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Innovation and economic growth: An empirical analysis for CEE countries

Andreea Maria Pece[a]*, Olivera Ecaterina Oros Simona[b], Florina Salisteanu[c]

[a]*PhD candidate, Finance Department, Faculty of Economics Sciences and Business Administration, Babes-Bolyai University, Cluj-Napoca, Romania*

[b]*PhD candidate, Accounting Department, Faculty of Economics, Valahia University, Targoviste, Romania*

[c]*PhD candidate, Accounting Department, Faculty of Economics, Valahia University, Targoviste, Romania*

Abstract

The innovation, R&D expenditures and the investments in technology are premises for ensuring competitiveness and progress, and through them a sustainable economic growth. A sustained level of education of the workforce, increasing investments in research area, the creation of the new products and the facile access of investors to stock markets, firstly, will ensure the development of the private and public sectors, and secondly, will improve the living conditions of the population. The purpose of this paper is to analyze if the long term economic growth is influenced by the innovation potential of an economy. Our analysis was performed by using multiple regression models estimated for the following CEE countries, namely Poland, Czech Republic and Hungary. In order to quantify the innovation we have used various variables, such as number of patents, number of trademarks, R&D expenditures. The results provide evidence of a positive relationship between economic growth and innovation.
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Keywords: economic growth, innovation, education, research and development, CEE countries.

1. Introduction

The advantages offered by the globalization, the development of information technology and media represent the premises for economic growth and for the improvement of companies' financial performance (OECD, 2007). Thus, we mention that innovation and technology, the increase in research and development expenditures are the

* Andreea Maria Pece. Tel.: +4-345-5444-343
*E-mail address:*andreeapece@yahoo.com

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prerequisites for ensuring competitiveness and progress, and through them a sustainable economic growth. Furthermore, a sustained training level of workforce, an increase in the level of investments, facile access of investors to stock markets will generate positive effects, firstly, on the private and public sectors development and secondly, on the improvement of standards of living of the population. We consider relevant the assumptions of (Gurbiel, 2002), according to which the innovation potential of an economy is influenced by both macroeconomic and microeconomic factors: GDP/capita, R&D expenditures, international trade, competitiveness, technological gap, level of profit recorded by foreign companies in a country.

According to (OECD, 2007) the innovation and the increase in the level of R&D expenditures are influenced by the following factors:

- adequate rules regarding market competition, which stimulates innovation, in conjunction with an adequate level of foreign direct investment, so as to stimulate cross-border transfers of information;
- the existence of a stable economic climate and low real interest rates to encourage innovation activity by creating a stable environment for investment in sectors that support the development of technology and information;
- availability for internal and external funding;
- the expansion of public research, which can further support the research in private sector, which will require adequate human resources
- tax incentives for companies that have as main object of activity, research and development;
- usage of foreign capital for R&D, which is associated with higher levels of productivity.

Moreover, we focus our attention on the Schumpeter mentions, that refer to the concept of "creative destruction", according to which innovations replace old products and technologies, having a positive impact on the turnover evolution. Therefore, the competition in the market caused by the entry of new innovations and the exclusion of old technologies, comes to support the strengthen of economic growth (Aghion et al., 2010).

The financial literature (Cameron, 1998) highlighted the externalities arising from innovations:

- technology spillover effect, which reduces the cost of competitors, imperfect patent, movement of skilled labor force to other companies;
- the failure of companies to acquire all the social gains generated by innovations;
- the replacement effect generated by innovations, in that new ideas will make the current production technologies to become old.

The objective of the current paper is to examine the connection between economic growth and innovation for some Central and Eastern European countries, namely: Poland, Czech Republic and Hungary. In order to quantify the innovation, we have used the following variables: the evolution of R&D expenditures, number of trademarks, number of patents. The paper is structured as follows: Section 2 reviews the financial literature, Section 3 presents the data and the methodology, Section 4 analyzes the empirical results obtained and Section 5, concludes.

