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Internet Use in Transition Economies

Economic and Institutional Determinants

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Abstract

The purpose of the study is two-fold. First, it examines whether Internet usage converges across the geographical space comprising the European Union and Central and Eastern Europe (CEE). Second, it aims to expand the currently rather limited empirical evidence on the determinants of Internet usage. With regards to convergence, the data show β and σ convergence over the period 1995 to 2001, although the speed of convergence is low. The empirical analysis of the determinants of Internet usage across CEE shows that the state of liberalization of the telecommunications sector and the state of political and civil freedoms are important factors in addition to the more traditional variables such as per capita income, openness to foreign influences and education.

Keywords: Internet, transition economies, institutions, communication technology

JEL classification: L86, P23, P37

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1 Introduction

Much has already been written in recent years about the so-called 'new economy' and the Internet. However, in the economic academic literature, the focus so far has been mainly on the potential impact of ICT (information and communication technologies) in general on output and productivity[1] and to a much lesser extent on the specific economic impact of Internet.[2]

Yet, at the policy level, the potential use of ICT and, more particularly, the Internet as an instrument of change, and of 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.

For example, in Europe, the European Commission is actively promoting the use of Internet as an instrument of structural change in its *eEurope 2002: An Information Society For All, Action Plan* for the current members and through the *eEurope+2003* initiative (see Box 1).

However, the empirical evidence of the determinants of the take-up of Internet in various countries is rather limited at the present time. Overall, we are aware so far of only four multivariate studies examining in greater detail potential factors explaining the different Internet take-up rate across the world. One study focuses on the OECD countries (Hargittai 1999), a second one on Africa (Conte 2000), the third one on Latin America (Estache *et al.* 2002),[3] and a fourth on a number of developing countries (Dasgupta 2001).

In the present study, we seek to expand the current stock of knowledge on the determinants of Internet use by focusing on developments in Central and Eastern Europe and the key factors driving these developments.[4] We also provide a comparison with developments in the European Union as, at least for the EU accession countries in Central and Southeastern Europe, such developments implicitly set benchmark targets that would need to be met if a digital curtain is to be avoided in the coming years between the present and future members of the European Union.

Section 2 provides a few stylized facts about Internet use in CEE and the European Union. Section 3 examines whether some convergence in Internet usage is observable across the geographical zone covered by our study. The existing literature on the

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1 For a good overview of the on-going debate on the likely impact of ICT on productivity see, for example Brynjolfsson and Hitt (2000), Gordon (2000), Jorgensen (2001), Bordhaus (2001) and Stiroh (2001).

2 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. For more information on the digital divide issue, see for example Cohen, deLong and Zysman (2000), G7/G8 (2000) and OECD (2001). Litan and Rivlin (2001) provide a good overview of the likely economic impact of the Internet.

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

4 This present report is part of a broader examination of Internet usage in Central and Eastern Europe.

determinants of Internet use is summarized in Section 4. Section 5 discusses the model that is being used in our empirical analysis and the estimation results are reported in Section 6. Finally, some policy observations and concluding remarks are offered in Section 7.

Box 1
EU initiatives in support of e-society[5]

Through 1999 and 2000, considerable work was done by the European Union and European Commission to promote the new economy and foster a wider and deeper use of ITC by the Union's citizens and businesses. These efforts culminated in the adoption by the June 2000 Feira European Council of the *eEurope2002: An Information Society For All, Action Plan*. This plan sets out a wide range of specific targets aiming to accelerate the development and the take'up of the information society over the next two years. The main objectives are to 'bring all Europeans into the digital age and online, create a digitally literate Europe, supported by an entrepreneurial culture and ensure that the process is socially inclusive and builds consumer trust' (European Commission 2000b).

The instruments envisaged are an acceleration of the setting up of the appropriate legal environment, the support of new infrastructure and services across Europe and actual implementation at the national level through coordination and benchmarking of intended and actual outcomes. Implementation of the plan is actively monitored and considerable progress will most likely be achieved over the two-year life of the action plan.

For the EU accession candidates, the emergence of the 'new economy' presents many new opportunities to accelerate the pace of transformation and restructuring. At the same time, the implementation of the *eEurope 2002* action plan carries the risk of increasing the 'new economy' gap in the absence of corresponding measures aiming at fostering the new economy in the accession countries. This risk has been clearly recognized and, following a meeting with the accession countries in Warsaw in 2000, a similar initiative, *eEurope+2003* has been developed jointly by the European Commission and the accession countries.

2 Internet use in Central and Eastern Europe and the European Union

A key issue faced by any study of Internet usage is how to define this usage. In practice, two measures are generally used, namely the number of Internet hosts and the number of Internet users. Ideally, one would want to use the latter measure. However, in reality this measure suffers from a high degree of imprecision, as it is often no more than a rough guess estimate.

On the other hand, the number of Internet hosts is likely to be a somewhat biased measure of real Internet use as the correlation between real Internet use and number of Internet users is less than one, especially in emerging and developing economies (Figure 1).

Moreover, there is not necessarily any correlation between a host's domain and where it is actually located and domains such as edu/org/net/com/int could be located anywhere. The bottom line is that, at the present time, there exists no perfect measure of Internet

5 For additional background information on the EU initiatives, see European Commission (2000a, 2000b, 2000c).

usage[6] and we will use the number of Internet hosts, as published by the ITU[7] in the present report. The determinants of the number of Internet will be the analysed in the second stage of our study.

