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Development of ICT in Transition Countries: Cross-Country Comparison

The goal of this paper is to present the development of ICT in transition countries. The paper will be based mostly on a modified methodology of the World Bank. After comparing the countries, the rating of transition countries from the point of view of ICT development is presented.

1. Introduction

There are a few main methodologies of measuring the knowledge-based economy (KBE) (see e.g. KMI 2002), one of pillar of which (according to the World Bank) is the information and communication technology (ICT). There are also some methodologies, which measure ICT itself without being related to KBE.

The most important institution, which successfully developed measurement of ICT, is probably OECD, which for many years has provided reports on KBE. It uses many indicators and presents them separately (see e.g. OECD 2001, OECD 2002). Huge progress in methodology of KBE measurement has also been made by the World Bank (especially the World Bank Institute), as well as some other institutions – APEC (Asia-Pacific Economic Cooperation), Australian Bureau of Statistics (which uses 125 indicators to describe KBE; Trewin, 2002), as well as some individuals. There are also some reports related to KBE, however not directly on this topic, e.g. The Innovation Scoreboard prepared by the European Commission (2000), as well as many others on e.g. ICT or human resources, regulatory framework (e.g. competition measured in World Competitiveness Reports of International Institute for Management Development).

Below the World Bank's approach has been chosen as the basis for further research. Instead of selecting and presenting only the indicators, what is still broadly used by e.g. OECD, it recalculated data in order to obtain normalised values (in a range of 0-10). It improved significantly the quality of international comparisons. Then, after grouping 69 indicators into five categories, it compares the structure of the KBEs. In all the cases of presentation of different large sets of data (e.g. by OECD or the World Bank) there is a problem with

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comparability of the data series, i.e. it is very difficult to collect dozens or even several indicators presenting the situation for the same year, enabling comparisons referring to this particular year and enabling comparisons of the changes of these indicators in time. However, these problems with measuring are a common problem in many new socio-economic phenomena and in the future more exact data should be available. Nonetheless, many efforts will be required to present a proper data.[2]

Below we use Knowledge Assessment Methodology (KAM 2002) as a methodological basis and the source of data. It should be noticed, that some indicators used by the World Bank in the group of ICT are based on the data provided by the International Telecommunication Union (ITU, five of them) and by the World Bank *World Development Indicators* reports (five of them, too).

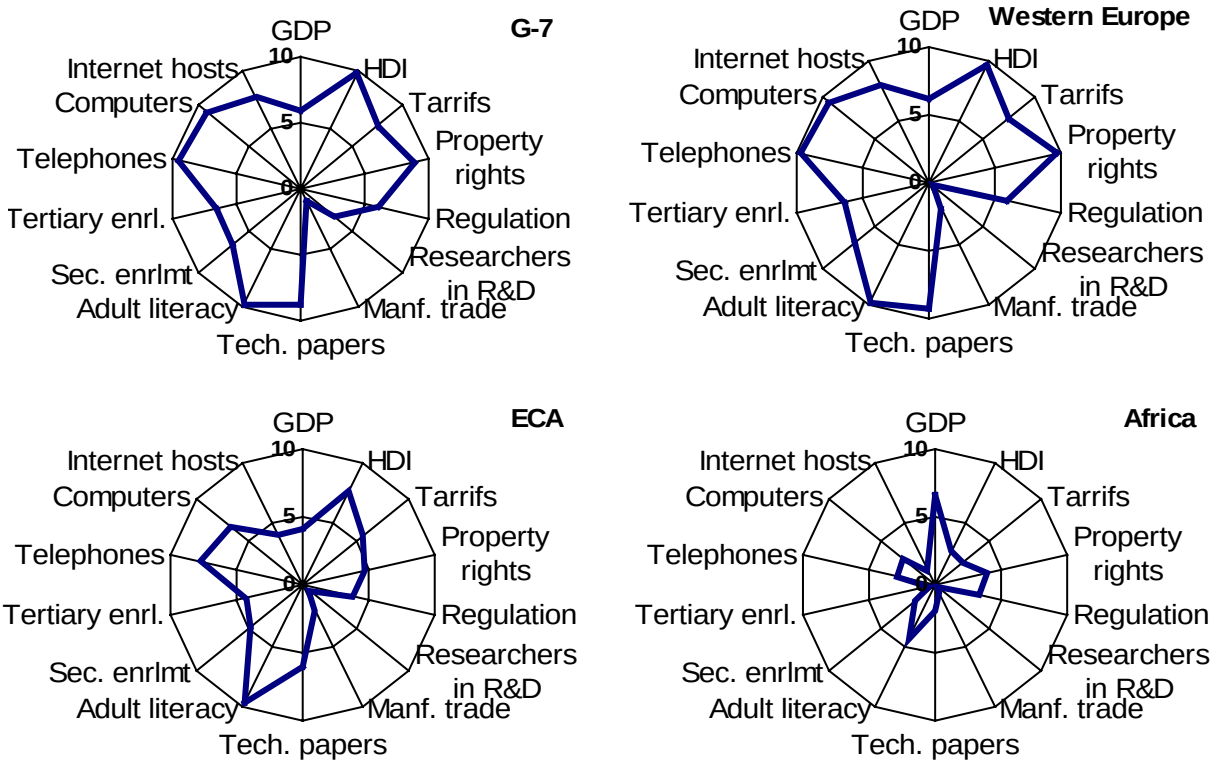
2. Measurement of ICT in the World Bank's methodology

Below some figures will be shown presenting the KBE performance of selected countries, using so-called simplified version (i.e. using 14 indicators only) of the *Knowledge Assessment Methodology* (the World Bank 2002), with the support of a tool: *the Interactive Internet-based KAM exercise*. Below some results obtained with the use of this tool will be presented, on the example of selected groups of countries (figure 1), presenting the comparisons of KBEs (for better comparisons of ranges of indicators G-7 and Africa were chosen).

