Research Notes

Can Information and Communication Technologies Make a Difference in the Development of Transition Economies?

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Abstract

This article investigates the potential of information and communication technologies (ICT) for faster convergence of seven transition economies from Central and Eastern Europe (CEE) and Russia (CEER) with the EU-15 and the U.S. income level. First, the article argues that ICT accelerated the convergence of the four new EU member states with the EU-15 (the case of technological leapfrogging) but decelerated convergence of Romania, Russia, and, to a lesser extent, Bulgaria and Slovakia (the case of a growing digital divide). This divergence was mainly because of the lower quality of the economic and institutional environment, which inhibited the diffusion of ICT. Second, the article shows that ICT has a large potential to increase long-term growth in transition countries. Third, it argues that the use of ICT has an important role in stimulating productivity growth at the industry level and that it offers considerable potential for faster productivity growth in non-ICT-using, "old economy" industries. Realizing this potential, however, will crucially depend on far-reaching structural reforms, business reorganization, investment in human capital, and well-designed public "push strategy." These lessons are pertinent not only to transition economies, but also to most advanced developing countries.

Introduction

Since 1995, information and communication technologies (ICT) have contributed to faster gross domestic product (GDP) and labor productivity growth in a number of developed countries, particularly the United States. This has been shown by numerous research studies on the impact of ICT on the macro-, industrial, and microlevel.[1] Despite the collapse of the "Internet bubble" in 2001, fast growth in productivity spurred by ICT has not been arrested. Recent estimates of the U.S. Department of Labor (2004) show that labor productivity growth in the United States during 1995–2004 was more than twice the average of the previous two decades. Jorgenson et al. (2004) project that this high productivity growth will continue until 2010.

**This paper should not be reported as representing the views of the International Monetary Fund.*
1. For macro-level research on the United States see, for instance, Jorgenson, Ho, and Stiroh (2004); on the EU-15 see Timmer, Ypma, and van Ark (2003). On the industry level in the United States and the European Union, see Stiroh (2002), Timmer and Van Ark (2005), and OECD (2003). On a microlevel in the United States and the European Union, see Brynjolfsson and Hitt (1996, 2000) and OECD (2004, 2003). For an initially skeptical view of the ICT impact on the U.S. economy, see Gordon (2000). Later, however, Gordon changed his mind (Gordon 2004).

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There is, however, a dearth of research on the impact of ICT on developing and transitional economies. Whereas IMF (2001) and Lee and Khatri (2003) document the positive contribution of ICT production and capital to growth in Southeast Asia in the late 1990s, there is a general paucity of studies on the contribution of ICT to economic development in transitional economies.[2]

The purpose of this article is to fill this gap. It does so by extending the results of the previous papers by the same author (Piatkowski 2004; Van Ark and Piatkowski 2004) to determine whether ICT might accelerate the convergence of seven transitional economies from Central and Eastern Europe (CEE) and Russia (CEER) with the EU-15 and the U.S. income levels.[3] The eight CEER countries are the only ones for which sufficient data was available.

This article investigates the question of ICT potential for faster productivity growth from both the macro- and industry-level perspective. First, it argues that between 1995 and 2003 ICT contributed to accelerated productivity growth in four new EU member states (the case of technological leapfrogging) and thus to their faster convergence with the EU-15 (but not with the United States). In Romania, Russia, and, to a lesser extent, Bulgaria and Slovakia, however, the productivity gap widened, mainly because of the lower quality of the economic and institutional environment, which inhibited the diffusion of ICT (a case of a growing digital divide). Second, on the basis of the projection of the impact of ICT on GDP growth in Poland through 2025, the article argues that ICT has a large long-term potential to accelerate the development of CEER countries. Third, the article shows that ICT use had an important role in stimulating productivity growth at the industry level in four CEE countries and that it offers significant potential for faster productivity growth in traditional, "old economy" industries that do not currently use much ICT. If these industries were able to achieve the same rate of productivity growth as the ICT-using industries, they would make a significant contribution to faster convergence. Realizing this potential, however, will crucially depend on far-reaching structural reforms, business reorganization, a larger investment in human capital, and a well-designed public "push strategy."

The article proceeds as follows. In the second section, it analyzes the role of each of the three channels through which ICT contributes to productivity growth and convergence. It then analyzes how the quality of the economic and institutional determines the diffusion and productive use of ICT. In the third section, the paper speculates on the long-term contribution of ICT to GDP growth in Poland as a proxy for other advanced CEE countries. In the fourth section, the article adopts an industry-level perspective to show the divergence in labor productivity growth between ICT-using and non-ICT-using industries in CEE countries, the EU-15 and the U.S. The fifth section discusses the economic potential of a more intensive use of ICT in the non-ICT-using sector. The final section presents conclusions and policy recommendations.

The Contribution of ICT to Convergence and Its Determinants

The measurement of the contribution of ICT to labor productivity is based on the growth accounting methodology developed by Solow (1957) and later extended by Jorgenson and Griliches (1967).[4] According to this methodology, ICT can affect economic growth through three channels:

1. Use of ICT capital as an input in the production of other goods and services.
2. Increase in total factor productivity (TFP) of production in the ICT sector, which contributes to aggregate TFP growth in an economy.
3. Contribution to economy-wide TFP from the increase in productivity in non-ICT producing sectors induced by production and use of ICT (spillover effects).

2. See also a recent paper by Jorgenson and Vu (2005), which analyzes the impact of ICT on growth in a large sample of developed, developing, and transitional economies. On a more general level, Kolodko (2000) provides an insightful analysis of the sources of growth in postcommunist countries.

3. CEE includes Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia.

4. In essence, the growth accounting methodology divides labor productivity growth into its sources in the change of physical capital available in an economy and in residual productivity that cannot be directly attributed to growth in either capital or labor (so-called total factor productivity, which can grow thanks to a more efficient use of the existing physical capital, rising quality of human capital, improvement in managerial skills, etc.). Details on the methodology are reported by Van Ark and Piatkowski (2004).