2. Literature Review

The connection between economic growth and innovation presents a great interest for researchers, as a result, the concept is a well debated topic in the financial literature. This concept has its origin in the research realized by (Solow, 1956), who pointed out the existence of a long term relationship between economic growth and innovation. (Schumpeter, 1912, 1939) makes the distinction between economic growth and economic development. Thus, from his point of view, the economic growth represents a slowly and progressive change of the economic system, resulting from exogenous factors of the economic system and on the other hand, the economic development which is generated by discontinuous internal changes caused by economic innovations, coming from the economic system. The economic growth model developed by Schumpeter argues competition through innovation and the importance of education in ensuring economic growth, these assumptions are supported also by empirical studies (Aghion et al., 2005, 2009).

Furthermore, on the one hand, the financial literature (Wong, P.K., et al., 2005) refers to theoretical models (Solow, 1956; Romer, 1986), which examines the connection between technological innovation and economic growth. In the neoclassical model of (Solow, 1956), the economic growth is sustained by capital and labor force. (Nadiri, 1993) has used a Cobb-Douglas function to highlight the link between innovation, output and productivity growth. In this model, the economic growth is influenced by the growth rate of innovations, which are determined exogenously. On the other hand, in the endogenous growth model developed by (Romer, 1986) the economic growth is endogenously determined and is influenced by agents' decisions to maximize profits, taking into consideration aspects related to entrepreneurship by modeling the innovation process based on microeconomic data.

The empirical studies from the financial literature that pointed out the relationship between economic growth, innovation, the research and development expenditures, make references both to developed and emerging markets, using both macroeconomic and microeconomic data.

Ulku, H. (2004) has investigate the relationship between economic growth, research and development expenditures, innovation for 20 OECD countries and 10 countries that are not OECD members, by applying the model that was proposed by (Romer, 1986), by using a panel model, built on GMM methodology. The study was conducted for the period 1981-1997 and tested the following assumptions: the research and development expenditures increase the level of innovations and the latter lead to permanent growth of GDP/capita. The results obtained provide evidence that innovations have a positive impact on GDP/capita, both for developed and emerging economies. Another conclusion was that only developed OECD countries can increase the level of innovation based on research and development expenditures, and furthermore, there is an interdependence between OECD countries, since some countries ensure their innovation by using the know-how of other OECD countries. Furthermore, the innovation is created endogenous in an economy and support the economic growth, but the assumption of the existence of constant yields of innovation is not sustained, indicating that innovation leads to an increase in the output for a short period of time, and cannot explain the perpetual economic growth.

Another research that investigates the connection between economic growth and innovation was developed by (Pessoa, 2007), who has focused on the role of the research and development expenditures in the relationship between innovation and economic growth in the case of Sweden and Ireland. The findings suggest that there is not a strong link between research and development expenditures and economic growth, and the innovation policy must take into consideration the complexity of economic growth process, by including other indicators, in addition to research and development expenditures.

Another study realized by (Westmore, 2013) was aimed to investigate the determinants of R&D expenditures and patents and the link between innovation and economic growth, by using a panel model, based on a sample of 19 OECD countries, during the period 1980-2008. The empirical results provide evidence that tax incentives and public support for research and development and for patent rights encourage innovation activities in private sector. Moreover, the results have not identified a direct effect of these policies on aggregate productivity growth. Also, the policies that support competition are important for the transmission of knowledge from both sources, both domestic and external.

Regarding the Central and Eastern European countries, (Petrariu et al, 2013) have examined the connection between economic growth and innovation, by using a panel model. Their findings indicated that the level of development of an economy, reflected in the allocation of resources for research and development is the main support for innovation. The results pointed out that Central and Eastern European economies recorded fast economic growth, but it was not based on the innovation process. Compared with the growth rate, innovation is seen as a catch-up process.