Values of indicators for transition countries (ECA) are generally worse than in KBE-advanced countries. The only exception was adult literacy (all values almost the same, apart from Africa). Although the levels of indicators are different, their structure is similar: relatively higher level of Human Development Index than GDP, progress in telephones and computers with lagging tertiary education. However, the protection of property rights is much worse than in Western Europe or G-7. We can notice the large digital divide between most-developed countries and the least ones – Africa. ECA compared to Africa look very optimistic.

[2] For instance IMD, Switzerland, still (after several years of publication of its World Competitiveness Yearbook) does not provide the data for the same year and compares values varying by e.g. five years.

Figure 1. Knowledge-based economy scorecards for groups of countries, basing on KAM (2002) methodology



Notes:

Western Europe: Denmark, Finland, Ireland, Netherlands, Norway, Spain, Sweden

Europe and Central Asia: Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia, Turkey, Ukraine, Uzbekistan

Africa: Benin, Botswana, Cameroon, Cote D'Ivore, Eritrea, Ethiopia, Ghana, Kenya, Madagascar, Mauritania, Mauritius, Mozambique, Namibia, Nigeria, South Africa, Tanzania, Uganda, Zimbabwe

Source: KAM 2002.

Figure 1 presents simplified version of KAM Application, named standard scorecard. In extended version, which uses 69 indicators, they are divided into six groups: performance, economic regime, governance, innovation systems, education and human resources, and ICT.

Some role within this simplified version of KAM, ICT indicators have played. Among 14 indicators, three of them related to ICT, namely: telephones per 1,000 persons (mainlines and mobiles), computers per 1,000 persons, internet hosts per 10,000 people. We could notice that among them the number of internet hosts in ECA is especially small in comparison to G-7 or Western Europe.

The World Bank in extended version of its methodology uses the following 14 indicators of the ICT infrastructure (table 1).

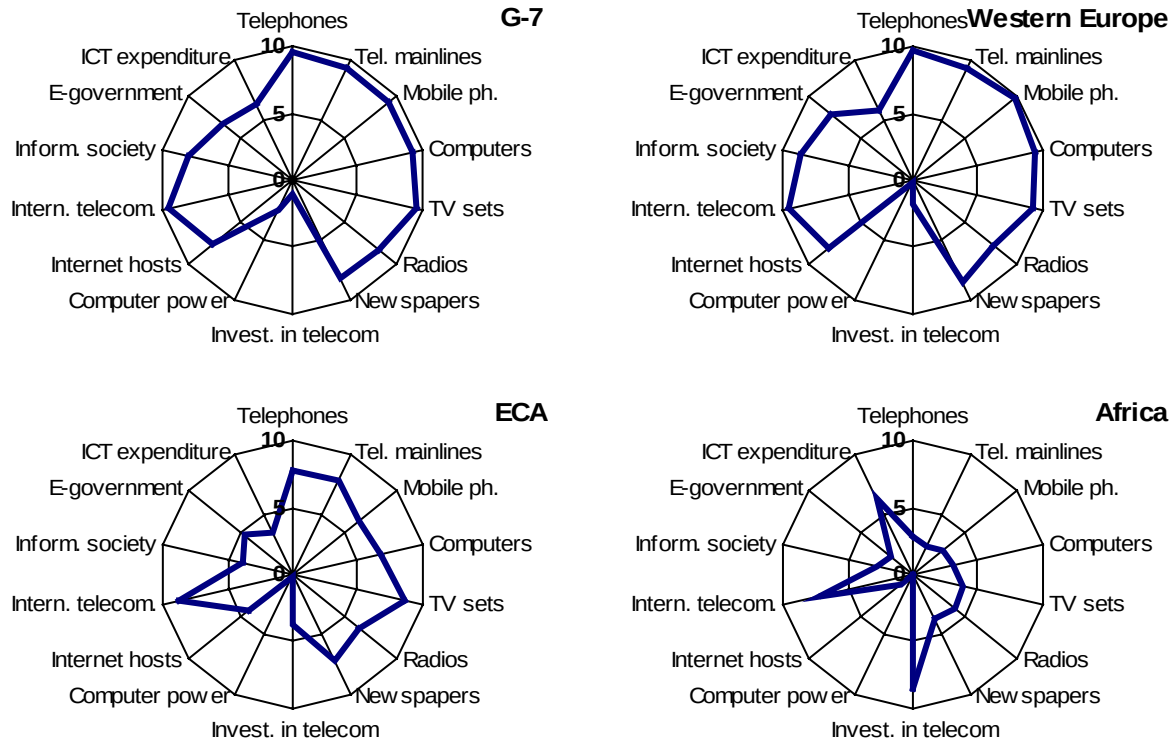
Table 1. ICT indicators used by the World Bank in KAM (2002)

