INNOVATION – A SUCCESSFUL STRATEGY TO BOOST THE ECONOMIC GROWTH IN CENTRAL AND EASTERN EUROPEAN COUNTRIES?

Alexandru FOTIA
The Bucharest University of Economic Studies
6 Piata Romana, 010374 Bucharest, RO
alexandru.fotia@gmail.com

Abstract. *Innovation, technology transfers and R&D expenditures are the key factors for ensuring the economic growth and competitiveness of a country, in today's economy. The link between the R&D expenditures of a state and its economic performance has attracted vivid debates and a great deal of attention in the academic field for quite some time. The main purpose of this study is to show empirical evidence on the relationship between innovation and economic growth in Central and Eastern Europe. Therefore, we analyzed variables such as R&D expenditures, number of patents, the number of trademarks and the expenses on tertiary education in order to measure innovation in this set of countries. Our empirical findings provide in most cases evidence of a positive relationship between economic growth and innovation and are in line with the existing literature.*

Keywords: *innovation; research and development; economic growth; CEE countries.*

Introduction

It is undebatable that a wide range of contemporary economists has attributed the sustainable economic growth to the intensity of R&D activities of a country. In a more and more competitive globalized world, the increase of research and development expenditures is the key factor of a country's progress and long-term growth.

In the last decades, Central and Eastern European countries have experienced different economic growth and reconstruction phases, shifting from the socialist model based on the planned economy to the market economy model. At the beginning of their economic evolution journey, they seemed to be the "promised land" for the Western European investors due to their cheap and rather skilled labor force; in addition, they pursued extensive privatization programs and, ultimately, they offered access to a market of 100 million consumers.

Their experience showed that the transition process was harder than it was imagined, that is why their economic growth did not reach its initial forecasts. However, starting with the preliminary negotiations and continuing with the accession stage, the increased economic performance of these countries has again revived economic analysts' interest. The economists' attention was gained especially due to significant economic growth increases based on intensive investments in the research and development activity and through technology transfer from the more developed Western EU members.

Figure 1 shows that between 1990 and 2015, the aggregate GDP of CEE countries has continuously grown except for 2009 (a significant decrease of -4.36% compared to 2008) due to the global economic crisis. Given the big contraction in 2009, the trend of GDP growth has been negative, even though the amount of GDP was almost uninterruptedly increasing, the growth rate fluctuated from one year to another.

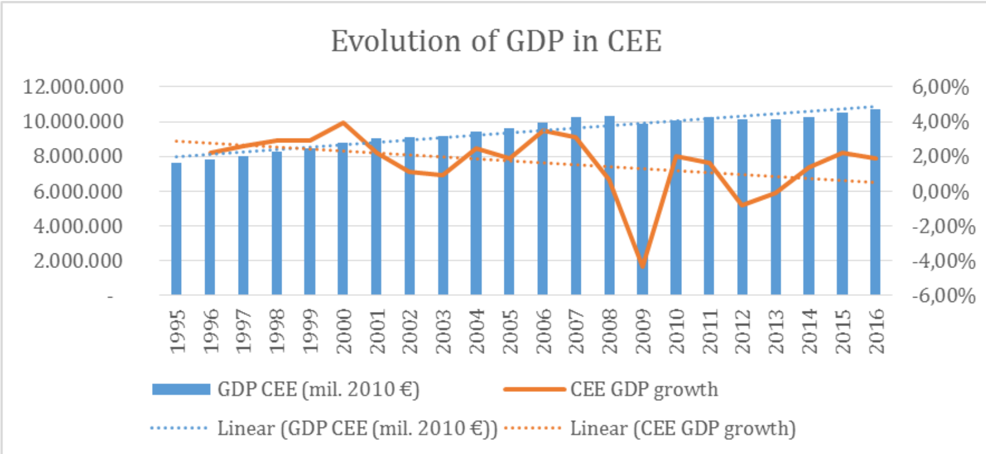

Figure 1. Evolution of GDP in CEE countries
(Author's calculation based on Eurostat data)

When comparing the growth rate of the GDP per capita in the CEE countries with the one in EU-15, Figure 2 shows a significant difference between the two, in favor of the former. In line with our research, Aghion et al. (2010) fully support the assumption that, in general, the countries which are catching up with the more advanced economies tend to growth faster because it is usually easier to imitate technologies which were pioneered in other countries than to innovate.

