Zagreb International Review of Economics & Business, Vol. 7, No. 2, pp. 95-106 , 2004

ISSN 1331-5609; UDC: 33+65

State of the Level of Technology in Central and East Europe

*Jurica Šimurina**

Abstract: This paper consideres selected technology indicators in Central and East Europe (CEE). Among the selected countries the distinction can be made between countries that joined the EU in May 2004 and othe countries in the sample. Differences exist in selected indicators among the performing countries. Other countries have modest to poor perfomance in general with few exceptions for individual indicators.

Key words: education, literacy, patents, R&D, technology

JEL Classification: O14, O31

Introduction

Technologies both tangible and intangible have always played an important role in growth and development of countries. However, not all countries are innovators on a larger scale but have capacity to acquire available technology from abroad and integrate it into their home economies. It is stipulated in the literature that a certain threshold of technology has to be present in an economy in order to innovate on there own or more so to transfer technologies from abroad.

The importance of technology for growth and development has been very high since the First industrial Revolution onward. Economies went from agricultural to industrial societies and today to information societies. The innovative activities that drive technology change stems from ability of countries to provide basis for such activities.

Abramovitz (1993) distinguishes different ways in which technology has influenced economy in nineteenth and twentieth century. The first, but not the crucial, difference is the pace of technological progress; however the character of technological progress seems to be more crucial in this division of centuries. This may be the reason why the conventional capital accumulation has played such an

* Jurica Šimurina is at the Graduate School of Economics and Business, Zagreb, Croatia.

important role in growth accounting for the nineteenth century and a much smaller role in the twentieth century. In the nineteenth century technological progress was heavily biased in a physical capital using direction, only to shift toward intangible (human knowledge) capital using direction in the twentieth century. This bias produced substantial contribution of education and of other intangible capital accumulation. The technological change of twentieth century tended to positively influence the relative marginal productivity of capital in terms of education and training of the labour force at all levels, from deliberately acquired knowledge through R&D investment, and in other forms of intangible capital (e.g. support for corporate and managerial structures and cultures, development of product markets subject to the infrastructure of the economies of scale and scope). The bias shift of the twentieth century encompasses the change in employment patterns. The shift occurred from agriculture (low education levels) to manufacturing, mining and construction (intermediate education levels) to services (relatively high education levels). There are several factors that contributed to this shift. First, there was an increase in income level per capita and associated Engle effect on the structure of the final demand. Second, growth of service sector industries was due to requirements of exploitation of scale intensive technological progress (e.g. trade, communications, and finance, legal, accounting and engineering professions). Finally, there was a technology bias toward agriculture and industry, where the productivity of labour was raised more than in services.

Out of many explanations for the productivity slowdown in the 1970s, one of the main items recognised for this situation is the exhaustion of inventive and technological opportunities. In the US the number of patents granted peaked about 1970 and declined afterward throughout the decade. With exception of Japan, similar trends can be observed throughout the world during the 1970s. At the same time there was a rapid growth in R&D expenditures while patenting diminished which suggests diminishing returns.

The crash of Soviet system in Central and East European (CEE) countries in 1990s has led to some serious development and growth problems. For the revival of growth and development process, the scholars count upon systemic institutional changes and technology as a factor of economic growth of these countries in 21st Century.

In the following pages we attempt to exhibit the different positions of technology in CEE in terms of indicators presented here. We find that on an average, countries that have joined the EU in May 2004 exhibit better positions on account of indicators that represent technology here. Furthermore, it is now evident that Slovenia on one side and Hungary and Czech Republic on the other side, as best performing transition economies, sharply differ in high technology exports, both as percentage of manufacturing and in dollar terms, patent applications, researchers in R&D, R&D expenditures and enrolment figures. While Hungary and Czech Republic dominate high technology exports, Slovenia dominates in patent applications, researchers in R&D, expenditures on R&D and tertiary gross enrolment.

Among other countries, Russian Federation has good performance in high technology exports, patent applications, and definitely dominates in number of researcher in R&D per million people. Expenditures for R&D are relatively high, along with secondary and tertiary enrolment. It seems Russian Federation has considerable technology backlog for further exploitation.