Furthermore, we focus our attention on the studies that were performed by using microeconomic data. (Norris, et al., 2010) have analyzed the innovation process for manufacturing industry from both developed and emerging countries, during the period 2005-2007. The authors have concluded that innovation has a major impact on financial performance of the companies. Furthermore, the authors have analyzed the connections between innovation, performance and capital markets and concluded that the positive effect of innovation on companies' performance is mediated through capital markets. The positive effect of innovation on productivity is significantly higher in countries with developed capital markets. Further, their findings showed that financial development may influence economic growth through the facility provided by technological innovations that will boost productivity. Another research was performed by (Czarnitzki and Toivanen, 2013) who have analyzed the link between economic growth

and research and development investments in the case of Germany and Belgium. The results indicated that public investments in research and development stimulate private investments and the effects vary based on experience in corporate innovation activity and the level of labor productivity from the past. Another research, using micro-level data for nineteen US manufacturing industries over the period 1975 to 2000, was conducted by (Minniti, Venturini, 2013). As indicator for innovation has been used the number of patents granted annually for each industry analyzed. The results obtained showed that the impact of tax incentives for research and development activity is lengthy. Furthermore, the subsidies awarded to for research activities increase the research and development efforts and the economic growth rate, but only for short term. For a long time horizon, this research and development policy does not have a significant effect, in the best case it is noted that subsidies for research and development activities have a temporary effects on growth. Studies from the financial literature pointed out that research and development policy supported more endogenous growth theory than semi-endogenous growth theory.

Finally, we review the innovation process from stock markets, which is achieved through the venture capital investments. Empirical evidences from financial literature (OECD, 2006) indicated that venture capital ensure the progress only in an economy with a high level of innovation and appropriate legal regulations. In developed markets, both in the US and Europe, venture capital investments are performed by institutional investors and banks. The development of capital markets and their role in achieving public offers represent premises for venture capital investments. Furthermore, the achievement of such venture capital in newly created companies, but with a high growth potential, assume the existence of specialized capital markets in the listing of companies with a high growth potential.

3. Data and methodology

The main objective of this paper is to quantify the connection between economic growth, innovations,

investments and human capital for the major economies from Central and Eastern Europe, respectively: Poland, Czech Republic and Hungary. The data source is Eurostat, the research was conducted at an individual level, by taking into consideration the time period 2000-2013. The main variable used to quantify innovation was the level of research and development expenditures, as a major factor of progress in an economy.

The variables used in the current study , can be observed in the below table:

Table 1 Variables used to quantify the connection between economic growth and innovation

Variable	Explanation
GDP	Logarithmic value of GDP
Number of patents	Annual number of registered patents
Number of trademarks	Annual number of registered trademarks
Research and development expenditures EUR/capita	Research and development expenditures EUR/capita
Research and development expenditures	The share of research and development expenditures in total expenditures
FDI	Logarithmic value of the foreign direct investment stock
The share of population with tertiary education in the total active population	The share of population with tertiary education in the total active population
Unemployment rate	Unemployment rate
Exports	Logarithmic value of exports

Source: Authors' calculations

The regressions used to estimate the connection between economic growth, innovation, foreign direct investments, education, labour force and the level of exports can be observed below:

$$GDP = c + \alpha \times Patents + \beta \times Trademarks + \gamma \times Research\ and\ development\ expenditures + \varepsilon_t\ (1)$$

$$GDP = c + \alpha \times FDI + \varepsilon_t\ (2)$$

$$GDP = c + \alpha \times Research\ and\ development\ expenditures \frac{EUR}{capita} + \varepsilon_t (3)$$

$$GDP = c + \alpha \times \frac{Population\ with\ tertiary\ education}{Total\ active\ population} + \varepsilon_t\ (4)$$

$$GDP = c + \alpha \times Unemployment\ rate + \beta \times Exports + \varepsilon_t\ (5)$$

4. Empirical results

The empirical results obtained from testing the connection between economic growth and its main determinants, respectively: innovation, foreign direct investment, human capital and exports for the Central and Eastern European economies are presented in the tables below.