	Indicator	Unit	Data of the year	Source	Date of publishing	Scale
1.	telephones (both telephone mainlines and mobile phones)	per 1,000 people	1999	ITU	2000	ln
2.	telephone mainlines	per 1,000 people	1999	ITU	2000	ln
3.	mobile phones	per 1,000 people	1999	ITU	2000	ln
4.	computers	per 1,000 people	2000	ITU	2000	ln
5.	TV sets	per 1,000 people	1999	WDI	2001	ln
6.	radios	per 1,000 people	1999	WDI	2001	ln
7.	daily newspapers	per 1,000 people	1996	WDI	2001	ln
8.	investment in telecom???	% of GDP	1998	IMD	2001	
9.	rating of computer processing power	% of total worldwide MIPS	1998	IMD	2001	
10.	internet hosts	per 10,000 people	1999	ITU	2000	ln
11.	international telecommunications, cost of call to US	$/3 min	1999	WDI	2001	
12.	information society index			IDC	2000	
13.	e-government			WEF	2001	
14.	ICT expenditure	% of GDP	1999	WDI	2001	

Notes:
MIPS – millions of instructions per second
e-government – the percentage of companies in a country that use the Internet for online government services
ITU – International Telecommunications Union, Telecommunications Indicators
WDI – the World Bank, World Development Indicators
IMD – International Institute for Management Development, The World Competitiveness Yearbook
IDC – IDC, http://www.idc.com/Global/ISI/ISIRanking_tbl.htm (this link is no longer valid, used www.idc.com)
WEF – World Economic Forum, Global Competitiveness Report

Below we present the detailed ICT infrastructure in above (Figure 1) groups of countries (see Figure 2), using the World Bank methodology.

Figure 2. ICT scorecards for groups of countries on the basis of KAM (2002)



Notes and source: see figure 1.

We can notice very high values of telecommunication indicators in G-7, Western European and ECA countries. The costs of international calls are similarly high, too. Much poorer results ECA countries accounted in the categories: internet hosts, information society, e-government and ICT expenditures. Especially interesting was comparison of groups of countries in the category: investment in telecom. The values especially for developed countries were low, while in Africa – high. It is a reflection of the need of less-developed countries to catch up with the developed ones; moreover, it shows that not for all indicators the developed countries obtain the highest values of ICT indicators. Similar situation can be noticed comparing values for ICT expenditures, where African countries obtained (slightly) higher values than G-7, but the values for Western European and ECA countries were lower than for the other groups.

KAM is an interesting platform stimulating further research. For instance, Kukliński and Burzyński (2004) used this approach. They eliminated five variables and replaced them with five new ones, in order to present in a better way the regional KBE dimension. Below we have followed the World Bank methodology and modified it.

3. The modification of the World Bank's methodology

Although the KAM is interesting, it can be criticised. For instance, some of indicators are contained in others; some indicators measure also corruption and there is a separate indicator of corruption; there are two indicators of regulation, two of property rights, a few measures education; HDI measures also life expectancy at birth, and there is such an indicator in another groups of KBE indicators.

This critique is still possible (and relatively easy) because of the lack of one, universal KBE database, thus the World Bank and other institution base on many sources of data, basing on different methodologies. Another problem, typical for KBE measurement is the lack of data for all the compared countries, especially for the developing ones. Moreover, the measuring of KBE using many indicators (like KAM) still does not provide data for a certain year, but for the period of e.g. five years.

Another problem of KAM is such one that it assumes that all indicators should be treated as equal in terms of importance for KBE description, however even intuitively we can have doubts, if the role of radios and internet hosts is equal for the knowledge-based economy and ICT. If we accept that indicators have different values for the KBE and ICT, the problems of proper weights emerge. We used the following solution: analysed all ICT indicators used in KAM 2002 discussing "pros" und "cons", then assigning weights from the range 0.0-2.0, sometimes choosing "0" to show, that certain indicators will not be used for further calculations. Thereafter, weighted average for different countries is counted. As a result, our approach emphasise the indicators, which are the most crucial for the ICT, and from this point of view (and not from the point of view of accessibility of data, which might be collected on ICT, as the World Bank did).

The problem, which might have appeared while using KAM, is "co-integration". Indicators should be independent, i.e. should not be correlated, because it would give too high final result. It is important not only by assigning weights, but also by counting average of indicators, as it is in KAM, because the World Bank treats all indicators equally, even if they might be highly correlated. The problem, which appears and makes the counts of correlation coefficients impossible, is the lack of data. The only solution we have found is the usage of own expert knowledge. Of course, it may be criticised thus the next step in developing this methodology should be the comparison of weights assigned by different experts in order to give objective opinion on importance of certain indicators for describing the ICT.

Below we will discuss all the ICT indicators (see table 2), indicating pros and cons.

Table 2. Discussion of ICT indicators used by the World Bank in KAM (2002)