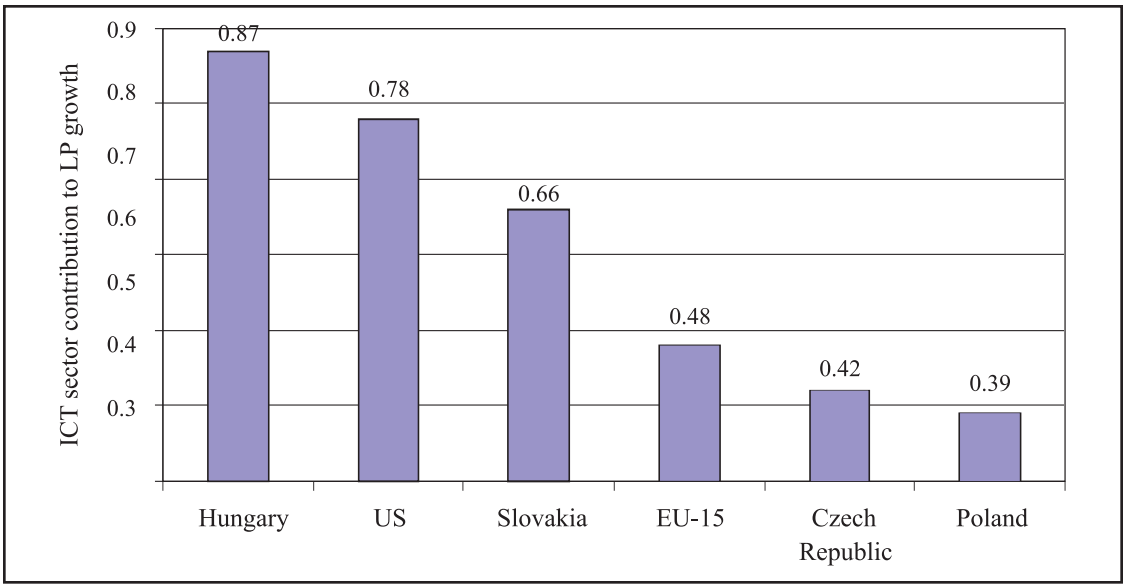

Figure 1. The contribution of the ICT-producing sector to labor productivity growth in four CEE countries, the EU-15 and the U.S., 1995–2003 annual average (%)

Note: Real estate has been excluded from both GDP and total persons engaged for all countries; productivity growth defined as GDP per person employed.
Source: Table 4

With regard to the contribution of the first channel to productivity in four CEE countries for which sufficient data is available, figure 1 shows that in Hungary and Slovakia the ICT sector accelerated convergence, because its contribution to labor productivity growth was higher than in the EU-15.[5] It was not the case of Poland and—to a lesser extent—the Czech Republic, however, where the contribution of ICT production to productivity was lower than in both the EU-15 and the United States. It mainly resulted from a slower productivity growth because of a lower share of high-value-added products in total ICT production.[6] As argued by Piatkowski and Van Ark (2005), the divergence in the size of the ICT sector among four CEE countries was mostly driven by differences in the value of Foreign Direct Investment flowing into the sector. This in turn depended on the degree of trade openness, basic rule of law, development of infrastructure, macroeconomic stability, and privatization policies.

A large ICT-producing sector is not, however, a prerequisite to benefiting from ICT to accelerate GDP growth and productivity (OECD 2004). This is so also because the evidence for positive spillover effects because of ICT production is scant.[7] What really matters is not production, but rather the use of ICT. This is particularly true in CEE countries, where because of the small size, the ICT-producing sector

5. There is not enough consistent data on the ICT producing sector in other CEE countries and Russia. Gáspár (2004), however, provides some data on the share of the ICT sector in GDP in Slovenia, Bulgaria, and Romania. In turn, Perminov and Egorova (2005) estimate the contribution of the ICT producing sector to growth in Russia. Alas, because of different methodologies, their results are not directly comparable with this study.
6. Higher productivity growth in the ICT producing sector in the United States was mostly because of rapid productivity growth in the production of semiconductors (Intel, AMD), which are not manufactured in CEE countries (Van Ark and Piatkowski 2004).
7. Trajtenberg (2005) provides a useful example. He argues that, although since 1990 the ICT sector in Israel grew at a double-digit rate per year, at the same time the rest of the economy stagnated. Productivity in some non-ICT producing sectors even declined. Thus, in contrast to the argument of spillovers effects, Trajtenberg asserts that the gap between the ICT sector and the rest of the economy actually increased socioeconomic inequality in Israel and led to the emergence of a "dual economy." The latter may affect the growth potential of the Israeli economy by restricting the pool of skilled labor and creating tensions detrimental to growth.