Table 2 Regression results for the connection between economic growth and its determinants in the case of Poland

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
c	12.659 (45.635)***	6.839 (12.429)***	12.058 (96.695)***	11.350 (100.96)***	7.869 (6.277)***
$Number\ of\ patents$	0.001 (2.230)***				
$Number\ of\ trademarks$	0.0001 (0.111)				
$R\&D\ Expenditures$	0.683 (1.914)*				
FDI		0.495 (10.296)***			
$R\&D\ Expenditures\ EUR/capita$			0.026 (3.925)***		
$Pop.with\ \ tertiary\ education/Active\ pop.$				5.124 (10.496)***	
$Unemployment\ rate$					-0.015 (-1.412)
$Exports$					0.427 (4.279)***
$Adj.R^2$	0.897	0.889	0.562	0.893	0.888

Source: Authors' calculations, ***,** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

The results pointed out that the economic growth is influenced by the following factors: innovations (quantified by number of patents and the level of research and development expenditures), foreign direct investments stock, education and exports. The education has a significant impact on economic growth.

Table 3 Regression results for the connection between economic growth and its determinants in the case of Czech Republic

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
c	10.718 (26.143)***	4.336 (12.459)***	10.609 (57.875)***	10.158 (41.243)***	4.018 (4.965)***
$Number\ of\ patents$	0.005 (3.981)***				
$Number\ of\ trademarks$	0.0002 (0.777)				

$R\&D\ Expenditures$	0.064 (0.201)				
FDI		0.660 (20.876)***			
$R\&D\ Expenditures\ EUR/capita$			0.010 (5.579)***		
$Pop.with\ \ tertiary\ education/Active\ pop.$				8.599 (5.942)***	
$Unemployment\ rate$					-0.006 (-0.249)
$Exports$					0.683 (11.134)***
$Adj.R^2$	0.929	0.971	0.698	0.725	0.942

Source: Authors' calculations, ***,** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

The results highlighted a positive impact of innovation on the evolution of economic growth. Furthermore, the findings support a strong and positive relationship between the quality of human capital and economic growth.

Table 4 Regression results for the connection between economic growth and its determinants in the case of Hungary

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
c	10.325 (24.204)***	4.020 (4.590)***	10.888 (72.720)***	9.722 (29.323)***	3.142 (2.139)*
$Number\ of\ patents$	0.006 (2.056)*				
$Number\ of\ trademarks$	0.0002 (0.306)				
$R\&D\ Expenditures$	0.025 (0.092)				
FDI		0.669 (8.316)***			
$R\&D\ Expenditures\ EUR/capita$			0.008 (2.942)**		
$Pop.with\ \ tertiary\ education/Active\ pop.$				6.595 (4.795)***	
$Unemployment\ rate$					-0.021 (-0.868)
$Exports$					0.763 (5.111)***
$Adj.R^2$	0.715	0.839	0.371	0.628	0.832

Source: Authors' calculations, ***,** and * represent statistical significance at the 1%, 5% and 10% levels, respectively.

Similar to the case of Czech Republic, the results obtained provide evidence of a positive link between economic growth and innovations. Furthermore, the results indicated a positive relationship between foreign direct investments stocks, research and development expenditure expressed in EUR/capita and exports. We note that the most important factor that influences economic growth is the quality of human capital.

5. Conclusions

The purpose of this paper was to examine the existence of the connection between economic growth and innovation for the economies from Central and Eastern Europe, namely: Poland, Czech Republic and Hungary. The economic development of an economy is influenced by the innovation degree, the allocation of resources for research and development activities, the quality of human capital and by foreign direct investments stock.

We have analyzed the relationship between economic growth and its main determinants by using a single country analysis, based on multiple regressions. The results have provided evidence of a positive connection between economic growth and innovations. Furthermore, we have concluded that foreign direct investments have a major

impact on economic growth through knowledge transfer and improvement of technological processes. Moreover, the results highlighted that education and human capital have a positive and strong impact on economic growth. We finalize by mention that the results obtained sustain the endogenous growth model, because the output of the model confirms a positive connection between economic growth and innovation.

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