	Indicator	Pro	Contra	Decision	Weight
1.	telephones (both telephone mainlines and mobile phones)	very universal and important	contains two next indicators	eliminate in favour of next indicators	0
2.	telephone mainlines	still important	indicator no. 3 more important for ICT	May be used	0,75
3.	mobile phones	very important	Lack of data for least developed countries	Use with higher weight	1.5
4.	computers	very important	Relatively "old" invention (PCs of 1980s)	May be used	1.0
5.	TV sets	Important, especially for developing countries	Old invention, its importance decreases	Use with smaller weight	0.25
6.	radios		"old" economy invention; not important nowadays, better use internet radios	Eliminate	0
7.	daily newspapers	Describes information society	"old" economy invention, old data (of 1996), (better would be e.g. no. of internet portals)	Eliminate	0
8.	investment in telecom	Important, shows catching-up process	Ambiguous results (see fig. 2); better use ICT expenditures; doubts on quality of source*	Eliminate	0
9.	rating of computer processing power	Shows development of computers (not by their number, as indicator no. 4, but by their power)	Very high concentration in the U.S.; rarely used in other methodologies; strongly biased by size of population – contrary to the level of computerisation of economy; lack of data	Use with very small weight or eliminate	0
10.	internet hosts	Very important	Problems with counting	Higher weight	1.75
11.	international telecommunications, cost of call to US	Important	Shows competition on telecom market and state regulation (more proper for category of regulations); favours U.S. neighbours	Use with smaller weight	0.5
12.	information society index	Important for KBE	Society-related index, rather ICT one (more proper for category of KBE foundations)	Eliminate	0
13.	e-government	Very important, shows gov. approach to ICT	View of government websites from the firm (not personal usage) point of view	Use with higher weight	1.25
14.	ICT expenditure	Extremely important		Use with higher weight	2.0

Notes:

* Data according to IMD obtained from Siemens International Telecom Statistics and from national sources present state-owned and private company.

While assigning the weights, we tried to indicate the sequence of indicators, from the most important for describing the ICT to the least important ones. We considered as the most important ICT indicators the following ones, presented in order of value of weights assigned to them: ICT expenditures, number of internet hosts, number of mobile phones, e-government index, number of computers, number of telephone mainlines, costs of international calls to the U.S., and number of TV sets. The decision of the weights was partly influenced by the age of invention (see also some cells in table 2, column "contra"), and especially not their date of invention, but of gaining much popularity (and accessibility) among society. For instance, TV sets began to be universal among households in developed countries in 1960s, personal computers in 1980s, internet hosts in 1990s, while radios and newspapers were present in many households even in the first half of the twentieth century.

Some of indicators had to be eliminated, because they did not describe the ICT well:

- are contained in another indicator (no. 8),
- are the sum of other indicators (no. 1 vs. no. 2 and 3),
- are out-dated (in terms of year of data – no. 7, while most of data are for 1999-2000 or appropriateness to describe ICT – no. 6),
- are very rarely used in other methodological approaches and favours countries with many persons and companies (not e.g. per capita or at least in relation to GDP – no. 9),
- or are description of KBE rather than ICT and should be used in another (than ICT) category of KBE indicators (no. 12).

Indicator no. 11 is partly connected with no. 2 (and no. 3), because it refers to the costs of telephone calls (although international only), what influence the penetration of telephones. That is why it should receive smaller weight, and smaller weight was assigned to mainline telephones, too, although in less-developed countries (like transition ones especially a few years ago) it is still an important proxy for ICT development.

4. Development of ICT in transition countries according to the modified KAM

Below we will present the data for the indicators selected above, together with the weights assigned to them and weighted average for all the transition countries, which the World Bank included in KAM, as well as with four groups of countries, to provide some space for comparisons not only within transition countries (please note that data for ECA countries is not the same as average of transition countries, because ECA includes also Turkey).

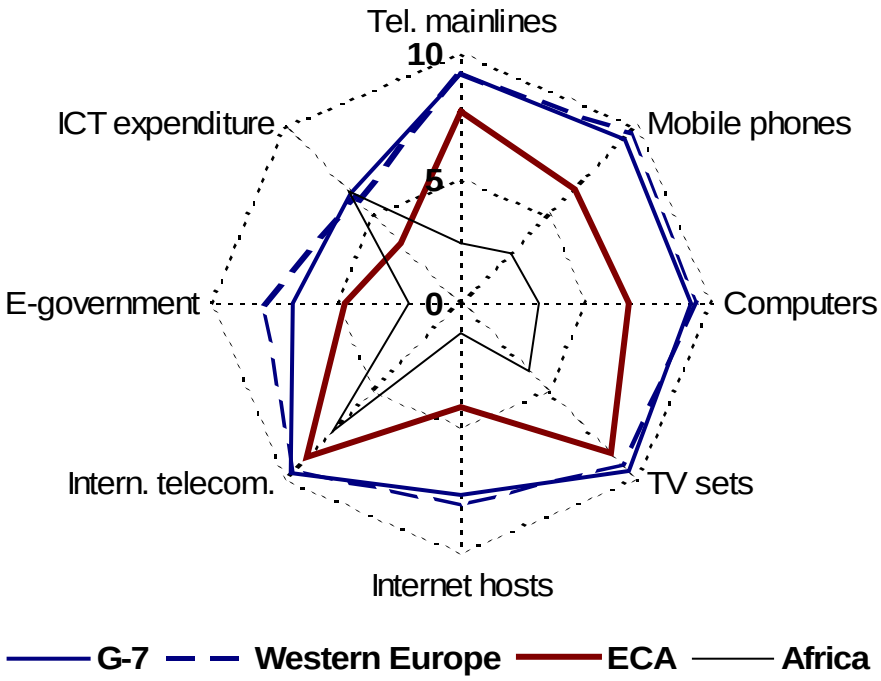
Table 3. Selected ICT indicators and their normalised scores for transition countries and selected groups of countries