Technology in CEE

According to Sachs (2000), it is evident that most of the new technology innovations come from developed countries, which accounts for some 15 per cent of total population. A second part, containing some half of world's population is able to adopt the new technology generated by the developed countries in consumption and production, while the remaining part, containing around a third of the world's population, is actually technologically disconnected, neither innovating at home not adopting foreign technologies.

Table 1.: GDP per capita (constant 1995 US$)

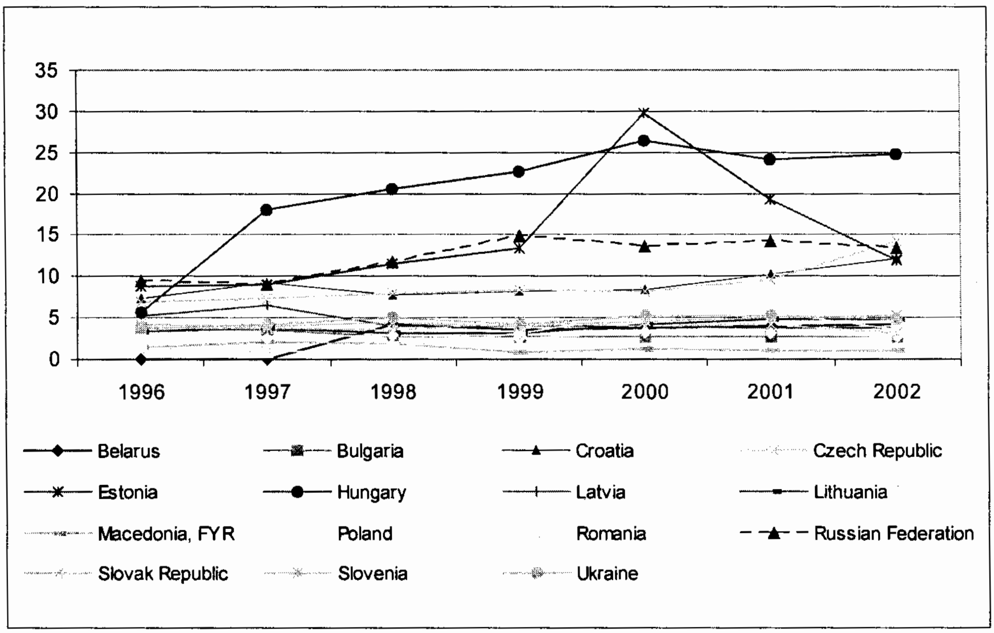
	1990	1995	1999	2003
Belarus	2,098	1,359	1,788	2,248
Bosnia and Herzegovina	..	546	1,551	1,721
Bulgaria	1,716	1,560	1,451	1,827
Croatia	5,432	4,029	4,749	5,720
Czech Republic	5,269	5,036	5,206	5,861
Estonia	3,822	2,840	3,518	4,546
Hungary	4,857	4,379	5,119	5,943
Latvia	3,611	1,902	2,423	3,279
Lithuania	3,418	2,020	2,501	3,208
Macedonia, FYR	2,741	2,263	2,441	2,494
Poland	2,990	3,293	4,165	4,781
Romania	1,702	1,564	1,451	1,745
Russian Federation	4,294	2,670	2,663	3,528
Serbia and Montenegro	..	..	1,547	1,898
Slovak Republic	4,258	3,617	4,223	4,877
Slovenia	..	9,419	11,155	12,763
Ukraine	1,934	936	825	1,133

Source: WDI, 2004.

CEE countries mostly fit into the category of able to adopt new technologies. This is not to say there is no inventive activity in CEE, but its magnitude is very modest compared to technological leaders. The ability to accept new technologies provided by leaders is important step toward faster convergence in technology levels and per capita GDP levels.

First, we look at GDP per capita level in the region (see table 1). Country dominating the picture is Slovenia that exhibits more than double GDP per capita compared to the next best country (Hungary) in 2003. Countries that joined the EU in May 2004 have recorded a GDP per capita around US$5000 in 2003. However, relative relations among countries remained roughly the same throughout 1990s and at the start of twenty-first century. However we can see that countries for the next round of the EU expansion, Romania and Bulgaria, lag behind Croatia considerably in terms of GDP per capita.