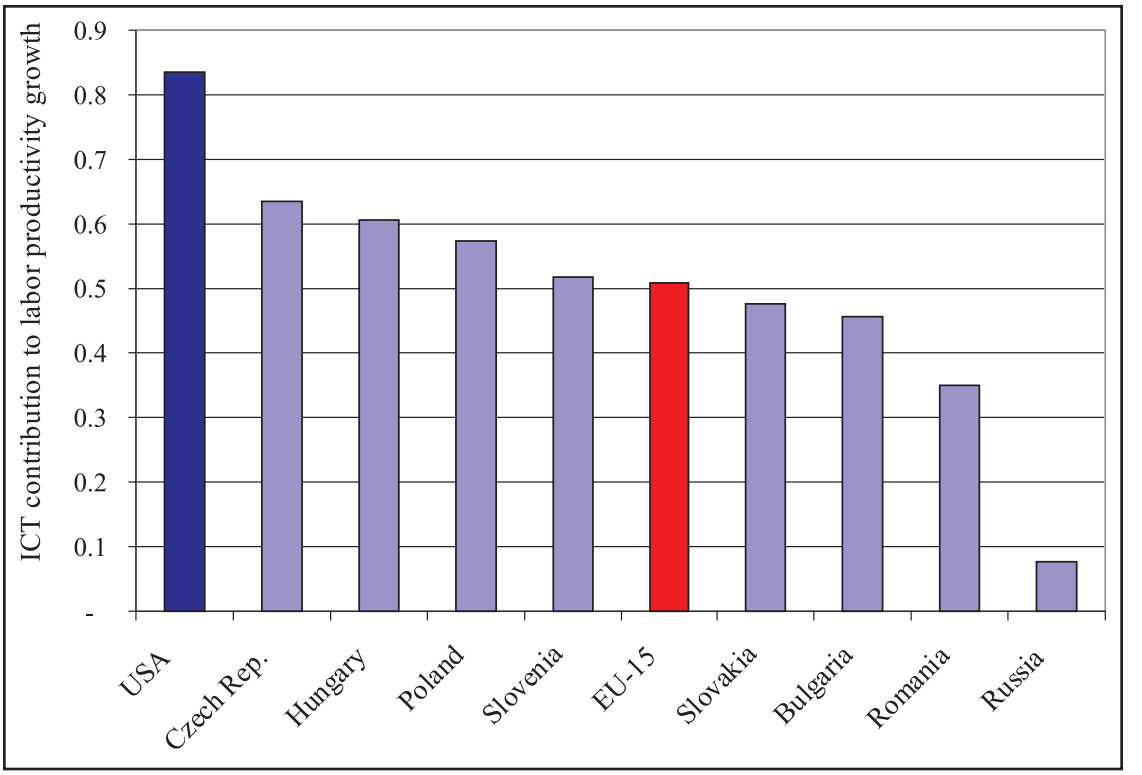

Figure 2. The contribution of ICT investment to labor productivity growth in CEER countries, EU-15 and the U.S., 1995–2003 annual average (%)

Source: Van Ark and Piatkowski (2006). Updated results from Piatkowski (2004) for Russia.

alone would not be sufficient to stimulate growth.[8] Hence, faster convergence with developed countries will have to rely on the use of ICT.

Fortunately, it turns out that the use of ICT may drive convergence. Figure 2 shows that between 1995 and 2003 the contribution of ICT investment to labor productivity growth in the Czech Republic, Hungary, Poland, and Slovenia was higher than in the EU-15. Thus, these four countries managed to benefit from ICT more than the EU-15, thanks to faster growth rates and a higher return on ICT investment. This result is all the more noteworthy, because all four countries have considerably lower levels of GDP per capita (higher GDP per capita is usually closely related to the intensity of ICT investment). Nonetheless, the contribution of ICT investment to productivity growth was still lower than in the United States. This lower contribution resulted from a lower level of ICT capital accumulated over time, because CEE countries started from a very low ICT capital base at the beginning of the post-communist transition. Also worrisome, in the case of Romania, Russia, and—to a lesser extent—Slovakia and Bulgaria, the contribution of ICT investment to productivity was below that of the EU-15 and the United States. This was mostly due to a much slower growth in ICT investment (WITSA 2004). Thus, low ICT investment was one of the factors that slowed the closing of the income gap between these four countries and developed economies.

What explains such large differences in the intensity of ICT investment and its impact on productivity growth in transition economies? Van Ark and Piatkowski (2004) argue that this divergence seems

8. Even if the share of the ICT sector in CEE countries grew to 10% of GDP and its productivity growth increased to 10% a year, its annual contribution to GDP growth would amount to only 1%. This is not enough, given that CEE countries need to grow at close to 4–5% a year to continue to close the income divide with developed countries.

Table 2. Projected ICT Investment Contribution to GDP Growth in Poland during 2002–2025 (%)

Real Annual Rate of Growth in ICT Investment[a]	GDP Growth	Total Capital	Non-ICT Capital	ICT Capital	Labor Force	TFP	Share of ICT in GDP Growth
5	3.76	1.94	1.59	0.35	0.32	1.50	9.3
10	4.01	2.19	1.59	0.60	0.32	1.50	15.0
15	4.26	2.43	1.59	0.85	0.32	1.50	20.0

[a]*Before adjustment for changes in hedonic prices of ICT investment.*
Source: Piatkowski (2004)

to be primarily due to differences in the overall quality of the economic and institutional environment, including labor and product market flexibility, development of infrastructure, spending on innovation, quality of human capital, development of financial markets, and macroeconomic stability.[9] Table A1 shows that in all of these economic and institutional dimensions, which Piatkowski (2002) combined in the *New Economy Indicator,* Slovakia, Russia, Bulgaria, and Romania lag behind most other countries.[10] World Bank (2005) and World Economic Forum (2005) provide similar results. The strong relationship between the impact of ICT investment on productivity and the value of the *New Economy Indicator* underscores the importance of the appropriate economic and institutional environment for the diffusion and efficient use of ICT.

As opposed to the large impact of ICT investment on productivity, the contribution of ICT to growth through the two remaining channels—that is, through the increase in TFP of ICT production and through spillover effects of ICT use—is not likely to be significant. This is because of the small size of the ICT sector and relatively low penetration of ICT networks, which limits spillover effects of ICT use (Piatkowski 2004).

The Potential of ICT for Long-Term Growth in Transition Economies

What are the prospects for the long-term role of ICT in growth? Can ICT drive convergence of not only the advanced CEE economies, but also of Bulgaria, Romania, Russia, and possibly other transitional and developing economies?

On the basis of the same growth accounting model, one can speculate about the long-term contribution of ICT to economic growth. The size of this contribution will mostly depend on the projected growth rate in ICT investment. The rate of growth, as argued in the previous section, will in turn be closely related to the pace of improvement in the overall business environment. Piatkowski (2004) shows that, depending on the projected rate of growth in real ICT investment, ICT investment alone would contribute between 10% and 20% of annual GDP growth in Poland between 2002 and 2025 (Table 2).[11] In light of the similar levels of income per capita, trends in ICT investment, institutional environment and posttransition economic structure, the results for Poland could also be seen as generally representative for other advanced CEE economies.