	Weight	G-7	Western Europe	ECA	Africa	Belarus	Bulgaria	Czech Rep.	Estonia	Hungary
Telephone mainlines	0.75	9.22	9.20	7.69	2.41	7.82	8.28	8.41	8.34	8.38
Mobile phones	1.5	9.26	9.63	6.42	2.82	2.35	6.72	9.05	8.91	8.50
Computers	1.0	9.18	9.44	6.75	3.14		5.52	7.69	7.99	7.08
TV sets	0.25	9.50	9.20	8.51	3.86	8.12	8.58	8.93	9.18	8.77
Internet hosts	1.75	7.67	8.12	4.17	1.20	0.92	3.84	6.30	7.09	6.25
Costs of int. calls	0.5	9.59	9.52	8.75	7.22	9.25		9.25	8.72	9.37
E-government	1.25	6.73	7.88	4.67	2.07		3.46	6.35	8.85	6.25
ICT expenditure	2.0	6.25	5.88	3.40	6.32		0.40	7.76		5.50
Weighted average		**8.94**	**9.21**	**6.07**	**3.89**	**3.53**	**5.11**	**8.61**	**8.25**	**7.84**
	Kazakhstan	**Latvia**	**Lithuania**	**Poland**	**Romania**	**Russia**	**Slovakia**	**Slovenia**	**Ukraine**	**Uzbekistan**
Telephone mainlines	6.23	8.01	8.13	7.90	7.06	7.45	8.09	8.41	7.29	5.37
Mobile phones	1.64	7.67	7.41	7.71	7.05	4.64	8.19	9.43	4.16	1.04
Computers		7.23	6.74	6.80	5.53	6.04	7.67	8.93	4.73	
TV sets	7.53	9.75	8.64	8.48	8.06	8.64	8.63	8.32	8.61	7.82
Internet hosts	1.72	5.38	4.72	5.42	3.41	3.88	5.47	5.92	2.59	0.12
Costs of int. calls	9.00	8.88	7.94	8.63	8.39	7.71	9.96	7.92		
E-government		4.04	6.35	5.58		2.69	4.23	4.81	4.42	
ICT expenditure				3.84	0.43	0.17	5.02	6.32		
Weighted average	**3.31**	**6.58**	**6.61**	**6.86**	**4.92**	**4.39**	**7.26**	**8.05**	**4.77**	**1.94**

Source: KAM (2002) and own counts.

Below we will not analyse individual data, which are in the table 3 (it will partly be done below), but compare the structure of ICT indicators in the transition countries. First, we see on one graph all four groups of countries, which have been presented before (on figure 2) with a few more indicators. Here we can notice that the structure of ICT in G-7 countries as well as in Western European ones was very similar. Three indicators show larger similarity of transition countries to them: telephone mainlines, TV sets and international communication.

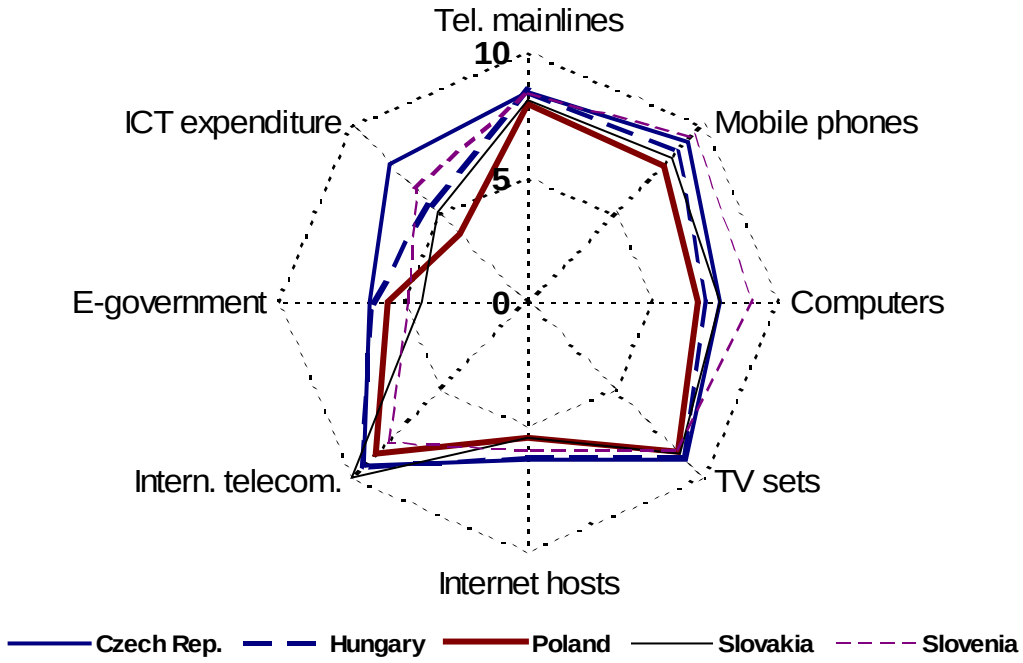
Figure 3. ICT scorecard for selected groups of countries



Notes: see table 1.
Source: see table 3.

The next figure (no. 4) presents Visegrad countries and Slovenia. We see that the structure of ICT indicators is very similar in all of them. The largest difference was for indicator: ICT expenditures, value for which was the lowest for Poland and the highest for the Czech Republic. Slovenia was much better than in Visegrad countries in terms of number of computers. The highest similarity can be observed for indicator: TV sets, what is a result of age of this invention and time to become very popular in households. Slovakia performed the best in comparison with other countries in all seven indicators in terms of costs of international calls, and its western neighbour was the best in most (five) indicators, what – according to both the World Bank's and our methodology – gave the Czech Republic the position of a leader among transition countries.