Figure 1.: High Technology Exports (% of manufactured export)



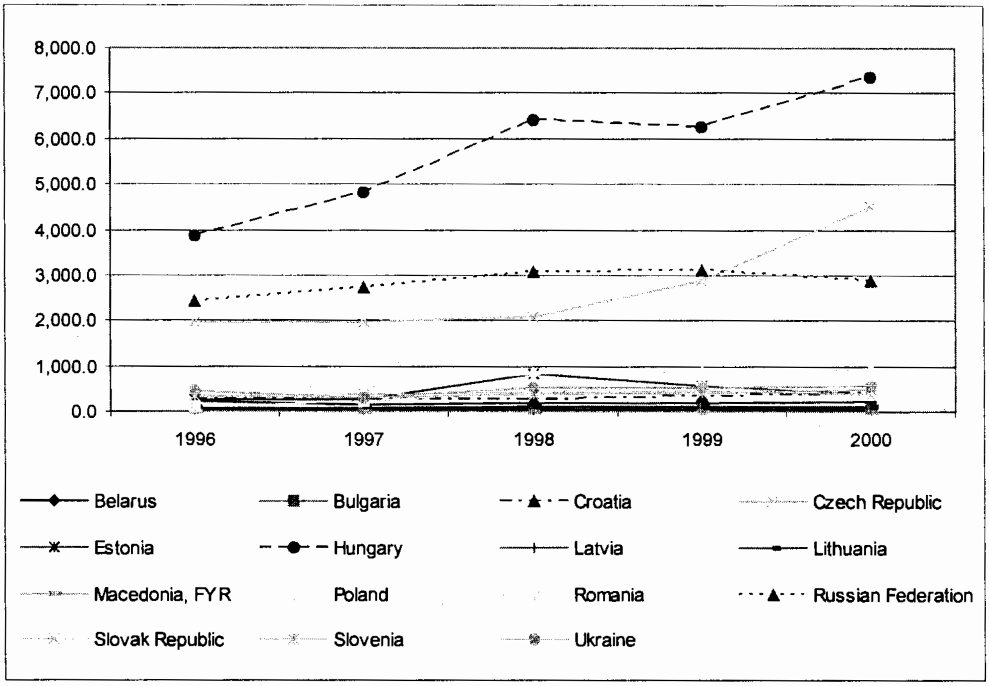
Source: WDI, 2004.

In terms of high technology exports as percentage of manufactured exports (see figure 1) we can observe consistent domination of Hungary throughout the observed period. While Estonia exhibited greater percentage in year 2000, this position was unsustainable, while Hungary has steady high figures. This is mostly due to heavy FDI of multinationals in Hungary. Among other countries, we can observe Czech

Republic, Croatia and Russian Federation with distinctly higher percentages compared to the remainder of the sample are below five percent throughout the period. We can see that Slovenia, best performing transition economy is in the group of countries below five percent of high technology exports out of manufacturing, while the next two transition economies, Hungary and Czech Republic, exhibit high and increasing percentages. It is likely that most of those exports stems from FDI made by multinational companies, which is considerable in Czech Republic and Hungary, and very modest in Slovenia.

While percentage terms of high technology exports may be somewhat bias in terms of the size of manufacturing, exports in dollar terms is not (see figure 2). Again, Hungary dominates the picture, while other countries remain far behind. While Russian Federation is at high dollar levels it is actually surprisingly low considering the size of the economy. Among other countries, Czech Republic exhibits high and increasing number, which is constant with its overall performance. Other countries lag behind, and Slovenia is still nowhere in sight.

Figure 2.: High Technology Exports (US$)



Source: WDI, 2004.

In terms of literacy (see table 2) we can see that figures are at high levels for all observed countries. Only country below 99 per cent in year 2000 is Bosnia and Herzegovina, which is not surprising because schools were out for many years during 1990s due to war activities. However, situation was not as favourable at the end of 1980s where Bulgaria, Croatia and Romania had literacy levels below 97 per cent. By the year 2000 all countries increased literacy levels.