The projected contribution of ICT investment to GDP growth in Poland is considerable. This projec-

9. Other studies on the determinants of the productive use of ICT call attention to the same factors (Clarke 2004; OECD 2003, 2004; Muller and Salsas 2003, 2004). Vu (2005) adds to the list institutional quality and fluency in English. Alas, given the paucity of data and the small size of the sample, it is not possible to statistically test the relative importance of each of these determinants for transition economies.
10. The New Economy Indicator has been constructed to measure the institutional capability of transition economies to exploit the potential of ICT. The indicator combines 10 variables based mostly on data from the World Bank's "World Development Indicators" and OECD. The sample mean of values of all variables is subtracted from each number, and the result is then divided by sample standard deviation. This implies a mean of 0 and a standard deviation of 1 across countries in the sample. Hence, all results are comparable and can be aggregated. For a complete methodology of the New Economy Indicator, refer to Piatkowski (2002) and Van Ark and Piatkowski (2004).
11. Piatkowski (2004) assumes that the quality-adjusted (so-called hedonic) prices of IT hardware, software, and telecommunications equipment until 2025 will decrease at a rate equal to the 1990–2001 average for the United States—that is, respectively, 20.7, 1.3, and 3.2% annually. For details, refer to Piatkowski (2004).

tion, however, does not take into account the additional impact of ICT on growth through the increase in productivity (TFP) in the ICT-producing sector and spillover effects of ICT use. If these two channels were factored into the projection, the total contribution of ICT to GDP growth would most likely surpass 25%.[12] Hence, provided that the growth in ICT investment will continue, ICT could have a large contribution to the future development of Poland and (per proxy) other advanced transition economies. It could also benefit Bulgaria, Romania, Russia, and other less-developed transitional economies as long as the institutional and economic environment improves sufficiently to stimulate faster growth in ICT investment and use.

The potential of ICT, however, does not stop here. It is because the impact of ICT on the pace of economic development could be much larger than what is now possible to measure with traditional economic methods. It mostly concerns the nonlinear effects of the spread of ICT networks, which can stimulate even higher productivity growth through

- Facilitating faster production, diffusion, and sharing of knowledge, which is likely to accelerate the pace of innovation;
- Stimulating changes in business models and investment in human capital;[13]
- Galvanizing the development of yet unknown applications enhancing overall productivity growth, as did earlier technological revolutions based on general-purpose technologies such as electricity and the combustion engine.[14] In this sense, ICT investment is generally superior to investments in alternative assets (real estate, machinery, means of transport, and so on), because the potential of the latter for stimulating new applications is most often dramatically smaller than that of ICT.

The ICT-driven boom in productivity will not happen, however, without substantial progress in the penetration of ICT networks in CEE countries, as the benefits of their use grow exponentially with every additional participant in the network. Alas, despite the extraordinary progress in recent years, ICT penetration in CEE countries is still much lower than in the EU-15 (Eurostat 2005). Consequently, until the CEE countries achieve higher ICT penetration, the network effects of the ICT use are not likely to be significant.

The ICT-led productivity boom will not materialize immediately, either. This is because firms investing in ICT need time to learn to use it productively. It took the U.S. economy more than 20 years to fully benefit from ICT investment started already in the early 1970s. Until the mid-1990s, Solow's (1987) famous "productivity paradox" still seemed to be valid.[15] It is only after 1995 that ICT started to drive the productivity boom. The adoption of electricity, another revolutionary general-purpose technology, exhibited a similar pattern: it was only in the 1920s—40 years after the discovery of electricity—that more than half of U.S. companies learned to use electricity in the production process (David 1990).

Therefore, it seems very likely that, in line with the growth in ICT penetration, a similar sequence of events could unfold in transitional economies. This time, however, thanks to the much higher level of the countries' openness and the development of the Internet, which immensely facilitates the exchange and sharing of knowledge, the learning process of ICT use may be shorter than earlier. Because investment in ICT in most CEE countries started in earnest only around 1995, ICT use should start to strongly feed into the productivity statistics around 2010.

Such a positive scenario, however, is by no means given. As Piatkowski and Van Ark (2005) ar-

12. Because projections on the future of the ICT industry in any country are burdened with a large risk, any long-term assumptions as to the size, TFP growth rate in the ICT sector, and ICT spillover effects are purely speculative. Nonetheless, it is very likely that the ICT sector—in line with the increasing penetration of ICT—should be growing faster than the rest of CEE economies.

13. It is not possible to introduce, for instance, ICT-based "just-in-time" procurement without substantial changes in enterprise organization and additional employee training. The introduction of ICT thus stimulates changes that are likely to enhance the productivity of the whole enterprise.

14. The history of the steam engine is a fitting example. The original purpose of steam engines was only to run pumps draining water from underground coal shafts. It was only much later that the potential of steam engines was fully realized in transport, manufacturing, and almost every other aspect of economic and social life. ICT seems to have the same extraordinary potential, which is still far from being fully discovered.

15. Solow (1987, p. 36) famously quipped, "You can see the computer age everywhere but in the productivity statistics."

Table 3. Labor Productivity Growth of ICT-Producing, ICT-Using and Non-ICT-Using Industries, 1995–2003

	EU-15	U.S.	Czech Republic	Hungary	Poland	Slovakia
Total Economy	1.2	2.4	2.2	2.5	5.0	4.0
ICT-Producing Industries	7.9	10.8	4.9	11.0	8.8	10.5
ICT-Producing Manufacturing	17.6	24.4	10.5	16.1	13.5	6.0
ICT-Producing Services	4.6	4.3	4.5	9.1	6.7	11.7
ICT-Using Industries	1.4	4.2	5.9	3.6	3.6	2.0
ICT-Using Manufacturing	1.6	1.9	5.4	11.1	12.2	5.5
ICT-Using Services	1.3	4.8	6.1	1.4	0.9	–0.1
Non-ICT-Using Industries	0.5	0.4	0.2	1.1	5.0	4.1
Non-ICT-Using Manufacturing	1.6	2.2	3.5	0.9	5.3	3.0
Non-ICT-Using Services	–0.1	0.3	–1.9	1.0	2.6	4.9
Non-ICT-Using Other	1.7	0.4	0.7	1.8	5.8	4.9

Note: Real estate has been excluded from both GDP and total persons engaged for all countries; for CEE countries the U.S. ICT deflators exclude prices of computers and semiconductors. Productivity growth defined as GDP per person employed.
Source: Updated results from Van Ark and Piatkowski (2004) based on the Groningen Growth and Development Centre, 60 Industry database, January 2006, www.ggdc.net

gue, the economic potential of ICT in transition economies will hinge on a continued increase in ICT investment and—even more important—on the ability to incorporate ICT into business models, improve the quality of human capital and enhance managerial skills.