In the geographical area covered by our study, the number of Internet hosts (per 10,000 inhabitants) ranged in 2001 from 0.08 in Uzbekistan to 1,707 in Finland. For comparison, this figure stood at 3,714 in the USA in 2001. As Table 1 shows, this aggregate picture hides significant regional differences in terms of both average number of Internet hosts within sub-regional groupings and differences among countries in these sub-groupings. Not surprisingly, Internet usage is markedly more developed in the EU than in the other two regional sub-groups.

Moreover, while considerably lower than in the EU, Internet usage in the Central and Southeastern European EU accession countries is nevertheless much higher than in the CIS[8] and Southeastern European non-EU accession countries.

Table 1
Key facts about Internet usage in the European Union and CEE in 2001
(per 10,000 inhabitants)

Internet usage proxy	All countries	EU	EU Accession countries in Central Europe (1		CIS and Southeastern Europe (2	
Internet hosts				*Index, EU average=100*		*Index, EU average=100*
Average	239	535	140	*26.2*	9	*1.8*
Normalized std deviation (3	2.78	0.98	0.68	*0.69*	1.28	*1.31*
Minimum	0.08	117	21	..	0.08	..
Maximum	1707	1707	357	..	47	..
Internet Users						
Average	1562	3166	1364	*43.1*	182	*5.76*
Normalized std deviation	0.98	0.33	0.67	*2.03*	1.04	*3.15*
Minimum	5	1321	447	..	5	..
Maximum	5163	5163	3008	..	562	..
Ratio of Internet users to Internet hosts	6.5	5.9	9.7	*1.6*	19.5	*3.3*

Notes: (1 = including Bulgaria and Romania;
(2 = excluding Bulgaria and Romania;
(3 = standard deviation divided by average.

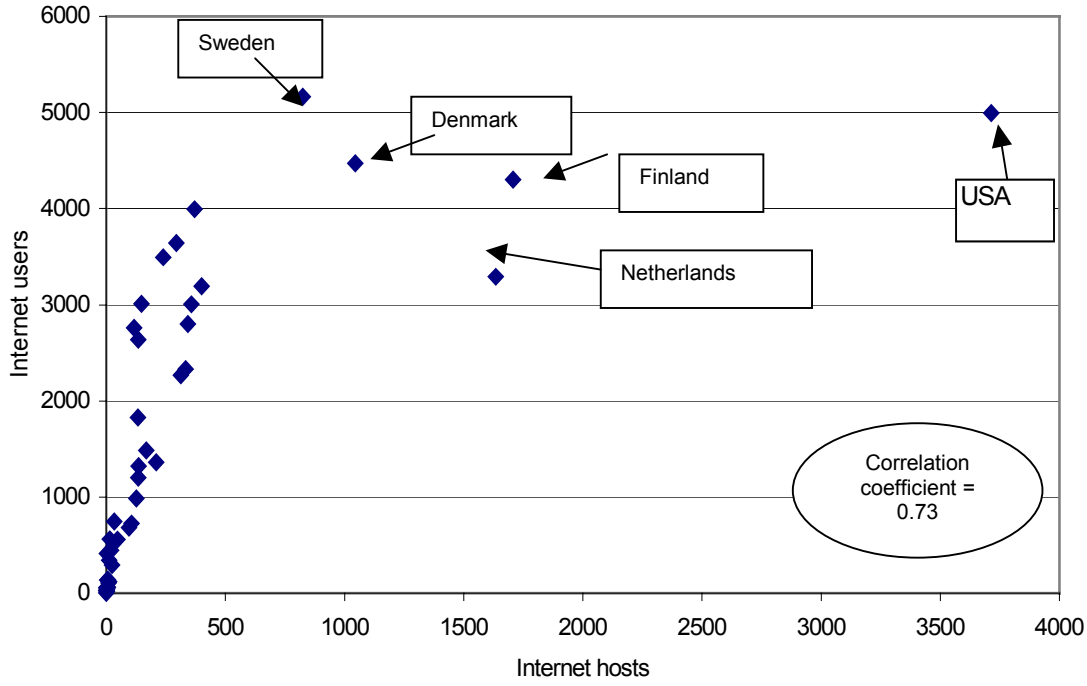
Source: ITU (2002).

6 For more details on measurement issues of Internet access and usage, see Minges (2000).

7 See for example ITU (2001) and ITU (2002). In the ITU databank, the Internet hosts measure is a count of the computers that are directly connected to the worldwide Internet network and the statistic is based on the country code in the host addresses.

8 Commonwealth of Independent States (former USSR).

Figure 1
Number of Internet hosts and users in the European Union and Central and Eastern Europe
(per 10,000 inhabitants)



Source: ITU (2002).

For example, in 2001, the average number of hosts (per 10,000 inhabitants) stood at 535 in the European Union, while the Central and Southeastern European EU accession countries averaged only 95 hosts (per 10,000 inhabitants) and the CIS and Southeastern non EU-accession countries posted an average of only 9 hosts.

In addition, the CIS and Southeastern European non-EU accession countries recorded a variation in the number of Internet hosts among them that is practically twice as large as that of the Central and Southeastern European EU accession countries. The latter appear to be significantly more homogeneous in their Internet usage (as proxied by the number of Internet hosts) than even the current EU members.

A broadly similar picture emerges from the data on the number of Internet users with two key differences. First, the difference between present EU members and Central and Southeastern European EU accession countries is much less pronounced. And, second, the present EU is the sub-regional grouping that is the most homogenous on the basis of this proxy of Internet usage.

Finally, it is worth noting that the ratio of the number of Internet users to the number of Internet hosts varies considerably, ranging from 5.9 in the EU to 19.5 in the CIS and Southeastern European non EU-accession countries.