Table 2.: Literacy Rate, adult total (% of people ages 15 and above)

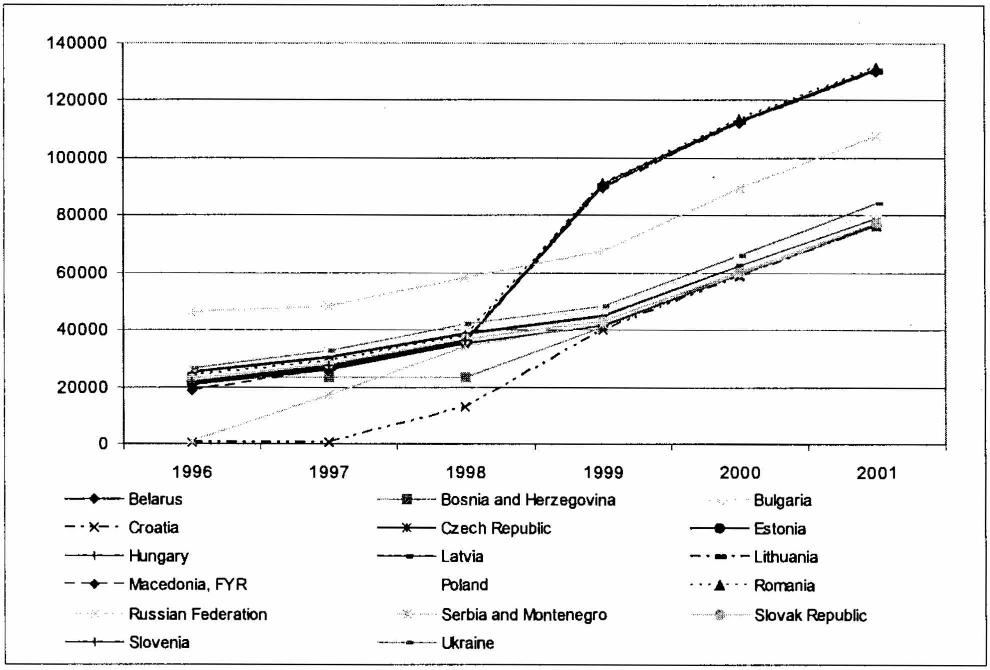
	1988	1991	1994	1997	2000
Belarus	99.42	99.49	99.55	99.61	99.65
Bosnia and Herzegovina	..	..	..	..	94.60
Bulgaria	96.82	97.32	97.73	98.08	98.41
Croatia	96.44	97.02	97.50	97.90	98.28
Estonia	99.80	99.79	99.79	99.79	99.80
Hungary	98.96	99.09	99.19	99.26	99.32
Latvia	99.79	99.79	99.79	99.80	99.75
Lithuania	99.24	99.34	99.42	99.49	99.56
Romania	96.78	97.18	97.51	97.81	98.13
Russian Federation	99.17	99.28	99.37	99.46	99.55
Slovak Republic	..	..	..	..	99.68
Slovenia	99.54	99.57	99.60	99.62	99.64
Ukraine	99.37	99.44	99.50	99.56	99.61

Source: WDI, 2004.

The problem with these figures is the definition of literacy, which is ability to understand, read and write a short, simple statement on their everyday life. From this World Bank definition of literacy it is obvious that literate people do not even have to finish elementary school. While this indicator may be indicative for low-income countries, it is very rough indicator for the selected countries. Nevertheless, it shows that majority of people receive at least basic education.

According to Griliches (1990: 1663) the purpose of patent system is 'to encourage invention and technical progress both by providing a temporary monopoly for the inventor and by forcing the early disclosure of the information necessary for the production of this item or the operation of the new process.' However there are some problems with using patents for economic analysis. The first is classification, which is primarily a technical problem. The problem is how to classify patent data; according to economically relevant industry or production groups? However, this is a matter of choice, methodology in use and available data. The other problem is much harder and refers to the fact that patents differ greatly in their technical and economic significance. Some patents refer only minor improvements of little economic value, while other patents prove extremely valuable.