On the other hand, we want to research whether the CEE countries based their growth only on imitations and technology spillovers from more advanced economies or they themselves invested plenty economic resources in order to fuel their GDP per capita increase.

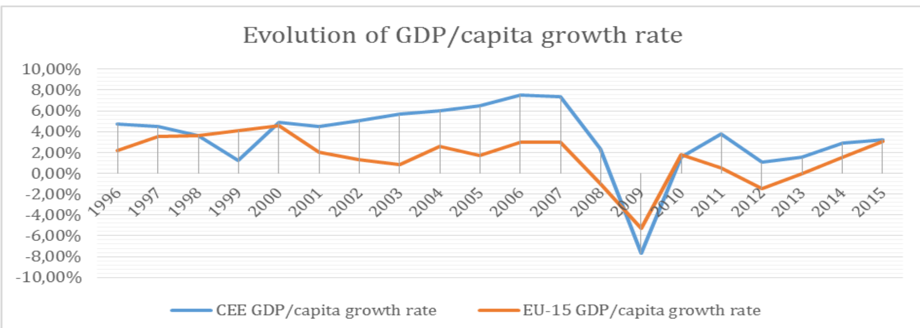

Figure 2. Evolution of GDP/capita growth rate
(Author's calculations based on World Bank data)

The aim of this paper is to study the link between economic growth and innovation for the Central and Eastern European countries. In order to measure innovation, we used the following variables: evolution of R&D expenditures, number of patents, number of trademarks, expenditures on tertiary education, enrolment in tertiary education, foreign direct investments (FDI) and unemployment in the mentioned countries.

The remaining of this article is structured as follows: Section 2 reviews the innovation related literature, Section 3 presents the database and the methodology, Section 4 presents the models and analyzes the empirical results obtained and Section 5 concludes.

Literature review

Innovation and economic growth

Economic growth has been a vivid subject for the theoreticians interested in the mechanisms through which a country expands its wealth. The theme was pioneered by Smith (1776), followed by Malthus (1798) and Ricardo (Ricardo, 1817). Their theories had been the cornerstones in this field for centuries.

Solow (1956) and Swan (1956) shed light on this subject, enriching the economic literature with the neoclassical model of growth. The "engine" of growth in their model was represented by the technological progress which was thought to be exogenous. This model assumed that a country's growth resides in combining the available stock of factors of production. Consequently, a country with limited capital can grow faster through the accumulation of new capital, whereas a country which has already accumulated capital does not gain too much by increasing its rate of accumulation, because of the decreasing returns to capital.

The remarkable works of Romer (1986) and Lucas (1988) managed to incorporate the technical progress into the model of growth, therefore this progress was not exogenous anymore. The significant contribution of the endogenous growth theory is linked to the possibility to explain why the technical progress is an important determinant of growth. Even though these two theories predict that the economic growth lays on the human capital accumulation (through learning by doing and investments in education), the novelty and innovation are not playing any role in growth.

The second generation of endogenous theories was based on the works of Romer (1990) and Aghion and Howitt (1992). They emphasized the differences between technological knowledge and other forms of capital and analyzed technological innovation as a separate activity towards economics and education. According to Aghion & Howitt's study (1992), economic growth is the result of innovations, skilled labor force and productivity of research.

These views are grounded on the remarkable work of Schumpeter (1934) who stated that the driving force of long-run growth in the product-variety paradigm is innovation. Schumpeter's growth theory comprises three important thoughts: growth is mainly generated by technological innovations, innovations are produced by entrepreneurs who seek rents and profits from them, new technologies drive out the old ones (in his view the growth model is centered on innovations whose aim is to improve the quality of the existing products considered to be obsolete, the term used by the author being *"creative destruction"*).

Grossman and Helpman (1991) deal with the concepts of innovation and imitation and create a model of endogenous growth where the economic growth is assumed to be equal to the aggregate rate of innovation.

In terms of empirical research, Nadiri (1993), using a Solow model, showed the connection between innovation, output and productivity growth, concluding that the economic growth is influenced by the growth rate of innovations, which are determined exogenously.