ICT Use and Convergence From a Sectoral Perspective

Aside from the macro perspective, it is also useful to look at the potential of ICT from an industry-level perspective. The first point to note is that, in light of the small size of the ICT-producing sector in CEE countries and the fact that the most straightforward transitional growth reserves (i.e., those resulting from an almost completed privatization, an advanced stage of institution building, macroeconomic stability, elimination of loss-making state-owned enterprises, and so on), have already been exhausted (although less so in Bulgaria, Romania, and Russia), the sustained convergence with developed countries will have to rely on faster productivity growth in the non-ICT-producing sectors, particularly in services.

Van Ark and Piatkowski (2004) provide estimates of labor productivity growth rates in ICT-producing, ICT-using and non-ICT-using, "old economy" industries in four CEE countries (the Czech Republic, Hungary, Poland, and Slovakia), the only four CEE countries for which sufficient data are available, for the period 1995–2001.[16] This article shows results extended to 2003.

Table 3 shows that productivity growth rates in ICT-using manufacturing in four CEE countries were significantly higher than in non-ICT-using, traditional manufacturing. This suggests that ICT use on the industrial level has been an important source of productivity growth and thus of convergence.[17]

Productivity growth rates in ICT-using manufac-

16. ICT-producing industries include manufacturing of computer hardware, software, and telecommunications equipment and provision of computer and telecommunications services. ICT-using industries are those that intensively use ICT in their operations, as reflected in the high share of ICT capital in total assets. These industries include, inter alia, printing and publishing, mechanical engineering, aircraft building, wholesale and retail trade, and financial intermediation. Non-ICT-using, "old economy" industries include, among others, food, textiles, pulp and paper, basic metals, hotels and catering, transport, public administration, agriculture, and utilities. The complete list is reported by Van Ark and Piatkowski (2004). The methodology underlying the ICT classification is reported by O'Mahony and Van Ark (2003).
17. It must be remembered, however, that these results do not prove the causality between ICT and productivity growth. It may be that either ICT use contributes to faster productivity growth or that industries with high productivity

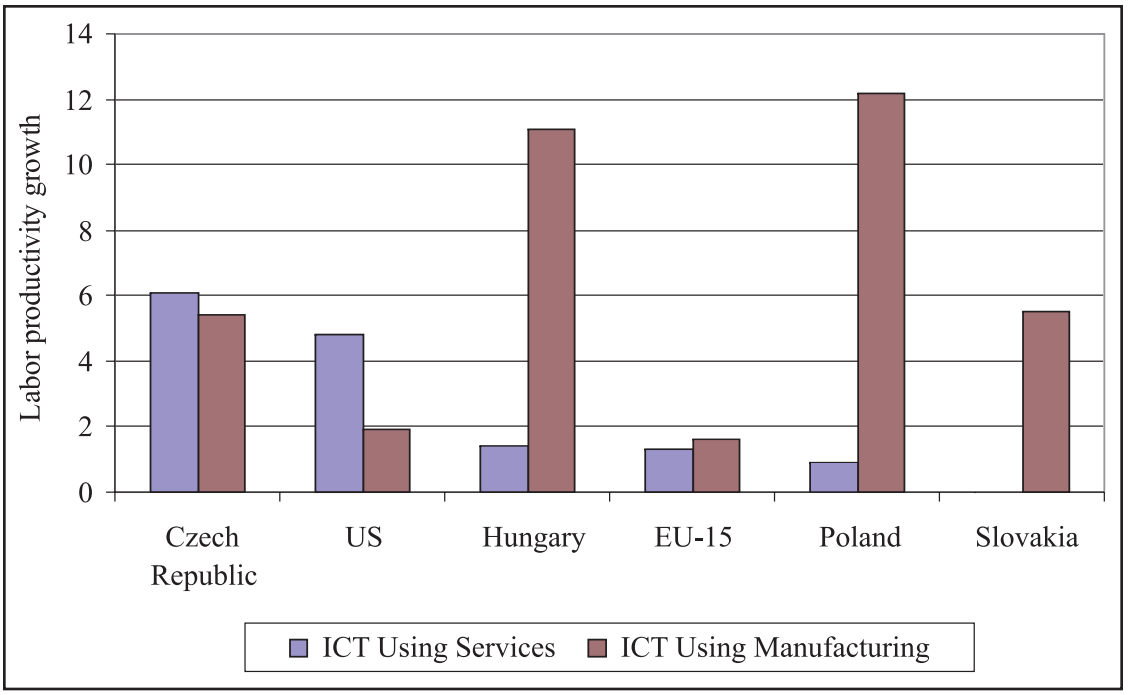

Figure 3. Labor productivity growth rates in ICT-using services and ICT-using manufacturing in CEE, the EU-15 and the US, 1995–2003 average

Note: Countries were ordered according to the size of labor productivity growth in ICT-using services.