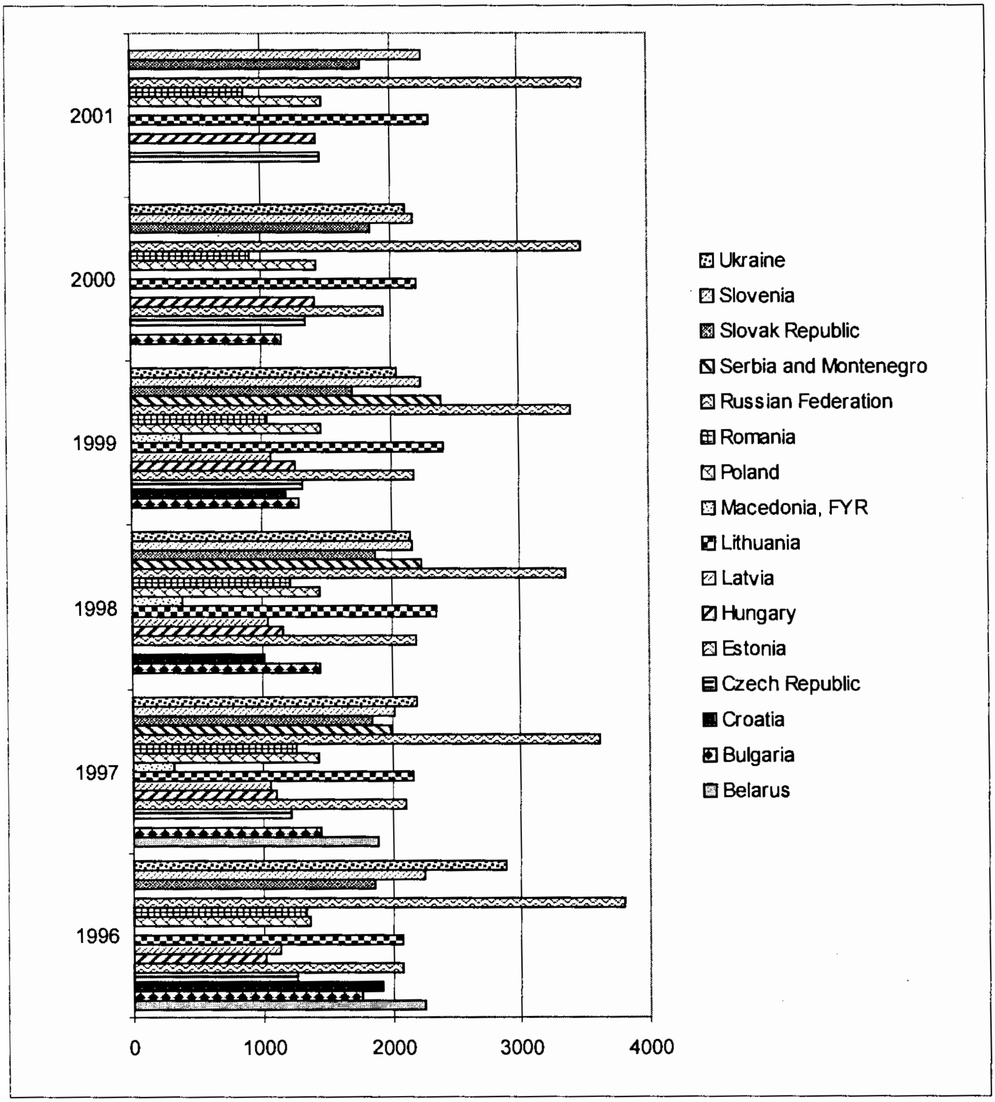
Figure 3.: Patent Applications (resident and non-resident)



Source: WDI, 2004.