Innovation and international trade

In terms of innovation and international trade, it is necessary to classify the countries into two big categories: countries which are at the technological frontier and countries that are substantially behind it. Even though the previous research had tried to include the Central and Eastern European countries in one of the two categories, a straightforward answer was difficult to be obtained. For example, Petrariu et al. (2013) point out that the CEE countries still lag behind the Western European ones and they are still facing a catching up process in terms of innovation. It is important to note that in the analysis performed by Petrariu et al. (2013) were included some countries which do not belong to ours (e.g. Moldova, Macedonia and Serbia) – these countries are seen by the economic community as less developed (however, we acknowledge that in the recent years some progress were made in terms of approaching to the European Union's values and principles). On the other hand, judging by the fact that the countries we analyzed (except for Croatia) have been members of the European Union for at least 10 years (Croatia became an EU member in 2013), we assume that some technology flows came from the more developed Western European countries in this meantime, but we are aware that at the group level the countries we analyzed are still lagging behind their Western European counterparts.

According to Riviera – Batiz and Romer (1991), when we talk about the impact of international trade on growth in the developed countries through technological flows, the conclusions are straightforward: the technological progress is transmitted equally to all countries at the worldwide technological frontier and there is no room for variation in terms of the growth.

On the other hand, the debate is more passionate when the less developed countries are subject to this analysis. Even though the economic literature is structured into three different views on this broad theme, we will discuss in more detail only the one which we consider to be appropriate for the CEE countries. These different views are as follows: "trade as the enemy of growth", "trade as the 'handmaiden' of growth" and "trade as the engine of growth" (Blume & Durlauf, 2008).

As previously said, judging by the United Nations' definition of "less developed countries" it is certainly not the case of these 11 countries we analyzed in this study (United Nations, 2016). Furthermore, taken into account that since they become EU members these countries have experienced a continuous GDP growth compared to the period before accession (except for 2009 – the peak of the economic crisis). In addition, statistics showed that a big percentage of the international trade of this countries is made with international partners such as the United States or the Western European countries members of the European Union. To conclude, trade with more technologically advanced economies is definitely a vehicle for the flow of innovations from them to which ultimately drives growth in the countries under study. This view is consistent with the one of Romer (1993), even the question of the mechanisms through which firms in our set of countries integrates the new technologies. According to Grossman and Helpman (1991), firms develop an impressive imitative activity or buy or rent equipment which contains foreign knowledge.

Coe et al. (1997) include human capital in their analysis of R&D spillovers through international trade from developed countries to developing ones. However, they ignore domestic technology activity in developing countries in their estimation of productivity effects on the grounds that domestic R&D is small in developing countries and R&D data for these countries are not available (Xu & Chiang, 2005).

The most powerful countries in the world spend large amounts on R&D in order to generate innovations. Taking the United States' example, we undoubtedly notice that R&D expenditures represented between 2.4 and 2.9 per cent of GDP every year from 1996 to 2014 (according to World Bank database). Even though, it is important to note that there are very few countries in the world that constantly produce innovations (Blume & Durlauf, 2008). In most of the countries, technology does not advance too significantly through disruptive innovations (Schivardi & Schneider, 2008), but by implementing new technologies developed in another part of the world. One important aspect to be mentioned is that even in this case, the implementation has its own costs because technologies tend to depend on the context they have been created and the knowledge tends to be tacit. Therefore, implementation brings with it an upfront investment to adapt the technology to a new environment (Evenson & Westphal, 1995). The same applies to countries.

Judging from the perspective brought by Gerschenkron (1962), who proposed the term "advantage of backwardness", the further the countries fall behind the world's technology frontier, the faster they will grow with any given level of implementation expenditures, because the bigger is the improvement in productivity when they implement any given foreign technology.

As shown by Howitt (2000), countries that will develop R&D activities will growth at the same rate, whilst those which will not perform such investments will probably stagnate. Even though there are some countries which allocate money for implementation expenditure, there is no guarantee that the technology gap between them and the rich countries will close because the innovations performed in these rich countries may not be appropriate for the needs of the implementing states (Basu & Weil, 1998; Acemoglu & Zilibotti, 2001).

Database and methodology

The outcome of this paper is to show the strong link between the level of innovation and the economic growth, based on an analysis performed in the Central and Eastern European countries.

The vast literature which studied the connection between innovation and growth focused mainly on the country behavior observed mainly in the rich economies such as United States, Japan, or some Western European countries (see for example (Mansfield, 1972) or (Crafts, 2003)). The CEE region was neglected by the empirical studies especially due to the lack of information about the major macroeconomic indicators, given the fact that all the countries in this region were under the communist rule until 1989.