Source: Table 3

turing in CEE countries are also substantially higher than in the EU-15 and in the United States. Such a rapid productivity growth resulted mostly from the deep restructuring of ICT-using manufacturing industries driven by basic fundamental reforms allowing for inflows of FDI, product market liberalization, an increase in management skills, labor shedding, and replacement of old equipment with new capital-embedding modern technologies, particularly ICT. Thanks to high productivity growth, ICT-using manufacturing industries in CEE countries had a considerable contribution to total labor productivity growth (Table 4). As opposed to ICT-using manufacturing, however, productivity growth in ICT-using services in CEE countries was much lower than in the U.S. and in manufacturing (Figure 3).

The difference in the productivity growth in the ICT using services in favor of the United States provides grounds for a hypothesis of a "two-phase" convergence.[18] In the first phase, as argued by Van Ark and Piatkowski (2004), productivity growth is driven by the restructuring of ICT-using manufacturing based on a relatively simple replacement of old machinery with new equipment and growth in FDI-driven ICT production. It is quite important to note that such a replacement does not require any major changes to enterprise organization or large investments in human skills. In the second phase, however, economy-wide productivity growth needs to be driven by ICT use in the service and "old economy," non-ICT-using sectors. This requires a more conducive business environment, the full opening of product markets to competition, more flexible labor markets, and reorganization of business processes around ICT rather than automation of the existing organizational structures, which yields only marginal

growth rates happen to use ICT intensively. However, in light of the available evidence from developed countries and CEE countries, the first proposition sounds more plausible.

18. It is worth noting though, that the measurement of productivity growth in the service sector is plagued by a number of measurement problems. See, for instance, Triplett and Bosworth (2004).

Table 4. Contributions to Labor Productivity Growth of ICT-Producing, ICT-Using and Non-ICT-Using Industries, 1995–2003

	EU-15	U.S.	Czech Republic	Hungary	Poland	Slovakia
Total Economy	1.2	2.4	2.2	2.5	5.0	4.0
ICT-Producing Industries	0.5	0.9	0.4	0.8	0.4	0.7
ICT-Producing Manufacturing	0.3	0.6	0.1	0.4	0.1	0.1
ICT-Producing Services	0.2	0.2	0.3	0.4	0.2	0.6
ICT-Using Industries	0.4	1.3	1.6	1.0	1.2	0.6
ICT-Using Manufacturing	0.1	0.1	0.4	0.7	0.7	0.3
ICT-Using Services	0.3	1.3	1.2	0.3	0.2	0.0
Non-ICT-Using Industries	0.3	0.2	0.1	0.7	3.1	2.6
Non-ICT-Using Manufacturing	0.2	0.2	0.6	0.1	0.7	0.5
Non-ICT-Using Services	0.0	0.1	–0.6	0.3	0.8	1.4
Non-ICT-Using Other	0.2	0.0	0.1	0.3	1.0	0.9

Note: Real estate has been excluded from both GDP and total persons engaged for all countries. Productivity growth defined as GDP per person employed.
Source: Updated results from Van Ark and Piatkowski (2004) based on the Groningen Growth and Development Centre, 60 Industry database, January 2006, www.ggdc.net

benefits (Brynjolfsson and Hitt 2000; Davenport 1992; OECD 2004). It also requires larger investment in human and ICT skills and improvement in management practices. As to the latter, Dorgan and Dowdy (2004) show, on the basis of an enterprise survey in the United States, U.K., Germany, and France, that productivity growth stemming from IT investment can be substantial only when it is supported by high-quality management practices. These seem to be indispensable to allow for the process innovation necessary to reap full benefits of ICT use.

Piatkowski and Van Ark (2005) argue that among the analyzed group of CEE countries, EU-15, and the United States, only the latter has succeeded in creating a sufficiently conducive business environment to move to the "second phase" of the productive use of ICT as evidenced by much higher productivity growth rates in ICT-using services. OECD (2004), World Economic Forum (2005), and Timmer and Van Ark (2005) also point to the success of the Nordic countries and Australia in promoting the diffusion and productive use of ICT.

As for CEE economies, this means that to move to the "second phase" of convergence they will have to implement far-reaching structural reforms largely modeled on either the U.S., Australian, or Nordic economies. This, however, will not be easy, in view of the social sensitivity to enhancing labor market flexibility (including the ease of hiring and firing) and opening industries to full competition (particularly in telecommunications, postal services, and utilities). Furthermore, in light of the lack of fiscal space for substantially higher public spending in most CEE countries (IMF 2005), it will be difficult to increase spending on research and development and innovation. Finally, as argued by Piatkowski (2004), given that under the centrally planned economic system there were no incentives to innovate, because of the lack of a history of innovation, enterprises in CEE countries will be less likely to experiment than those in developed economies. All in all, if the structural reforms are not implemented, the ICT-led convergence may slow as the restructuring process in ICT-using manufacturing nears completion and further investment in ICT yields only diminishing returns.

The Potential of ICT Use in Services and "Old Economy" Industries

Because ICT-using industries in CEE countries reported higher productivity growth than non-ICT-using services and "old economy" industries, higher investment in ICT business applications (ERP, CRM, online procurement, e-commerce, and so on), coupled with organizational innovations and enhanced human skills, could contribute to faster productivity

