBusiness W@atch
a1	Percentage of companies using computers	eBusiness W@atch
Llgdp_cap	Log of GDP per capita (current US$)	World Bank (GDP) and ITU (population)
Ltrade_gdp	Log of imports and exports of goods and services (in US$) as % of GDP (in US$)	WTO (imports) and World Bank (GDP)
Lfdi_in	Foreign Direct Investment (current US$) as % gross fixed capital formation	UNCTAD
L2edu	Education Index	Human Development Report, various issues, UNDP
Li4211_cap	Internet hosts per 100 inhabitants	ITU
Li4212_cap	Internet users per 100 inhabitants (estimated)	ITU
dindi3	Dummy variable = 1 it telecommunications transition indicator is 2 or 3 and = 0 otherwise	EBRD/London Economics
dindi4	Dummy variable = 1 if telecommunications transition indicator is 3 or more and 0 otherwise	EBRD/London Economics
desector1	Dummy variable = 1 if sector is Business services	Constructed
desector2	Dummy variable = 1 if sector is Chemicals	Constructed
desector3	Dummy variable = 1 if sector is Crafts & Trade	Constructed
desector4	Dummy variable = 1 if sector is Electronics	Constructed
desector5	Dummy variable = 1 if sector is Health services	Constructed
desector6	Dummy variable = 1 if sector is ICT services (omitted variable)	Constructed
desector7	Dummy variable = 1 if sector is Retail	Constructed
desector8	Dummy variable = 1 if sector is Textile	Constructed
desector9	Dummy variable = 1 if sector is Tourism	Constructed
desector10	Dummy variable = 1 if sector is Transport	Constructed
region1	Dummy variable = 1 if country is a New EU Member State and 0 otherwise	Constructed
region1_a1	Dummy variable = a1 if country is a a New EU Member State and 0 otherwise	Constructed

Descriptive statistics

The descriptive statistics and correlations for the variables used in our models are provided in Table 4 to Table 9.

Table 4: Descriptive statistics

Variable	Mean	Std. Dev.
a2	91.37	10.89
a6a	88.60	13.48
a6b	82.96	16.49
b1a	68.70	21.83
b21	16.31	14.71
lx1	5.64	1.30
g1	52.84	27.97
a1	96.11	6.35
Llgdp_cap	-3.90	1.38
Ltrade_gdp	0.87	0.53
Lfdi_in	19.79	16.34
deLindi23	0.28	0.45
deLindi45	0.68	0.47
L2edu	0.96	0.02
Li4211_cap	7.72	9.04
Li422_cap	71.00	90.36

Table 5: Frequencies of sectoral dummies

Sector dummies	Freq.	Percent
Business services	12	10.0
Chemicals	11	9.2
Crafts & Trade	8	6.7
Electronics	13	10.8
Health services	12	10.0
ICT services	12	10.0
Retail	13	10.8
Textile	13	10.8
Tourism	13	10.8
Transport	13	10.8
Total	120	100.0

Table 6: Frequencies of New EU Member States dummies

EU Countries dummies	Freq.	Percent
EU15+Norway	79	65.83
New EU Member States	41	34.17
Total	120	100.0

Table 7: Frequencies of transition indicator dummies

Transition indicator dummies	Freq.	Percent
2	4	3.33
3-3+	34	28.34
4-4+	82	68.34
Total	120	100

Table 8: Frequencies of countries used in the analysis

Country	Freq.	Percent
Austria	3	2.5
Czech Republic	5	4.17
Denmark	3	2.5
Estonia	10	8.33
Finland	3	2.5
France	10	8.33
Germany	10	8.33
Greece	5	4.17
Hungary	3	2.5
Ireland	3	2.5
Italy	10	8.33
Latvia	3	2.5
Lithuania	1	0.83
Netherlands	3	2.5
Norway	2	1.67
Poland	10	8.33
Portugal	3	2.5
Slovak Republic	4	3.33
Slovenia	5	4.17
Spain	10	8.33
Sweden	4	3.33
United Kingdom	10	8.33
Total	120	100

Table 9: Correlations of variables

		Correlations												
Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
a2	(1)													
a6a	(2)	0.98												
a6b	(3)	0.79	0.81											
b1a	(4)	0.71	0.74	0.73										
b21	(5)	0.33	0.35	0.37	0.59									
lx1	(6)	0.41	0.45	0.41	0.56	0.20								
g1	(7)	0.51	0.54	0.54	0.62	0.04	0.77							
a1	(8)	0.87	0.84	0.63	0.56	0.20	0.36	0.42						
Llgdp_cap	(9)	-0.07	-0.12	-0.23	0.04	0.04	0.09	0.00	0.02					
Ltrade_gd														
p	(10)	0.21	0.24	0.35	0.07	0.03	-0.04	0.04	0.13	-0.68				
Lfdi_in	(11)	0.17	0.21	0.34	0.19	0.17	0.08	0.15	0.15	-0.49	0.54			
L2edu	(12)	0.04	0.04	0.09	0.26	0.29	0.23	0.08	0.06	0.24	-0.18	-0.31		
Li4211_ca														
p	(13)	0.17	0.15	0.19	0.31	0.30	0.16	0.15	0.16	0.59	-0.29	-0.07	0.39	
Li422_cap	(14)	0.10	0.06	0.07	0.18	0.14	0.06	0.07	0.14	0.72	-0.49	-0.21	0.17	0.82