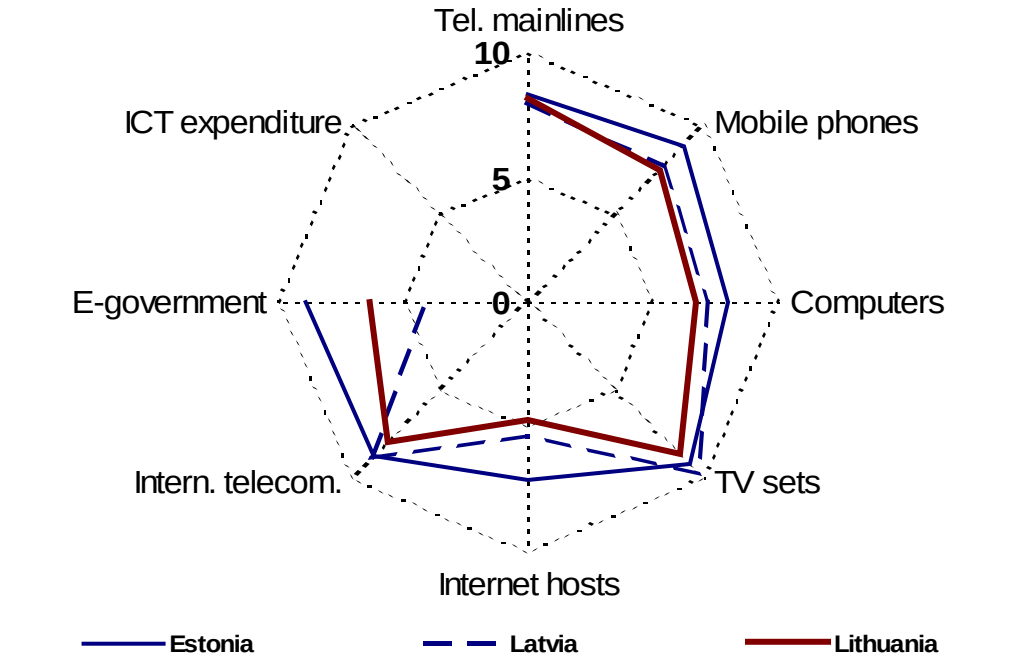
Figure 4. ICT scorecard for Visegrad countries and Slovenia



Notes and source: see figure 3.

The next figure presents three other EU accession countries: the Baltic States. While the ICT structure is quite similar in Latvia and Lithuania, Estonia performed mostly much better.

Figure 5. ICT scorecard for the Baltic States

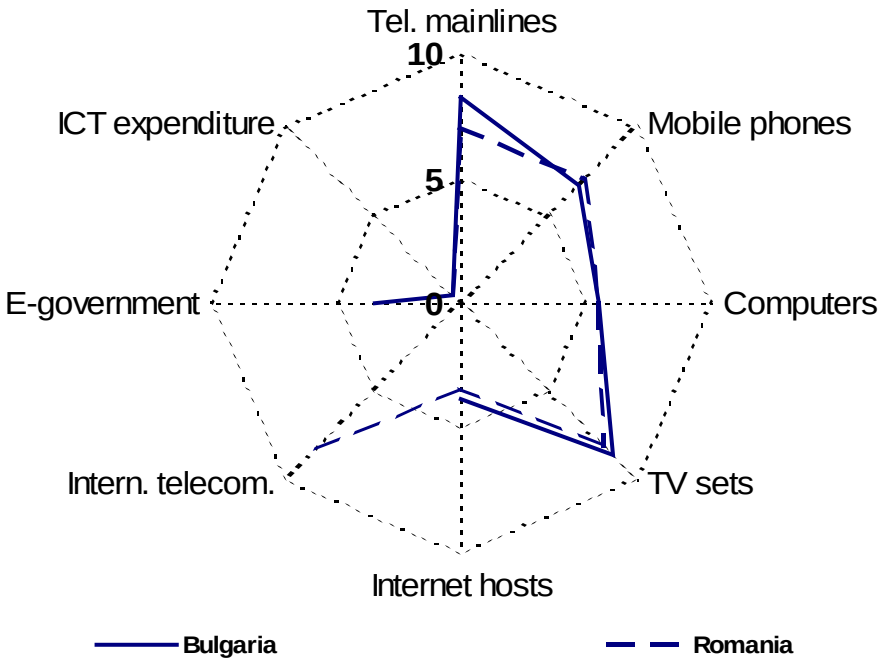


Notes and source: see figure 3.

The largest gap between them can be noticed for e-government (and internet hosts), what partly confirms common opinions of very active ICT government policy in Estonia and interest of enterprises in technological innovation (here: internet).

The problem of the lack of data starts with analysis of EU candidate countries, which will not join it in 2004. Bulgaria and Romania have been presented together, and indeed, they had similar ICT structure (as for the indicators, for which the data were accessible).