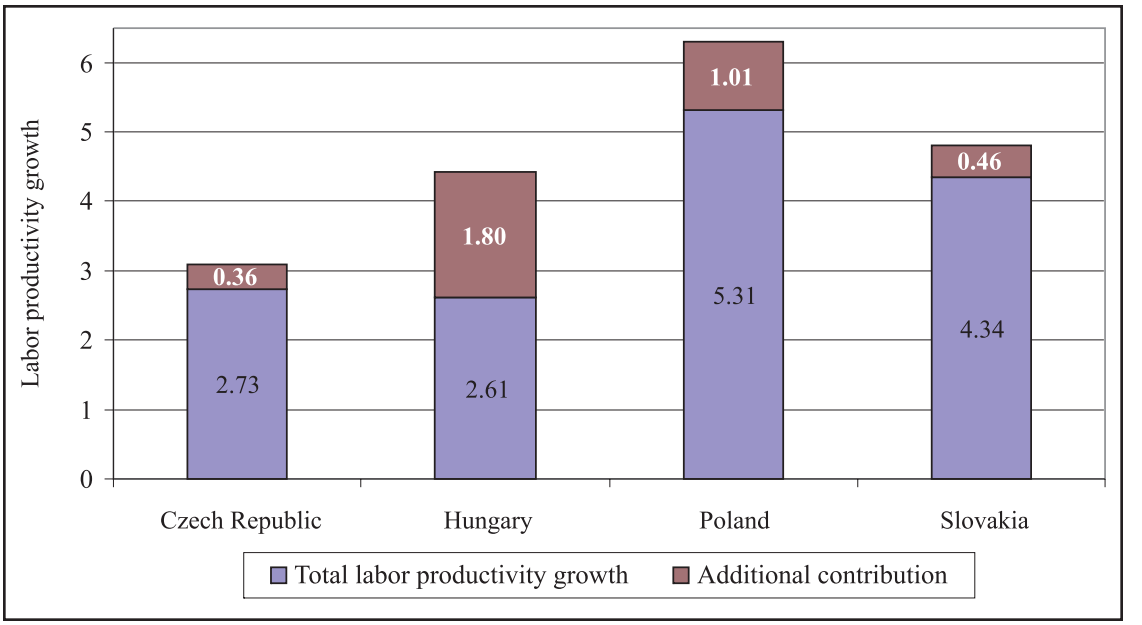

Figure 4. Additional contribution to aggregate labor productivity growth from ICT-led acceleration in productivity growth in the non-ICT-using, "old economy" manufacturing in CEE countries, 1995–2003 average

Source: Author's calculations based on extended results from Van Ark and Piatkowski (2004)

growth in "old economy" industries and thus accelerate convergence with developed countries.

What would be the impact on a nationwide productivity growth if the non-ICT-using, "old economy" industries increased their productivity growth thanks to a more intensive ICT use? Figure 4 shows that under the assumption that the "old economy" manufacturing industries in CEE countries could achieve the same rate of productivity growth as in modern ICT-using manufacturing, the additional contribution to the economy-wide productivity growth would be substantial. In the case of Poland, the additional 1.01% contribution to labor productivity growth would allow it to catch up with the average EU-15 level of productivity 6 years earlier than in a baseline scenario, that is, in 2023 instead of 2029. The Czech Republic, Hungary, and Slovakia would also catch up faster.

Is this projected acceleration in productivity growth in non-ICT-using, "old economy" industries in CEE countries realistic? It seems so, in light of this existing considerable productivity gap. According to Havlik and Urban (2003), in the Czech Republic, Hungary, and Poland the level of labor productivity in the "old economy" industries of food processing, textiles, wood products, pulp, paper and publishing, chemicals, and basic metals in 2002 did not exceed 40% of the average EU-15 level. Hence, there is ample scope for ICT-driven productivity growth.

As Piatkowski (2005b) argues, similarly large economic benefits to the whole economy would ensue if the ICT-using services in CEE countries caught up with the labor productivity growth rate in the ICT-using service sector in the United States.[19] As asserted in the previous section, however, such a sizeable productivity increase could not be achieved without a large increase in ICT investment, supported by macroeconomic stability and fully developed market institutions, complemented with improvements in the business organization, process innovation, human skills, management practices and in the quality of the business climate.

Apart from the private sector, ICT use can also stimulate productivity growth in the public sector

19. Although the high productivity growth in the U.S. service sector seems to have been at least partly driven by factors unique to the United States, including economies of scale, stock market boom, and the "Wal-Mart effect." See, for instance, McKinsey Global Institute (2001).

(eGovernment Observatory 2005). Potential benefits from more intensive ICT use would be particularly large for transition economies, where the overall quality and efficiency of the public sector is low relative to developed countries (World Bank 2005). A more intensive use of ICT would increase the public sector's productivity, enhance the quality of spending, improve collection of tax revenue, and generate large savings in operating costs.[20] It would also boost productivity of the private sector through the reduction of red tape, a decrease in corruption, better quality of services, and easier access to information. These benefits could go a long way toward generating additional resources for funding additional investments in infrastructure, human capital, and ICT.

A more intensive use of ICT in the public sector and active public ICT policies are also indispensable to promote the diffusion and use of ICT in the private sector, as shown by Nordic countries, the United States, and Australia (OECD 2004). Public "push strategy" is particularly important in the context of transition economies, where the market mechanisms do not yet work as efficiently as in developed countries and thus leave more scope for effective public intervention. A number of countries in the CEE region have demonstrated the benefits of active public ICT policies. This in particular concerns Estonia and Slovenia, the two regional leaders in ICT diffusion and the development of information society (Gáspár 2004).[21]

Conclusions

Between 1995 and 2003 ICT contributed to faster growth and accelerated convergence of the Czech Republic, Hungary, Poland, and Slovenia with the EU-15; however, Romania, Russia and—to a lesser extent—Slovakia and Bulgaria lagged behind. This was because of the lower quality of the economic and institutional environment, which stymied the diffusion and efficient use of ICT. The cross-country divergence in the economic impact of ICT investment indicates a close link between the diffusion of ICT and advancement of economic reforms. Because Bulgaria and Romania will join the European Union in 2007–2008, which will strengthen their economic environment as well as provide each with substantial additional funds for investment in ICT, the role of ICT in the development of these two countries is likely to increase. Likewise, increased EU funding and improved business climate should also spur ICT investment in Slovakia, already an EU member. However, this will not be the case of Russia and other transition economies not joining the EU. There is therefore a risk that the divergence in the ICT contribution to growth between the EU members and other transition countries will grow.

Far-reaching structural and institutional reforms modeled on best practices from the United States, Australia, and Nordic countries are the main way to benefit from the large potential of ICT for faster economic development. The same reforms, however, will also be vital to stimulate overall growth not only through ICT, but also through the "old economy," traditional sources of growth: more intensive innovation, higher physical investment, and enhanced quality of human capital. Nonetheless, ICT can be a potent source of growth on its own, as its production and use until 2025 is likely to accelerate economic growth in CEE countries by more than a fourth.