Our study was conducted in 11 countries from CEE (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia). The period taken into account was 1990-2015, a time span long enough in order to have an in-depth analysis. The main source of data was the database provided by the World Bank. Due to the poor country reporting back in the 1990s there are some datasets which are not fully complete. However, our analysis was not biased by the missing data.

The variables analyzed in this study are specified in Table 1. The descriptive statistics of the variables for the period 1990-2015 are presented in Table 2 below.

Table 1. The variables analyzed in this study (Author's calculations)

Variable	Explanation
GDPcapita	The GDP per capita for each of CEE state (constant 2011 international $)
GDPgrowth	GDP growth from year to year for each CEE state
Education	The percent of education expenditure in GDP for each CEE state
TertiaryEducation	Expenditure on tertiary education, as a percentage of government expenditure on education
TertiaryEnrollment	School enrollment in the tertiary education sector, as a percentage of total school enrollment
FDI	The percent of net inflow Foreign Direct Investment in GDP for each CEE state
Unemployment	Unemployment for each CEE state
HDI	Human Development Index
R&D	The percent of R&D expenditure in GDP for each CEE state
Patents	Total number of patents for each CEE state
Trademarks	Total number of trademarks for each CEE state

GDP growth rate measures how fast the economy is growing, namely which is the annual change in GDP. GDP growth is considered to be a good measure for an economy at a given moment. Stern et al. (2000) note that GDP per capita is an estimate of the size of the technological development of a country.

A patent represents the sole right or the title conferred by a government authority for a set period to exclude others from making, using, or selling an invention. On the other hand, a trademark is a symbol, word, or words legally registered or established by use as representing a company or product. The number of patents and the number of trademarks usually testify the innovative capacity of a country.

The amount of R&D expenditure of a country is a good indicator to quantify its governmental policy towards innovations and economic progress. The higher the R&D expenditures, the more developed a country is. In the same vein, judging from a theoretical perspective, the higher the expenditures on tertiary education, the greater the capacity of a country to turn the research into innovations.

Unemployment is used in our models as a control variable due to its negative correlation with economic growth and innovation, respectively.

Table 2. The descriptive statistics of the variables analyzed (Author's calculations, based on World Bank data)

Variable	Mean	Median	Minimum	Maximum	Std. Dev.
GDPcapita (PPP, constant 2011 int. $)	18.361	18.280	8.002	31.138	5.901
GDDgrowth (% annual change)	2,8532	3,5822	-14,8142	11,8894	4,5156
Education (as % of GDP)	4,6604	4,7422	2,3256	6,6874	0,8420
TertiaryEducation (as % of gov. expend. on educ.)	19,7758	19,6260	11,1425	28,9826	3,3800
TertiaryEnrollment (as % of total enrollment)	47,0580	45,8411	8,4070	88,4635	20,6466
FDI (net inflows, as % of GDP)	4,5907	3,5530	-16,0708	50,7415	5,8031
Unemployment (as % of total labor force)	10,5470	10,1000	1,5000	21,4000	4,0438
HDI	0,7787	0,7840	0,6630	0,8900	0,0558
R&D (as % of GDP)	0,8599	0,7424	0,3520	2,6039	0,4489
Patents (number)	686	289	12	4.676	886
Trademarks (number)	3.793	2.161	1	14.708	3.759

In order to capture the most from the empirical analysis and judging by the database typology, we used panel data regression models (significance level of 5%). Firstly, a pooled regression was computed in order to analyze the situation of all the CEE countries included in the model. Then, we checked for fixed effects among both cross-section and times series in order to find whether there are specific effects coming either from each country or over time between countries which can influence our findings. A number of three regressions for each model has been computed in order to check the three possible situations: cross-section series fixed effects, time series fixed effect and, ultimately, both cross-section and time series fixed effects. Results showed no significantly different parameters compared to the initial regression due to an approximately economic evolution of the countries under scrutiny in the period analyzed. However, we will present the full data in the results tables below.

Moreover, we also checked for random effects using the same algorithm as for the fixed effects. In this case, only two regressions were computed for each model due to the unbalanced typology of the database. In order to verify the data consistency, we used the Hausman test. The results were that some regression models with random effects are more conclusive then some of the fixed effects models. Lastly, we used the Wald test in order to check whether the pooled regression or the fixed effects model was appropriate (if was the case).