Figure 6. ICT scorecard for Bulgaria and Romania

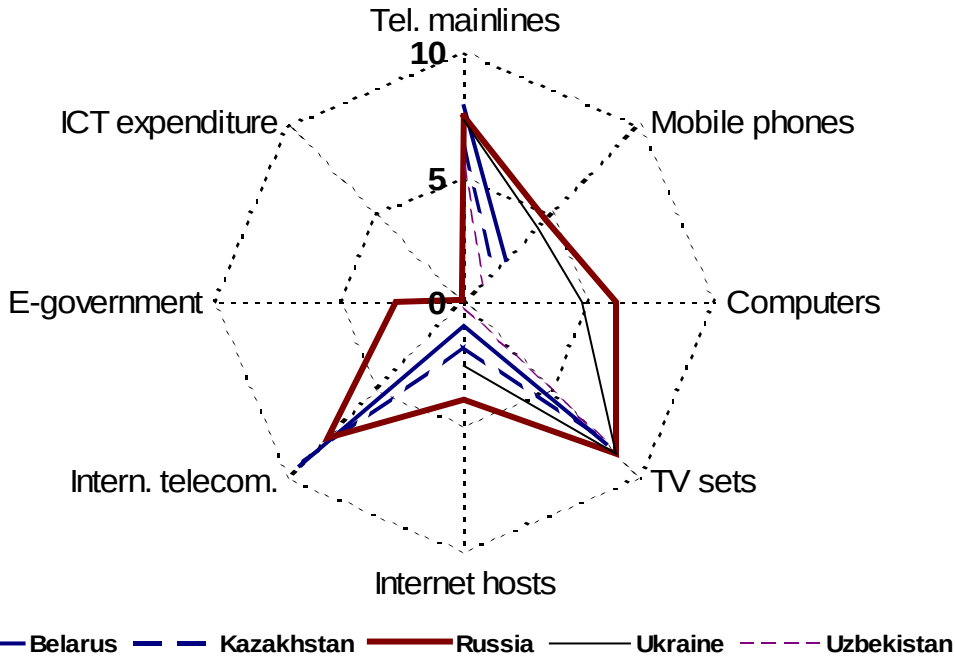


Notes and source: see figure 3.

The last group of analysed transition countries was Russia and other countries of the Commonwealth of Independent States (CIS). There were all data for Russia, but incomplete for other four countries. There were only two values for the number of computers and for e-government (Russia, Ukraine). Thus for an analysis of these countries as a group these two indicators together with ICT expenditures should not be included.

Comparing available data for these countries, we can notice that their structure was similar, however Russia in most cases performed better (in three indicators, out of five analysed). Surprising is the very low level of ICT expenditure in Russia, and very low costs of international calls in Belarus.

Figure 7. ICT scorecard for some CIS



Notes and source: see figure 3.

Assuming, that all the countries within one group are similar[3] we count average indicators for them, in order to compare ICT structure in groups of transition countries. We did not count average, when more than half of values for certain indicator was not accessible. The results of counts are shown in the table 4 and presented at figure 8, as well.

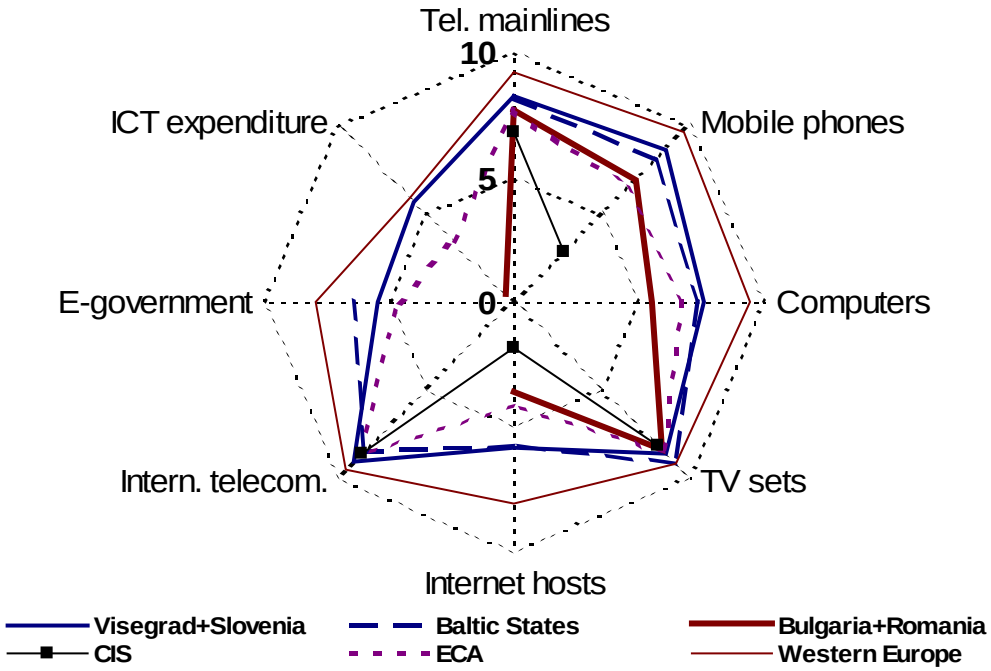
Table 4. Development of ICT in groups of transition countries

	Tel. mainlines	Mobile phones	Computers	TV sets	Internet hosts	Intern. telecom.	E-gov.	ICT exp.
Visegrad + Slovenia	8,24	8,58	7,63	8,63	5,87	9,03	5,44	5,69
Balic States	8,16	8,00	7,32	9,19	5,73	8,51	6,41	
Bulgaria + Romania	7,67	6,89	5,53	8,32	3,63			0,42
CIS	6,83	2,77		8,14	1,85	8,65		

Source: own counts based on table 3.

[3] It is not true for the Baltic States, because Estonia performed much better – see figure 5 and 8, however from the geographical point of view Estonia is very often treated equally to Latvia and Lithuania, as one of the Baltic States; it is also partly not true for Russia, however ICT level as a whole (figure 8) was comparable.