In fact, the correlation between these two proxies of Internet usage is only 0.73 in 2001 in the geographical zone covered by the study. The existence of only a limited

correlation is further illustrated by Figure 1, which plots the number of Internet users (per 10,000 habitants) against the number of Internet hosts (per 10,000 habitants).

In the present report we will focus on the number of Internet hosts and we will investigate the factors determining the number of Internet users in a second stage of our longer-term study.

3 Is Internet usage converging in the EU and CEE?

As a first step in our analysis of developments in Internet usage across the EU and CEE, we examine whether Internet usage shows a tendency to converge in the geographical zone of interest.[9] As the Internet is still a relatively young phenomenon and started to take off only around 1993,[10] we focus our analysis on the period of 1995 to 2001. By 1995, Internet usage had already started to develop rapidly in the USA and some European countries such as Finland.

We consider both β convergence and σ convergence. The latter convergence statistic is simply the standard deviation of Internet usage across countries in a given year and its evolution over time describes the evolution of the distribution of Internet usage of the entire group of countries.[11]

In contrast, β convergence reflects the movement of individual countries within a group. The hypothesis that is tested is whether countries that exhibited low Internet usage in 1995 post faster growth in Internet usage over the period of 1995 to 2001 than those countries that exhibited higher Internet usage in 1995. Empirically, this hypothesis is tested by estimating equation (1) below, and detailed estimation results are reported in Table 2.

$$\gamma_{i,\,1995,2001} = \alpha - \beta * \log(\gamma_{i,\,1995}) + \varepsilon_{i,\,2001} \qquad (1)$$

where

$\gamma_{i,\,1995,2001}$ $\log(\gamma_{i,\,2001}/\gamma_{i,\,1995})*(1/6)$.

The detailed estimated σ convergence and β convergence statistics[12] are reported in Tables 2 and 3.

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9 The countries included in this analysis are the EU and Central and Eastern Europe except Bosnia and Herzegovina, Moldova and the FYR Yugoslavia. Only incomplete data are available for these countries.

10 For a detailed overview of initial Internet developments, see for example Werle (2001).

11 Because the number of Internet hosts on a per capita basis is growing rapidly over the period of 1995 to 2001, we present the normalized standard deviation, i.e. the annual standard deviation divided by the annual average.

12 The STATA software package was used to estimate equation (1).

Table 2
σ convergence:(1 Number of Internet hosts per capita
1995-2001

	1995	1996	1997	1998	1999	2000	2001
All countries	2.09	1.88	1.97	1.61	1.47	1.47	1.64
EU countries	1.32	1.18	1.21	0.92	0.78	0.86	0.99
Central & Eastern Europe	1.58	1.56	1.64	1.57	1.51	1.39	1.41

Note: (1 σ convergence = normalized standard deviation of log of γ, where γ = number of Internet hosts per capita and i = country i.

Source: ITU (2001).

Table 3
Absolute convergence – number of Internet hosts per capita

$_{i, 1995,2001}$ = – * log($y_{i, 1995}$) + $_{i, 2001}$
(t- statistic in parenthesis)

	All countries	EU	Non-EU
	0.323	0.313	0.340
	(9.93)	(13.99)	(4.37)
	-0.041	-0.047	-0.039
	(5.44)	(2.84)	(2.72)
Adj. R^2	0.45	0.38	0.28
RMSE	0.13	0.07	0.16

Note: $_{i, 1995,2001}$ = log ($\gamma_{i, 2001}/\gamma_{i, 1995}$).(1/6) and γ_i = number of Internet hosts per capita in country i.

Source: Source: ITU (2001).

First, examining the σ convergence statistic, it appears that:

i) With the exception of 2001, the distribution of Internet usage across all the countries in our sample tends to become slowly more homogeneous, although the intra-sample variation remains still very large. By 2001, this statistic stands at 1.64. In other words, the annual standard deviation of Internet hosts, on a per capita basis, is 1.64 the sample average;

ii) The EU countries also show a narrowing of the differences across countries in Internet usage, although some reversal is observable in 2000 and 2001;

iii) Moreover, the EU countries post much smaller inter-country differences than the Central and Eastern European countries (σ of 0.99 versus σ of 1.41); and,

iv) CEE countries show no sign of substantial σ convergence of the period 1995 to 2001.

Second, the β convergence statistics show slow absolute convergence for all three samples of countries (all countries, the EU countries and CEE countries). Across all the countries in our sample, the average annual growth rate of Internet usage (as proxied by

the number of Internet hosts on per capita basis) over the period 1995 to 2001 is, on average, 0. 41 per cent lower for each ten-percentage points higher Internet usage in 1995. Of note is the fact that the EU countries show a convergence rate that is about 20 per cent higher than the one posted by CEE countries (-0.047 versus -0.039).

4 Overview of the literature of the determinants of Internet usage

A survey of previous studies of the factors (see Table 4 for a summary overview) explaining the variation in Internet usage across countries shows that it is generally closely related to a country's income (GDP per capita or a similar measure).

Other socioeconomic factors that have been conjectured as playing a role are the size of the population, income inequality, the overall education level of the population, the relative size of the urban population, although the empirical estimates do not so far provide strong evidence that these are major factors.

However, a country's openness (trade, FDI, etc.) to other countries is a robust predictor of Internet penetration, especially in the emerging and developing countries.

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.

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.[13]

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 to the Internet only more recently, it is possible that it is, in fact, the availability of Internet that determines the decision to acquire a personal computer and that, hence, the causality is reversed.