Models and empirical results

We conducted a total of six analyses based on the recent existing literature (see inter alia Petrariu et al. (2013) or Pece et al. (2015), expanding the literature with two models grounded on the impact the tertiary education sector has on the economic growth.

The models are described below:

Model 1

$$\log GDPcapita_{it} = c + \beta_1 \log Patents_{it} + \beta_2 \log Trademarks_{it} + \beta_3 R\&D_{it} + \varepsilon_{it}$$

Model 2

$$GDPcapita_{it} = c + \beta_1\ TertiaryEducationExpenditures_{it} + \beta_2\ Unemployment_{it} + \varepsilon_{it}$$

Model 3

$$GDPcapita_{it} = c + \beta_1\ TertiaryEnrollment_{it} + \beta_2\ Unemployment_{it} + \varepsilon_{it}$$

Model 4

$$\log Patents_{it} = c + \beta_1\ R\&D_{it} + \beta_2 \log GDPcapita_{it} + \beta_3\ EducationExpenditures_{it} + \beta_4\ FDIadj*_{it} + \beta_5\ Unemployment_{it} + \varepsilon_{it}$$

Model 5

$$\log Trademarks_{it} = c + \beta_1\, R\&D_{it} + \beta_2 \log GDPcapita_{it} + \beta_3\, EducationExpenditures_{it} + \beta_4\, FDIadj*_{it} + \beta_5\, Unemployment_{it} + \varepsilon_{it}$$

Model 6

$$GDPgrowth_{it} = c + \beta_1 \log Patents_{it} + \beta_2 \log Trademarks_{it} + \beta_3\, R\&D_{it} + \beta_4\, FDIadj*_{it} + \beta_5\, HDI_{it} + \beta_6\, EducationExpenditures_{it} + \beta_7\, Unemployment_{it} + \varepsilon_{it}$$

*We used FDIadj instead of FDI because we eliminated from the dataset the outliers (BG 2007, HU 2007, 2008).

Regarding *model 1*, the fixed effects regression explained better the correlation of the independent and the dependent variable. Therefore, all three models presented in Table 3 surprisingly show that there is a negative and insignificant relationship between the number of patents and the increase in GDP per capita *the* conclusions are in line with theory and with the empirical studies made. R&D expenditures are positively related to the GDP per capita growth, except for the cross-section and period fixed effects regression. The greater the allocation of governmental funds toward research and development, the higher the economic growth in CEE countries.

Table 3. The results of the model 1
(Author's calculations, based on computing data in Eviews)

Variable (coefficient & p-value)	Pooled regression	Cross-section fixed effects regression	Period fixed effects regression	Cross-section and period fixed effects regression
C	8,860608	5,548753	9,451217	9,396509
	0,000000	0,000000	0,000000	0,000000
LogPatents	-0,047672	-0,035483	0,012512	0,040946
	0,022300	0,456400	0,440100	0,094900
LogTrademarks	0,096152	0,517514	-0,009221	0,027677
	0,001100	0,000000	0,689100	0,399200
R&D	0,553551	0,414983	0,435831	-0,047169
	0,000000	0,000000	0,000000	0,153400
R squared	0,494148	0,754380	0,751013	0,950927
Adjusted R squared	0,486445	0,737305	0,721803	0,941926

For the *model 2,* we firstly ran a regression where we included the education expenditures itself as a percentage of GDP. This model explained only 21% of the evolution of the GDP per capita of the countries under scrutiny. Therefore, we introduced in the model the expenditures for tertiary education (as a percentage of total education expenditures). This new model explains 44% of the trend of GDP per capita. When checking the regressions with the Hausman test, the results are interesting: the random effects model is more suitable when the cross-country differences are taken into account and the fixed effects model is more appropriate when checking for variations through time. Therefore, in both cases, the expenditures on tertiary education are statistically significant and positively correlated with the GDP per capita increase, contrary to the opinion of Aghion et al. (2010) who consider that the CEE countries grew based on the investment in primary and secondary education, not in high education.

The results presented by *model 3* are in line with the findings made in *model 2*. The above situations happen again: when the cross-country differences are taken into account, the random effects are more suitable and when time variations are checked the fixed effects model is more appropriate. The conclusion after running this mode is that enrollment in tertiary education is a prerequisite in order for a country to experience economic growth

Unemployment was used as a proxy in *models 2 and 3*. As previously demonstrated by the empirical literature, unemployment strongly affects economic growth.