On the sectoral level, because the ICT-producing sector in CEE countries is too small to be a main driver of growth and because the simple transition growth reserves have been already exhausted, sustained productivity growth and convergence with the EU-15 and the United States will now have to rely on the productive use of ICT in the non-ICT producing sector, in services and in the "old economy" manufacturing industries. This article provides evidence that ICT use had an important role in stimulating productivity growth, as ICT-using industries reported much higher productivity growth rates than non-ICT-using industries.

If non-ICT-using industries, in both the service

20. For instance, according to Poland's Ministry of Finance, streamlining the existing more than 200 various IT tax systems and creating a single treasury management account could generate annual savings of up to 1.5 percent of GDP (Polish Ministry of Finance 2005)

21. Piatkowski (2005a) also recounts a story of a successful public push strategy in Poland. In 1999 the Polish Social Security Agency made it mandatory for all firms, large and small, to file social security documentation only in an electronic form. As a result, despite some early complaining, within the next couple of years the computer penetration in the business sector became practically universal.

and "old economy" manufacturing sector, were able to increase the intensity of ICT investment and thus achieve the same rate of productivity growth as the ICT-using industries, they would provide a considerable boost to the convergence with developed countries. Realizing this potential, however, would require further structural reforms aimed at opening borders to trade, increasing inflows of foreign capital and spending on human capital, improving effectiveness of law enforcement, enhancing macroeconomic stability, and—above all—promoting vigorous competition in the labor and product markets. At the firm level, this would in turn require accelerating re-organization of business processes around ICT, improving management practices, increasing spending on innovation, and, finally, augmenting investment in human capital and ICT skills. These recommendations are valid for not only transition economies, but also for most advanced developing countries.

The public sector could also have a special role in driving ICT-led growth by stimulating a conducive business environment and promoting ICT use. The latter could be done primarily through full development of public e-services, including e-procurement. This would not only bring considerable savings in the public sector, decrease bureaucracy, reduce corruption, and enhance the quality of the business climate, but also stimulate the interest of enterprises in using more advanced ICT applications. Such a public "push strategy" could then have sizable spillover effects on the use of ICT in the whole economy.

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Table A1. The New Economy Indicator for CEE Countries, EU-15 and the U.S., 1995–2003 Average

Country	Rank	Value 1995–2003	Regulations and Law Enforcement	Infrastructure	Trade Openness	Financial System	R&D Spending	Human Capital	Labor Market Flexibility	Product Market Flexibility	Openness to Foreign Investment	Macro-economic Stability
United States	1	8.91	0.75	1.10	–1.60	2.87	1.23	1.49	2.16	1.03	–0.54	0.40
Sweden	2	8.45	0.84	1.76	–0.15	0.36	2.49	1.14	–0.04	0.69	0.88	0.47
Finland	3	6.91	1.09	1.15	–0.40	–0.38	1.71	2.26	–0.09	0.52	0.58	0.47
UK	4	6.88	1.01	0.71	–0.73	1.04	0.35	0.51	1.56	1.16	0.88	0.39
Ireland	5	6.60	0.83	0.38	2.06	0.41	–0.36	–0.40	0.51	0.90	2.02	0.24
Netherlands	6	6.24	1.05	0.76	0.91	0.96	0.47	0.04	–0.37	0.61	1.45	0.35
Denmark	7	6.24	0.95	1.42	–0.26	0.03	0.71	0.38	1.39	0.90	0.30	0.40
Belgium	8	5.79	0.35	0.17	1.81	0.06	0.50	0.37	1.23	0.51	0.34	0.45
Austria	9	3.15	0.90	0.44	0.19	0.55	0.38	0.08	0.13	0.60	–0.57	0.46
Germany	10	2.18	0.75	0.59	–0.66	0.83	0.96	–0.29	–0.70	0.53	–0.32	0.50
France	11	–0.17	0.22	0.36	–0.92	0.20	0.76	0.01	–1.30	0.12	–0.08	0.46
Portugal	12	–0.68	0.26	–0.19	–0.39	0.77	–0.89	–0.29	–0.86	0.35	0.26	0.30
Czech Rep.	13	–1.73	–0.42	–0.58	0.91	–0.38	–0.44	–1.59	0.79	–0.14	–0.19	0.30
Spain	14	–1.79	0.23	–0.17	–0.78	0.34	–0.71	0.24	–1.30	0.24	–0.19	0.32
Hungary	15	–2.33	–0.28	–0.83	1.05	–0.94	–0.85	–1.00	0.29	–0.07	0.52	–0.23
Slovenia	16	–2.53	–0.46	–0.14	0.83	–0.83	–0.08	0.43	–1.19	–0.26	–0.73	–0.11
Italy	17	–3.23	–0.26	0.26	–0.89	–0.14	–0.53	–0.28	–0.81	–0.11	–0.84	0.37
Slovakia	18	–3.98	–1.04	–1.03	1.35	–0.53	–0.85	–1.64	0.18	0.07	–0.37	–0.11
Greece	19	–4.79	–0.38	–0.12	–0.93	–0.61	–1.03	0.37	–1.30	–0.09	–0.93	0.24
Poland	20	–6.12	–0.70	–1.36	–0.79	–1.01	–0.98	0.01	0.29	–1.13	–0.50	0.06
Bulgaria	21	–8.90	–1.38	–1.25	0.60	–1.06	–1.13	–0.83	–0.09	–2.15	–0.44	–1.17
Russia	22	–10.27	–2.56	–1.70	–0.72	–1.23	–0.54	0.91	0.68	–2.15	–0.82	–2.14
Romania	23	–14.82	–1.76	–1.73	–0.47	–1.32	–1.18	–1.92	–1.14	–2.15	–0.71	–2.44

Source: Van Ark and Piatkowski (2006)