13 See for example Spiller and Cardilli (1997) and Wallenstein (2001).

Table 4
Key determinants of Internet usage in previous studies
(Only statistically significant variables are reported)

Study	Clarke (2001)(1	Conte (2000)	Dasgupta *et al.* (2001)	Estache *et al.* (2001)	Hargittai (1999)
Countries	Eastern Europe and Central Asia	Africa	No of developing countries in Africa, Asia and Latin America	Latin America	Western Europe
Dependent variables	Probability that an enterprise has access to the Internet	No. of Internet accounts	Growth in Internet usage, 1990 to 1997 (Internet subscribers and Internet hosts)	No. of Internet users	No. of Internet hosts
Explanatory variables					
Socioeconomic					
GDP or GDP per capita	X			X	X
Population	X	X			
Urban population	X		X		
Income distribution				X	
The economy's openness					
Trade (imports)	X	X			
FDI					
Education					
State of telecommunications infrastructure					
Number of telephone lines	X	X			X
Costs of a local call		X			
Competition in the telecommunication sector					
Monopoly provider					X
Nature of regulation/competition			X		
Internet costs					
Number of PCs					X

Note: (1 Only country specific factors are reported in the table.

5 The model

Our basic model of the determinants of Internet usages starts from the existing literature. It includes a number of socioeconomic indicators (X1), a number of indicators of the state of telecommunications infrastructure (X2), an indicator of the state of competition in the telecommunications sectors (X3) and two dummy variables

indicating whether the country is a EU accession country (acc) or non-EU accession country in Central and Eastern Europe (not).[14,15].

Essentially, the basic model is given by equation (2):

$$\gamma_{t,i} = \alpha + \sum\beta 1_j X1_{j,t,i} + \sum\beta 2_j X2_{j,t,i} + \sum\beta 3_j X3_{j,t,i} + \delta_1 \text{ acc} + \delta_2 \text{ not} + \varepsilon_{t,i} \qquad (2)$$

where:

- The set of X1 variables comprises GDP per capita (gdpc2), the human development indicator education index (edu) and imports of goods and services as per cent of GDP (mgdp2);

- The set of X2 variables includes the number of telephones lines per 100 habitants (lines), the cost of a local call as a percentage of daily GDP per capita (cost2) and the cost of a monthly residential telephone subscription as a percentage of monthly GDP per capita (subsgdp2); and

- X3 is initially proxied by the number of cellular phone subscribers per 100 habitants (celsubs). The rational for using such a proxy in the absence of any other data is the fact that the economic literature generally shows that a competitive and well regulated telecommunications sector is conducive to rapid growth in cellular phone usage; and,

- $\gamma_{t,i}$ = the number of Internet hosts on a per capita basis.

The precise data definitions and data sources are provided in Annex 2. All the non-dummy variables are used in logarithmic form[16] in the models whose estimation results are reported in this paper.

The model given by equation (2) is first estimated for all countries in our sample over the period 1995 to 2000 (Model 1 in Annex 1). The same model is then re-estimated for the CEE countries over the same period.

Because the local telephone call cost variable is not available for a number of CEE countries (including Russia), the same model without the local telephone cost variable is re-estimated for all countries (Model 2) and the CEE countries only.

This modified basic model is then re-estimated for the period 1998-2000 only for all the countries in our sample (Model 3) and the CEE countries only.

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14 In addition, fixed years effects are included in the model.

15 A major missing explanatory variable is the cost of Internet access. Due to the absence of consistent internet cost or price data, this variable is presently omitted from the model. As the ITU has started to publish such data, it is hoped that it will be soon feasible to incorporate a price/cost measure in the model.

16 The names of the variables that are used in log from are prefixed with a l.

The reason for re-estimating the basic model over a shorter period is that we wish to test whether the more refined indicators of the state of transition of the telecommunications sector in CEE produced by the EBRD (see Annex 2 for details) would help provide more directly-derived and robust estimates of the impact of the competition and regulation on Internet take-up rates (Model 5).

An alternative version of Model 3 tests whether differences in political freedom and civil liberties across countries, as reflected by the freedom indicators produced annually by Freedom House, contribute to explain differences in Internet usages. The underlying hypothesis is that more repressive political regimes explicitly or implicitly limit the spread and use of Internet (Model 4).

Finally, the last model (Model 6) includes both the transition and the freedom indicators. Models 4, 5, 6 are estimated only the sub-sample of Central and Eastern European countries.

6 Empirical results

The detailed estimation results[17] for Models 1 to 6 are provided in Annex 1 and, to facilitate their analysis, are summarized in Table 5.[18]

i) Overall, the explanatory power of the various models is relatively high with an adjusted R^2 ranging from 0.88 to 0.92 depending on the model. The key estimation results to note are the following:

ii) Income or GDP per capita (lgdpc2) is a key factor explaining variation in Internet use. This variable is always statistically significant and the estimated Internet usage elasticity to per capita income ranges from 1.1 to 0.7, depending on the estimation period and the model (see Annex 1 for details). Of particular interest is the fact that the more elaborate models show an elasticity of about 0.7 to 0.8 over the period 1998-2000;

iii) Openness to foreign influences, as proxied by the ratio of imports of goods and services (lmgdpc2), is also a critical factor. In fact, in the case of the CEE countries, Internet usage is somewhat more sensitive to openness than to GDP per capita over the period 1998-2000. For example, in Model 6, the most comprehensive model, Internet usage increase by 0.95 percentage point for each percentage point increases in the ratio of imports of goods and services while a one percentage point rise in per capita GDP increases Internet usage by 0.84 percentage points;

iv) Education (ledu) is generally statistically significant. It is always for the full sample of countries and it is statistically significant in the case of Central and European countries, once the freedom and telecommunications indicators are included in the model;

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17 All models are estimated with the STATA package.