Models 4 and 5 focus on the link between the output of innovation (patents and trademarks) and the economic growth. These models follow the one proposed by Petrariu et al. (2013), with the only exception that we eliminated HDI from them due to the fact that GDP per capita is also taken into account when calculating HDI. Furthermore, the correlation between the two variables was 0.80. For a better estimation of the relationships in models *4 and 5,* we used the random effects models. The conclusions are different for the two models; therefore, we will present them distinctly.

The cross-section random effects of the *model 4* show a positive correlation between the number of patents produced on one hand and the research and development expenditures, on the other. The other four independent variables have also a positive, but the insignificant relation with the number of patents (surprisingly, unemployment and FDI depict the same positive link, which is in contrast with the evidence found in the literature).

On the other hand, the period random effects of the *model 4* present a negative connection between the number of patens and education expenditure, FDI, unemployment and R&D expenditures (only the first two variables are significant in this case). In this case, FDI negatively affects the production of patents due to the fact that the foreign companies are not interested in focusing on local R&D activities. On contrary, they import already produced Western European technologies.

The cross-section and the period random effects of the *model 5* also depict contrasting findings. In the former, the number of trademarks produced is negatively related to the R&D funds allocated and the unemployment (statistically insignificant). There is a positive link between the increase of GDP per capita and the increase in the number of trademarks produced. In the latter, the R&D expenditures are again negative correlated with the trademarks, whereas the increase of GDP per capita impact positively the production of trademarks.

The results of the *model 6* are presented in Table 4. The connection between GDP growth and innovation is best explained (with an adjusted R^2 is 73%) by the cross-section and period fixed effects regression which show that there is a positive correlation of GDP growth to trademarks, R&D, and FDI, surprisingly. R&D and the number of patents produced have a negative impact on GDP growth, this suggesting the existence of a catch-up process according to Petrariu et al. (2013). This is a clear sign that a large amount of innovation was actually imported from the Western European countries, not produced in-house.

Table 4. The results of the model 1
(Author's calculations, based on computing data in Eviews)

Variable (coefficient & p-value)	Pooled regression	Cross-section fixed effects regression	Period fixed effects regression	Cross-section and period fixed effects regression
C	17,441830	57,874330	0,730300	76,376810
	0,055800	0,000000	0,940200	0,001100
LogPatents	-0,830844	-5,849705	-0,880390	-3,546948
	0,113900	0,000000	0,010600	0,000300
LogTrademarks	0,698183	6,181159	0,911361	1,740456
	0,349700	0,000900	0,078800	0,217600
R&D	-0,893982	3,768548	-1,345497	2,087425
	0,418500	0,029100	0,072500	0,080500
FDIadj	0,213136	0,215788	0,001884	0,062584
	0,018800	0,021500	0,975200	0,347600
HDI	-19,008340	-72,457080	2,282587	-73,619890
	0,058300	0,000000	0,842500	0,001700
EducationExpenditure	0,200218	-3,352221	0,173922	-1,396482
	0,666700	0,000000	0,604400	0,011400
Unemployment	-0,088318	-0,135996	-0,095494	-0,334534
	0,345100	0,204500	0,140700	0,000200
R squared	0,144338	0,424963	0,712409	0,793860
Adjusted R squared	0,102743	0,352010	0,658061	0,733956

Conclusions

The purpose of our study was to determine if innovation was a strategy in order to boost the economic performance of the Central and Eastern European countries. There are some empirical models which support the existing literature, but there are also differences related to the previous findings. These disparities are due to the fact that the previous studies analyzed different countries in Central and Eastern Europe, they focused on the shorter period of time and did not take into account the heterogeneity between countries.

The conclusions of our study show that the economic growth experienced by the CEE countries during the period 1990-2015 was based on a high proportion of technology transfers and knowledge inflows from the developed countries. Even though the CEE countries were seen as being "latecomers" in the innovation process, they used the innovation strategies in order to foster the macroeconomic indicators, trying permanently to catch-up the Western European countries' performances. Future looks as challenging as the past was: despite some progress has been made, the CEE countries still lag behind many of their European Union neighbors. They have not only to continue the imitation process in terms of innovation but to develop new strategies to boost their economic output in order to increase their competitiveness.

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