While there are methodological issues with patent statistics, as with literacy figures, they can help in identification of innovative activity in countries. While we can observe (see figure 3) increasing patent applications in all countries, the majority, some 90 per cent, relate to non-residential applications. These are mostly connected to patent of multinational corporations, where their activities increased considerably during 1990s and later. While Russian Federation dominated in this area by the 1998, Slovenia, Slovakia, Romania, Macedonia, Lithuania and Latvia leapfrogged and over passed Russian Federation in subsequent years. Group of lower band of countries, among others includes Hungary and Czech Republic, which dominated previous categories, whiles this time, Slovenia is in the top bound of countries. However, as mentioned above, magnitude of patents cannot be distinguished from these figures.

Figure 4.: Researchers in R&D (per million people)



Source: WDI, 2004.

In terms of researchers in R&D per million people (see figure 4) we can observe absolute domination of Russian Federation, which is not surprising. Although research activity was historically high in Russian Federation, the activities were mostly concentrated in military complex with very few spin-offs to other sectors. This is true for almost all countries in the sample. However, in 1990s these activities shifted away from military toward more commercial areas. The domination in numbers is shown in Russian Federation by more than 3000 researchers in R&D per million people. Other countries lag behind considerably, however next best countries do not include Czech Republic and Hungary, while Estonia, Lithuania, Serbia and Montenegro, Slovenia and Ukraine dominate the group where there are roughly 2000 researchers in R&D or more. The number of researchers is influenced by passed decades, due to a mere fact that it takes a lot of time to produce people able to be involved in R&D. In terms of oscillation in numbers of researchers, all countries exhibit modest changes, either in positive or negative direction, while Croatia mysteriously 'lost' 900 people between 1996 and 19981. Furthermore, top performing transition economy, Slovenia, in this category as well exhibits advantage in comparison to Czech Republic and Hungary.

Table 3.: Research and Development Expenditure (% of GDP)

	1996	1997	1998	1999	2000	2001	2002
Bulgaria	0.52	0.52	0.59	0.59	0.55	..	0.52
Croatia	0.45	0.39	..	0.98	..	..	0.45
Czech Republic	1.03	1.24	..	1.24	1.33	1.31	1.03
Estonia	0.57	0.57	0.62	0.76	0.66	..	0.57
Hungary	0.65	0.72	0.68	0.69	0.80	0.95	..
Latvia	0.46	0.42	..	0.40	..	..	0.46
Lithuania	0.52	0.69	0.64	0.51	0.63	..	0.52
Poland	0.71	0.71	0.72	0.75	0.70	0.67	..
Romania	0.71	0.58	0.49	0.40	0.37	0.40	..
Russian Federation	0.90	0.99	0.92	1.01	1.05	1.16	..
Slovak Republic	1.03	0.83	1.00	0.74	0.61	0.62	1.03
Slovenia	1.44	1.42	1.48	1.51	1.52	1.63	1.44
Ukraine	..	1.19	..	..	0.95	..	..

Source: WDI, 2004.

When looking at figures of research and development expenditure as percentage of GDP (see table 3) we can see some interesting shifts in terms of dominating countries. Top country in this segment is Slovenia with far the highest portion of GDP for research and development, roughly around 1.5 percent for the observed period. Czech Republic and Russian Federation are next in line. While these two countries steadily increased the portion for R&D, Slovenia maintained high values throughout the observed period. Other countries are below one- percent share, and most of the remaining countries are around or below 0.5 per cent mark. For the countries with available data for 2002, Croatia is the poorest performing country in this category, while Slovenia remains at the top.

As far as enrolment ratios are concerned, we have used gross enrolment ratios. While net enrolment rates would be more favourable, they are harder to come by. Gross enrolment ratio is the ratio of total enrolment, regardless of age, to the population of the age group that officially corresponds to the level of education shown, while net enrolment ratio is the ratio of the number of children/students of official school age (as defined by the national education system) who are enrolled in school to the population of the corresponding official school age.