18 All non-dummy variables are prefixed with the letter l because they are used in log form in the models that are being estimated.

v) Phone density, proxied by the number of lines per 100 habitants (llines), is a statistically significant factor only in the models focusing only on CEE and only when no special variables measuring the state of liberalization of the telecommunications or political and civil freedom are included;

vi) The costs of a local call (lcostpc2) are not statistically significant;

vii) In contrast, the cost of a monthly residential subscription (lsubsgdp2) is generally highly significant. However, the sign of the estimated coefficient is positive rather than negative. This suggests that telephone usage and Internet usage are either substitutes, a doubtful proposition, or this variable captures the influence of another, omitted, variable. This puzzling result will require further investigation in future work;

viii) The number of cellular phone subscribers (lcelsubs) is always statistically significant (and the coefficient is positive), even in the models introducing explicit measures of the state of liberalization of the telecommunication sector. This suggests that this variable does more than simply proxying the state of deregulation and competition in the telecommunications sector. It may capture more generally the overall dynamism of the telecommunications sector, which, in turn, may stimulate Internet supply and hence raise Internet usage rates. This is another area that warrants further research;

ix) The freedom variable (free) is highly significant Countries that are free or partially free according to the Freedom House indicators, experience significantly higher Internet usage—the semi-elasticity of Internet usage to this dummy is 1.3;

x) The state of transition of the telecom sector towards a full liberalization (ind23,ind34) matters also, but only when a high degree of liberalization (ind34) has been achieved—the equivalent of a rating of 3+ and more on the scale of the EBRD transition ratings. Quantitatively, with a semi-elasticity of about 0.7 to 0.9, this latter factor is significant as well, albeit somewhat less than the freedom variable;

xi) Everything being equal, countries that are free and fairly advanced in their transition to full telecommunications liberalization post an Internet usage that is 2.0 percentage points higher;

xii) When all countries are included in the sample, the EU accession country dummy (acc) is always statistically significant while the dummy of the non-EU accession countries in Central and Eastern Europe (not) is never statistically significant. As the constant term implicitly captures the state of being a EU country, the estimation results suggest that Internet usage in the EU accession countries (relative to Internet usage in the EU and non-EU accession countries) is being given an extra boost that is not explained by the socioeconomic and telecommunications variables included in the model;

xiii) Similarly, in the less refined models focusing only on CEE countries, the EU accession countries always post an Internet usage that, with identical socioeconomic and telecommunications sector conditions, is higher than in the non-EU accession countries. However, once the state of transition towards a

liberalized telecommunications sector (ind23, ind34) is introduced explicitly in the model, the accession country dummy is no longer significant.

In short, the estimation results show that differences in Internet usage across CEE over the period 1998 to 2000 are largely explainable by (i) differences in income per capita; (ii) the economy's openness to foreign trade; (iii) the education level; (iv) the number of cellular phone subscribers; (v) the cost of a monthly residential phone subscription; (vi) the state of political and civil freedoms; and, (vii) the state of transition of the telecommunications sector towards a fully liberalized sector.

Table 5
Summary of estimation results:
sign of estimated coefficient and statistical significance
Dependent variable = number of Internet hosts per capita

	1		2		3		4	5	6
Country sample	A	B	A	B	A	B	B	B	B
Explanatory variable									
X1 variables									
lgdpc2	+**	+**	+**	+**	+**	+**	+**	+**	+**
lmgdpc2	+**	+**	+**	+**	+**	+**	+**	+**	+**
ledu	+**	-*	+**	..	+**	..	+**	+	+**
X2 variables									
llines	..	+**	+	+**	+*	+*	..	–	–
lcost2	..	..	/	/	/	/	/	/	/
lsubsgdp2	+*	+**	+	+**	+*	+**	+*	+	+
X3 variables									
lcelsubs	+**	+**	+**	+**	+*	+**	+*	+**	+*
EBRD indicator 23	/	/	/	/	/	/	/	–	–
EBRD indicator 34	/	/	/	/	/	/	/	+*	+
Free and partially free dummy	/	/	/	/	/	/	+**	/	+**
acc dummy	+**	/	+**	/	+**	/	+**	–	–
not dummy	..	-**	+	-**	..	-*	/	/	/
Adj. R^2	0.8567	0.8898	0.8756	0.8786	0.8419	0.8722	0.9032	0.8787	0.9209

Notes: A = all countries; B = only CEE countries. See text for definitions of Models 1 to 6 and Annex 2 for precise data definitions; Models 1 to 2 are estimated over the period 1995-2000 while Models 3 to 6 are estimated over the period 1998–2000.

+ = positive coefficient; - = negative coefficient; ** = statistically significant at 5%; * = statistically significant at 19%; no * = statistically significant at 20%; .. = statistically insignificant; / = variable not used in the model.

7 Policy implications and concluding remarks

The results presented in this study are broadly consistent with those reported in previous multivariate studies of the determinants of Internet usage in other parts of the world. As noted above, income per capita, openness, education, political and civil freedoms, the

state of transition towards a liberalized telecommunications regime and the cost of telephone subscriptions are the key variables that explain the variation in Internet usage in the European Union and in Central and Eastern Europe.

The *three key policy prescriptions* that emerge from the estimation results described in the previous section are that countries in Central and Eastern Europe wishing to promote the use of Internet should:

i) liberalize the telecommunications sector as rapidly possible;

ii) promote political and civil freedoms; and

iii) open their economies to the rest of the world.

A key issue to address in future research is the need to include some Internet price or cost variable as, at least in the case of the European Union and CEE countries, the cost of a local phone and the monthly telephone subscription price do not play the role of useful proxy.