Figure 8. ICT indicators in groups of transition countries



Source: table 4.

From this point of view, we see structural differences within the transition countries quite well, and the conclusion is that they should not be regarded as one group, because differences between countries are large[4]. It is better to divide this group into subgroups, e.g. in more traditional way into Visegrad group (with Slovenia), CIS, the Baltic States, and two European, non-CIS, transition countries (Bulgaria and Romania). We see that the ICT structure of Visegrad and Baltic countries is quite similar, being slightly more different only in e-government (however we should remember that Estonia improved performance of this group much). Bulgaria and Romania performed worse (and much worse in the case of ICT expenditures), but usually better than CIS. CIS are backward in comparison to leading transition countries especially in case of mobile phones and internet hosts – very recent inventions (but in TV sets are on similar position, however – as we discusses before – this indicator do not describe well present ICT structure and should be treated with lower weight).

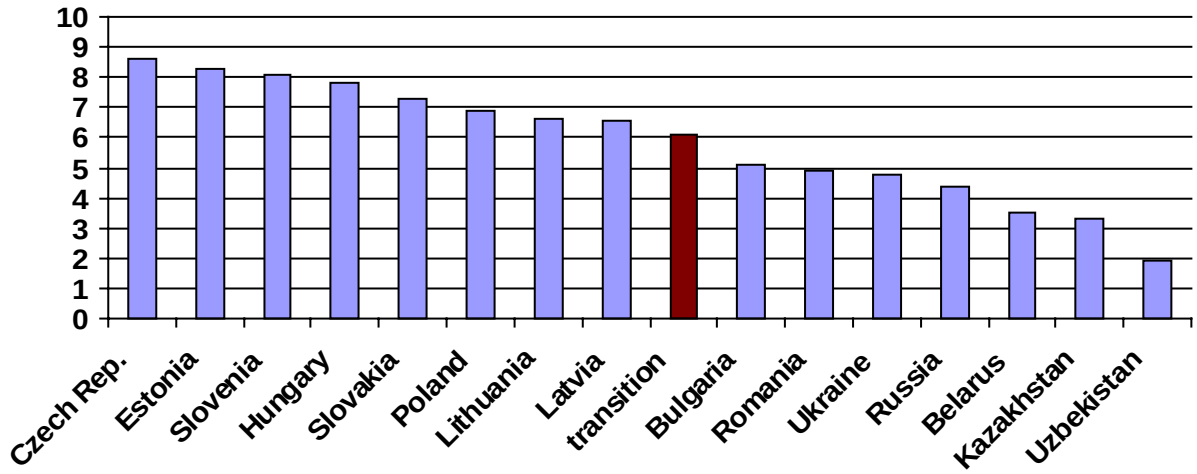
Thanks to this grouping of transition countries, we can compare groups of them with e.g. West European countries or ECA average. The largest gap between two groups of leading transition countries and West European ones was in internet hosts and e-government.

[4] As we have checked, the average of coefficients for all the countries in ECA category of the World Bank is not the arithmetic ("normal") average of transition countries plus Turkey. It may suggest that the World Bank used average weighted with e.g. the size of countries (or there may be mistakes).

Although the values for ICT expenditure are very similar (for Visegrad countries and Slovenia), it is not promising because more financial sources should be directed to catch up with more ICT developed countries, because such a need exists (see gaps indicated above). The most pessimistic from this point of view was the situation of Bulgaria and Romania, which obtained very bad results in this category, also in comparison with ECA countries as a whole.

The most important comparison according to the modified KAM is presented at the figure 9. It gathers all the analysed transition countries, giving one value describing the global level of ICT development according to the significance of eight indicators for the ICT.

Figure 8. ICT development in transition countries



Note: transition – value obtained using our methodology for the World Bank's group of ECA countries.

Source: table 3.

We see that the most advanced transition country in terms of development of ICT structure measured with our methodology was the Czech Republic. The second position occupied Estonia, third – Slovenia, fourth – Hungary. Surprising may be the sequence of the next two countries: Slovakia performed better than Poland; next two Baltic countries are not far behind and still above average for ECA countries. Below this level were Bulgaria and Romania, as well as other CIS, which have been analysed. Asian CIS performed worse than European ones, and Russia was not the leader (however it obtained some best results within this group for particular, however not-much-important for ICT, indicators; see figure 7).

5. Conclusions

In the paper, we presented the structure of ICT indicators and then the level of development of ICT in most of transition countries, including especially all EU accession transition countries. We used modified methodology of the World Bank to study this topic. It was justified by the fact that some indicators are more and some less (nor even not) important for description of overall ICT structure in different countries and for counting an index showing the level of development of ICT.

We see that the leaders in the development of ICT in the transition countries are the Czech Republic and Estonia, which the structure of ICT indicators (which were used to measure the level of development) is already quite similar to the structure of ICT indicators for the most developed countries. It is promising for the enlarged EU from the point of view of the threat of deepening the digital divide between accession countries and old 15 EU member states.

There are however also lagging countries among most advanced (in terms of ICT development) transition countries: these are Poland, Lithuania and Latvia. They are still above average for the studied 15 transition countries. Below this average were Bulgaria and Romania, which have weak potential in catching up in ICT with the EU due to esp. very small ICT expenditures (much smaller than e.g. African average), and later – European CIS countries, and then – Asian CIS countries.

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