Table 4.: School Enrolment, secondary and tertiary (% gross)

	Secondary			Tertiary		
	1990	1995	2000	1990	1995	2000
Belarus	93.05	93.35	84.60	48	42	58
Bosnia and Herzegovina	65.00	67.94		15	16	..
Bulgaria	75.22	78.00	92.52	31	39	40
Croatia	76.18	81.85	89.66	24	28	34
Czech Republic	91.15	98.68	94.65	16	22	30
Estonia	101.94	103.70	110.09	26	38	59
Hungary	78.56	97.76	98.20	14	24	40
Latvia	92.74	84.98	92.64	25	27	64
Lithuania	91.85	84.20	98.45	34	28	59
Macedonia, FYR	55.74	60.91	84.56	17	19	24
Poland	81.46	96.32	101.27	22	35	55
Romania	92.02	77.90	82.31	10	18	27
Russian Federation	93.30	85.75	83.32	52	42	63
Serbia and Montenegro	63.42	63.50	88.72	18	20	36
Slovak Republic	87.40	93.75	87.33	19	20	30
Slovenia	91.13	90.54	106.36	24	34	61
Ukraine	92.79	92.61	96.15	47	42	53

Source: WDI, 2004.

The problem with the enrolment figures is that current enrolment measures the flow of schooling. The accumulation of these flows creates the future stock of human capital that has effects on economic activates (Barro, Lee, 1993: 366).

We can observe (see table 4) from the figures on enrolment that most countries increased secondary enrolment, but in Romania and Russian Federation secondary enrolment dropped in the observed period. However, secondary enrolment is volatile among the countries. Among the countries that joined the EU recently, secondary enrolments are higher than 90 per cent, with exception of Slovak Republic. Other countries are roughly between 80 and 90 percent. Tertiary enrolment increased in all countries; however, figures quite differ in magnitude. The highest tertiary enrolments are recorded for Latvia, Russian Federation and Slovenia. On the other hand, the lowest tertiary enrolments are recorded for Macedonia, Romania, Czech Republic and Slovak Republic.

As we could see from the indicators above, best performing transition countries have different positions for respective indicators. The difference is obvious between Slovenia, and Hungary and Czech Republic. Other countries are lagging behind in most categories. Furthermore, it could be said that performance by different countries in terms of above indicators is not common. However, in order to get more insight in these relations more formal econometric analysis is needed. It is obvious that countries that recently joined the EU have favourable trends and levels of indicators. These indicators are still mostly below those for top performing countries in the world.

Conclusion

In the provided analysis we can see a clear distinction in performance between countries that joined the EU in May 2004 and other countries in the sample. Furthermore, there is the difference among the best performing countries that joined the EU as well. They differ in high technology exports, both as percentage of manufacturing and in dollar terms, patent applications, researchers in R&D, R&D expenditures and enrolment figures. While Hungary and Czech Republic dominate high technology exports, Slovenia dominates in patent applications, researchers in R&D, expenditures on R&D and tertiary gross enrolment. It can be concluded that their growth performance stems from different sources of the observed indicators. This is not to say that either way is preferred because both yield results. Naturally country specific historical developments should not be forgotten as well.

Furthermore, it is interesting that Poland, the largest country to enter the EU in May 2004, both in terms of population and size, does not stand out in any of the categories. On the other hand, we have Russian Federation with its large backlog of technology potential that is standing far out in number of researchers, and stands relatively high in most of the other categories, but failed to capitalise on this potential during the observed period.

However, there are shortcomings of the selected indicators that should be taken into account when forming final conclusions. In terms of relation of selected indicators to GDP growth, more formal econometric analysis might be needed to get more insight and form better basis for final conclusions on this subject.

NOTE

[1] Data for 1997 is not available.

REFERENCES

Abramovitz, M., (1993), 'The Search for the Sources of Growth: Areas of Ignorance, Old and New', The Journal of Economic History, Vol. 53, No. 2, June, 217-243.

Barro, R. J., Lee, J-W., (1993), 'International Comparisons of Educational Attainment', Journal of Monetary Economics, Vol. 32, 363-394.

Griliches, Z., (1990), 'Patent Statistics as Economic Indicators: A Survey', Journal of Economic Literature, Vol. 28, No. 4, December, 1661-1707.

Sachs, J., (2000), 'A New Map of the World', The Economist, June 24th-30th 2000, pp.99-101.

World Development Indicators Database, (2004), World Bank, Washington.