The estimation results also suggest that further research is required to unravel the puzzle of the statistically significant positive coefficient of the monthly telephone subscription price and precise role played by the number of cellular phone subscribers in models aiming to explain why Internet usage varies across countries.

An additional strand of required research is to further refine the use of indicators of the liberalization of the telecommunications sector by including explicitly variables related to structure of the Internet service providers markets (number of providers, role of incumbent telecommunications operator, regulatory approach to provision of Internet services, etc).

Finally, the analysis will need to be extended to the number of Internet users.

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Annex 1: Estimation results

MODEL 1 PANEL 1995–2000

ALL COUNTRIES

```
     Source |       SS       df       MS              Number of obs =     196
------------+------------------------------           F( 14,   181) =   84.26
       Model |  964.066053    14   68.861861           Prob > F      =  0.0000
    Residual |  147.915079   181  .817210383           R-squared     =  0.8670
------------+------------------------------           Adj R-squared =  0.8567
       Total |  1111.98113   195  5.70246735           Root MSE      =    .904
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   1.117602    .154955     7.21   0.000     .8118519    1.423353
      lmgdp2 |   .4925593   .1768933     2.78   0.006     .1435211    .8415975
      llines |   .2637493   .2448436     1.08   0.283    -.2193656    .7468642
    lcelsubs |   .2443496   .0659926     3.70   0.000     .1141359    .3745633
      lcost2 |   .0658779   .0812145     0.81   0.418     -.094371    .2261268
   lsubsgdp2 |   .2788476   .1453721     1.92   0.057    -.0079944    .5656896
        ledu |   7.455862   2.759546     2.70   0.008     2.010844    12.90088
         not |   .3685013   .4450272     0.83   0.409    -.5096073     1.24661
         acc |   1.284619   .3016158     4.26   0.000      .689484    1.879755
       dyear2 |   .5023714   .2383239     2.11   0.036      .032121    .9726218
       dyear3 |   .9801513   .2497904     3.92   0.000     .4872757    1.473027
       dyear4 |   1.218768   .2680892     4.55   0.000     .6897864    1.747751
       dyear5 |   1.381312   .2856187     4.84   0.000     .8177418    1.944883
       dyear6 |   1.388632   .2942405     4.72   0.000     .8080491    1.969215
         cons |  -11.03708   1.526172    -7.23   0.000    -14.04846   -8.025707
------------------------------------------------------------------------------
```

NON-EU COUNTRIES ONLY

```
      Source |       SS       df       MS              Number of obs =     106
-------------+------------------------------           F( 13,    92) =   66.19
       Model |  518.703162    13  39.9002432           Prob > F      =  0.0000
    Residual |  55.4596037    92   .60282178           R-squared     =  0.9034
-------------+------------------------------           Adj R-squared =  0.8898
       Total |  574.162765   105  5.46821681           Root MSE      =  .77642
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   .9174054    .184775     4.96   0.000     .5504264    1.284384
      lmgdp2 |   .8183255   .2566352     3.19   0.002     .3086259    1.328025
      llines |   .7572534   .2844335     2.66   0.009      .192344    1.322163
    lcelsubs |   .3429042   .0956428     3.59   0.001     .1529494     .532859
      lcost2 |  -.0376906   .0766022    -0.49   0.624    -.1898291    .1144479
   lsubsgdp2 |   .7118833   .1660663     4.29   0.000     .3820614    1.041705
        ledu |  -8.129597   4.286549    -1.90   0.061    -16.64305    .3838594
         not |  -.9233237   .2466681    -3.74   0.000    -1.413228   -.4334196
       dyear2 |   .3720351   .3008806     1.24   0.219    -.2255398      .96961
       dyear3 |   .7957904   .3293804     2.42   0.018     .1416125    1.449968
       dyear4 |   .9640545   .3646505     2.64   0.010     .2398272    1.688282
       dyear5 |   1.035768   .4011962     2.58   0.011     .2389578    1.832578
       dyear6 |   .9763131   .4491356     2.17   0.032      .084291    1.868335
         cons |  -9.501871    1.57542    -6.03   0.000    -12.63079   -6.372952
------------------------------------------------------------------------------
```

MODEL 2 PANEL 1995 – 2000

ALL COUNTRIES

```
      Source |       SS       df       MS              Number of obs =     214
-------------+------------------------------           F( 13,   200) =  117.29
       Model |  1261.31996    13  97.0246124           Prob > F      =  0.0000
    Residual |  165.441381   200  .827206906           R-squared     =  0.8840
-------------+------------------------------           Adj R-squared =  0.8765
       Total |  1426.76134   213  6.69841006           Root MSE      =  .90951
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   1.086875    .139394     7.80   0.000     .8120044    1.361745
      lmgdp2 |   .4833928   .1653758     2.92   0.004      .157289    .8094966
      llines |    .342242   .2331295     1.47   0.144    -.1174652    .8019493
    lcelsubs |   .2501387   .0602597     4.15   0.000     .1313127    .3689646
   lsubsgdp2 |   .1963862   .1377767     1.43   0.156    -.0752952    .4680676
        ledu |   9.345623   2.706262     3.45   0.001     4.009155    14.68209
         not |   .6723262   .4111009     1.64   0.104     -.138322    1.482974
         acc |   1.470981   .2809408     5.24   0.000     .9169951    2.024967
      dyear2 |   .5394321    .224152     2.41   0.017     .0974277    .9814365
      dyear3 |   .9307207   .2400506     3.88   0.000      .457366    1.404076
      dyear4 |   1.189758   .2565334     4.64   0.000     .6839009    1.695615
      dyear5 |   1.318135   .2758105     4.78   0.000      .774265    1.862004
      dyear6 |   1.397557   .2877295     4.86   0.000     .8301841    1.964929
        cons |  -11.78467   1.383696    -8.52   0.000    -14.51318   -9.056168
------------------------------------------------------------------------------
```

NON-EU COUNTRIES ONLY

```
      Source |       SS       df       MS              Number of obs =     124
-------------+------------------------------           F( 12,   111) =   75.21
       Model |  661.184091    12  55.0986743           Prob > F      =  0.0000
    Residual |  81.3187426   111  .732601285           R-squared     =  0.8905
-------------+------------------------------           Adj R-squared =  0.8786
       Total |  742.502834   123   6.0366084           Root MSE      =  .85592
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   1.037201   .1730536     5.99   0.000      .694284    1.380119
      lmgdp2 |   .5842491   .2502084     2.34   0.021     .0884444    1.080054
      llines |   .7471134   .2999656     2.49   0.014     .1527116    1.341515
    lcelsubs |   .2857018   .0877994     3.25   0.002     .1117216    .4596821
   lsubsgdp2 |    .394809   .1635593     2.41   0.017     .0707054    .7189127
        ledu |  -.6596959   4.420676    -0.15   0.882     -9.41956    8.100168
         not |  -.7196817   .2591085    -2.78   0.006    -1.233122   -.2062408
      dyear2 |   .5450244    .290381     1.88   0.063     -.030385    1.120434
      dyear3 |   .8836748    .327479     2.70   0.008     .2347532    1.532596
      dyear4 |   1.155259   .3577229     3.23   0.002     .4464076    1.864111
      dyear5 |   1.200331    .398127     3.01   0.003     .4114162    1.989247
      dyear6 |   1.319377   .4493216     2.94   0.004     .4290159    2.209737
        cons |   -11.2114   1.484567    -7.55   0.000    -14.15316   -8.269628
------------------------------------------------------------------------------
```

MODEL 3 PANEL 1998–2000

ALL COUNTRIES

```
      Source |       SS       df       MS              Number of obs =     117
-------------+------------------------------           F(  8,   108) =   78.24
       Model |   600.13833     8  75.0172912           Prob > F      =  0.0000
    Residual |  103.554439   108  .958837397           R-squared     =  0.8528
-------------+------------------------------           Adj R-squared =  0.8419
       Total |  703.692769   116  6.06631697           Root MSE      =   .9792
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   .8406026   .2195253     3.83   0.000     .4054653     1.27574
      llines |   .5702465   .3125699     1.82   0.071    -.0493213    1.189814
    lcelsubs |   .1399129   .0807056     1.73   0.086    -.0200596    .2998855
   lsubsgdp2 |    .363904   .1939538     1.88   0.063    -.0205461    .7483542
         not |  -.0002904   .6273715    -0.00   1.000    -1.243849    1.243269
         acc |   .8423383   .4119181     2.04   0.043     .0258452    1.658831
      lmgdp2 |   .6210756   .2400115     2.59   0.011     .1453313     1.09682
        ledu |   8.505815   3.534137     2.41   0.018     1.500543    15.51109
       _cons |  -7.739669    1.79229    -4.32   0.000     -11.2923   -4.187039
------------------------------------------------------------------------------
```

NON EU COUNTRIES

```
      Source |       SS       df       MS              Number of obs =      72
-------------+------------------------------           F(  7,    64) =   70.22
       Model |  302.136694     7  43.1623849           Prob > F      =  0.0000
    Residual |  39.3363571    64   .61463058           R-squared     =  0.8848
-------------+------------------------------           Adj R-squared =  0.8722
       Total |  341.473052    71   4.8094796           Root MSE      =  .78398
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |    .646327   .2319906     2.79   0.007     .1828726    1.109781
      llines |   .5692203   .3106604     1.83   0.072    -.0513952    1.189836
    lcelsubs |   .3009205   .0992517     3.03   0.004     .1026425    .4991985
   lsubsgdp2 |   .3864868   .1763116     2.19   0.032     .0342639    .7387097
         not |  -.6934805   .3500861    -1.98   0.052    -1.392858     .005897
      lmgdp2 |   .7690259    .291082     2.64   0.010     .1875227    1.350529
        ledu |   3.473836   4.190952     0.83   0.410    -4.898553    11.84623
       _cons |  -5.995799   1.575067    -3.81   0.000    -9.142357   -2.849242
------------------------------------------------------------------------------
```

MODEL 4 PANEL 1998–2000

NON EU COUNTRIES ONLY

```
      Source |       SS       df       MS              Number of obs =      72
-------------+------------------------------           F(  8,    63) =   83.76
       Model |  312.128627     8  39.0160783           Prob > F      =  0.0000
    Residual |  29.3444249    63  .465784523           R-squared     =  0.9141
-------------+------------------------------           Adj R-squared =  0.9032
       Total |  341.473052    71   4.8094796           Root MSE      =  .68248
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   .8127021   .2051253     3.96   0.000     .4027919    1.222612
      llines |    .119927   .2873118     0.42   0.678    -.4542198    .6940737
    lcelsubs |   .1586301   .0917012     1.73   0.089    -.0246201    .3418802
   lsubsgdp2 |    .275684   .1553384     1.77   0.081    -.0347349     .586103
         acc |   .6497942   .3049076     2.13   0.037      .040485    1.259103
      lmgdp2 |   .7721675   .2533975     3.05   0.003     .2657929    1.278542
       dfree |   1.346107   .2906347     4.63   0.000     .7653202    1.926894
        ledu |   12.20053   4.106168     2.97   0.004     3.995009    20.40605
        cons |  -7.135024   1.294234    -5.51   0.000    -9.721344   -4.548704
------------------------------------------------------------------------------
```

MODEL 5 PANEL 1998–2000

NON-EU COUNTRIES ONLY

```
      Source |       SS       df       MS              Number of obs =      72
-------------+------------------------------           F(  9,    62) =   58.16
       Model |  305.310654     9   33.923406           Prob > F      =  0.0000
    Residual |  36.1623977    62  .583264478           R-squared     =  0.8941
-------------+------------------------------           Adj R-squared =  0.8787
       Total |  341.473052    71   4.8094796           Root MSE      =  .76372
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   .6825723   .2293027     2.98   0.004     .2242027    1.140942
      llines |    .282041   .3921898     0.72   0.475    -.5019352    1.066017
    lcelsubs |    .307327   .0990958     3.10   0.003     .1092373    .5054167
   lsubsgdp2 |   .3177404   .2041319     1.56   0.125    -.0903134    .7257941
         acc |   .2939153   .3868419     0.76   0.450    -.4793707    1.067201
      lmgdp2 |   .9884274   .3050907     3.24   0.002     .3785598    1.598295
     dindi33 |   .2560443   .4145235     0.62   0.539    -.5725764    1.084665
     dindi34 |   .8647173   .5022019     1.72   0.090    -.1391701    1.868605
        ledu |   5.672082   4.435063     1.28   0.206    -3.193483    14.53765
        cons |  -6.339143   1.477108    -4.29   0.000    -9.291839   -3.386447
------------------------------------------------------------------------------
```

MODEL 6 PANEL 1998–2000

NON-EU COUNTRIES

```
      Source |       SS       df       MS              Number of obs =      72
-------------+------------------------------           F( 10,    61) =   71.03
       Model |  314.466937    10  31.4466937           Prob > F      =  0.0000
    Residual |  27.0061145    61  .442723188           R-squared     =  0.9209
-------------+------------------------------           Adj R-squared =  0.9079
       Total |  341.473052    71   4.8094796           Root MSE      =  .66537
------------------------------------------------------------------------------
     lhostsp |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      lgdpc2 |   .8410655   .2027928     4.15   0.000     .4355562    1.246575
      llines |  -.0868349   .3511835    -0.25   0.806    -.7890697       .6154
    lcelsubs |   .1674646   .0916495     1.83   0.073    -.0157999    .3507291
   lsubsgdp2 |   .2319826    .178843     1.30   0.199     -.125636    .5896012
         acc |   .3012972   .3370326     0.89   0.375    -.3726412    .9752357
      lmgdp2 |    .954273   .2659105     3.59   0.001      .422552    1.485994
     dfree   |   1.293406   .2844076     4.55   0.000     .7246974    1.862114
     dindi23 |   .1785282   .3615478     0.49   0.623    -.5444313    .9014877
     dindi34 |   .7083162   .4388835     1.61   0.112    -.1692856    1.585918
        ledu |   13.59775    4.23881     3.21   0.002     5.121728    22.07378
        cons |  -6.844703   1.291695    -5.30   0.000    -9.427606     -4.2618
------------------------------------------------------------------------------
```

Annex 2: Data definitions and data sources

Variable name	Variable definition	Data source
lgdpc2	Log of GDP per capita in US$	GDP in US$ and population from ITU
limp	Log of imports of goods and services (in US$) as % of GDP (in US$)	Imports of goods and services from WTO/IMF and GDP from ITU
ledu	Log of education index	*Human Development Report*, various issues, UNDP
llines	Number of main lines per 100 habitants	ITU
lfaults2	Log of number of telephone faults per 100 main lines	ITU
lcelsubs	Log of cellular subscribers per 100 inhabitants	ITU
lcost2	Log of cost of three minute local call in US$ as % of daily per capita GDP in US$	Cost of local call and GDP from ITU
lsubsgdp2	Log of monthly residential telephone subscription in US$ as % of monthly per capita GDP in US$	Subscription and GDP from ITU
lcelsub	Log of number of cellular subscribers per 100 habitants	ITU
lhostp	Log of Internet hosts per 100 habitants	ITU
dfree	Dummy variable = 1 when country is free or partially free and 0 otherwise	Freedom House
din23	Dummy variable = 1 when EBRD telecommunications transition indicator is 2 or 3 and = 0 otherwise	EBRD, see Box 2
dind34	Dummy variable = 1 when EBRD telecommunications transition indicator is 3+ or more and 0 otherwise	EBRD, see Box 2
acc	Dummy variable = 1 when country is a EU-accession country and 0 otherwise	
not	Dummy variable = 1 when country is not an EU or an EU-accession country	

Box 2
EBRD telecommunications transition indicators

EBRD telecommunications transition indicators

Rating = 1:	Little progress has been achieved in commercialization and regulation. There is a minimal degree of private sector involvement. Strong political interference takes place in management decisions. There is a lack of cost-effective tariff-setting principles, with extensive cross-subsidization. Few other institutional reforms to encourage liberalization are envisaged, even for mobile phones and value-added services.
Rating = 2:	Modest progress has been achieved in commercialization. Corporatization of the dominant operator has taken place and there is some separation of operation from public sector governance, but tariffs are still politically set.
Rating = 3:	Substantial progress has been achieved in commercialization and regulation. There is full separation of telecommunications from postal services, with a reduction in the extent of cross-subsidization. Some liberalization has taken place in the mobile segment and in value-added services.
Rating = 4:	Complete commercialization (including privatisation of the dominant operator) and comprehensive regulatory and institutional reforms have been achieved. There is extensive liberalisation of entry.
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. There is a consumer ombudsman function.
Source:	EBRD (2001)