Does Innovation Capacity Constraint Economic Growth in Republic of Macedonia

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Abstract

The main goal of the paper is to answer the question if the lack of innovation capacity and low productivity is binding constraint to economic growth of Macedonian economy. To fulfill this goal we use two empirical techniques. Growth accounting production approach is a useful technique which estimate the relative contribution of technological progress to economic growth rate and allow us to identify the current growth pattern. The estimated results by applying growth accounting based of decomposition production approach show that the capital accumulation has significant contribution to growth of Macedonian economy. But, what is more worrying here is the fact that capital accumulation based on recent investment is not appropriately followed by technological progress, giving us a strong argument that this capital structure is not capable to promote the long-run economic growth. For illustration, our estimated results show that the contribution of technological progress as a part of total factor productivity is negligible (only 8,5% of the average rate of economic growth in the analyzed period is based on technological progress) compare with its contribution in more developed countries.

The other method that was used in the paper so as to fulfill the main goal of the paper is the international benchmark analysis. This empirical tool allowed us to investigate the innovation capacity of Macedonian economy in a comparative manner with the countries in the wide region via number of patent's application and firms' capacity for adaptation and transfer of new technology. The number of registered patents is much larger than expected from a country with such a size and development level as Republic of Macedonia, but the analyze of applicants structure show that non-resident applicants are a bit larger than the resident applicants, indicating that domestic science and R&D sector is not enough competitive.Additionally, the analysis indicates the Macedonian companies lagging behind the companies in more countries in the region regarding the expenditure *on R&D and the abilities to adopt new technology. This paper tend to give a useful insights to policymakers in Macedonia that the process of creation national innovation system.*

JEL classification: O47, O3, O32, O38

Keywords: *Economic growth, innovation capacity, growth accounting, comparative analysis, Republic of Macedonia*

1. INTRODUCTION

The main goal of the paper is to answer the question if the leak of innovation capacity and low productivity is binding constraint to economic growth of Macedonian economy by applying the growth diagnostic approach. This approach is significantly different from growth theory and empirics. It is based on the idea to identify the country specific factors that constrain economic growth, instead of investigating the factors that determine economic growth in the average country. According to this approach, there might be several variables that constraint economic growth in the same time, and the main challenge of researchers in this field have to be directed to identifying the most binding constraint to economic growth. In the context, our task is to investigate the innovation capacity of Macedonian economy and try to answer whether theleak of functional and efficient national innovation system and appropriate innovation performance is the most binding constraint to economic growth.

To fulfill this goal we use two empirical techniques. Growth accounting production approach is very useful technique which estimates the relative contribution of production factors (physical capital, labor force and total factor productivity)with the specific focus on the investigation of technological progress contribution to economic growth rate. This empirical tool will allow us to analyze current growth pattern by decomposing the growth sources as a basic fundament for identification of the bottlenecks that constraint the sustainable economic growth in long run.

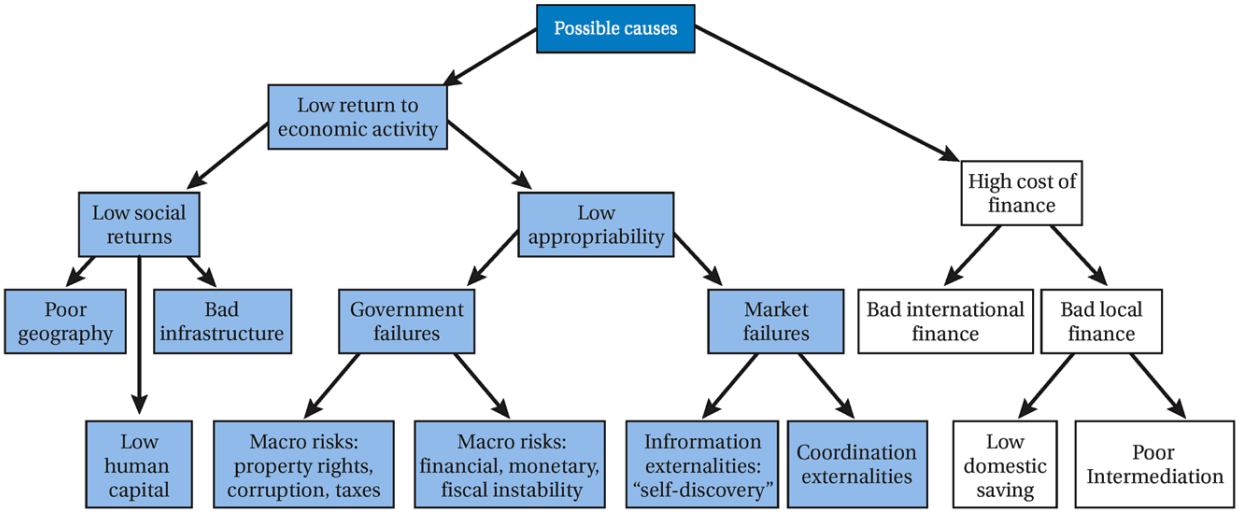
The second growth diagnostic method that is used in the paper is the international benchmark analysis. This empirical tool allows us to investigate the innovation capacity of Macedonian economy in a comparative manner with the countries in the wide region via number of patent's application and firms' capacity for adaptation and transfer of new technology. The number of registered patents is much larger than expected from a country with such a size and development level as Republic of Macedonia, but the analyze of applicants structure show that non-resident applicants are a bit larger than the resident applicants, indicating that domestic science and R&D sector is not enough competitive. Additionally, the analysis indicates the Macedonian companies lagging behind the companies in more countries in the region regarding the expenditure on R&D and the abilities to adopt new technology.

The paper proceeds as follows. After the introduction, where the main objectives are presented and the main goal of the paper is introduced, Section 2 elaborates the theoretical literature review related to HRV growth model and how we apply it for analyzing the innovation capacity and economic growth in Republic of Macedonia. The third section presents a research methodology framework that is used in the empirical analysis. Section 4 present the estimated results of growth accounting decomposition production approach and elaborate the relative contribution of production factors by special focus on the contribution of technological progress to economic growth in Republic of Macedonia. Section 5 and 6 discusses the results of comparative analysis concern to innovation capacity of Macedonian economy investigated by the percent of R&D spending to GDP, the number of patent applications, and the firms' capacity to innovate and to their capacity for innovation diffusion (the capacity for transfer and adoption of new technology at firms' level).

2. THEORETICAL LITERATURE REVIEW: HRV GROWTH MODEL AS A BASIC FRAMEWORK TO INVESTIGATE IF THE INOVATION CAPACITY IS THE MOST BINDING CONSTRANT TO ECONOMIC GROWTH

The methodological principles of the growth diagnostic approach are based on the HRV growth model created by Hausmann, Rodrik and Velasco (2004). The main challenge of this empirical concept is to identify the most binding constraint to investment and entrepreneurship as fundamental factors of sustainable economic growth. This concept is very complex and including many areas such as the quality and quantity of complementary production factors (human capital, infrastructure, geography), financial sector, macro and micro institutions. All of these areas are potential bottlenecks and binding constraint to economic growth which give a very useful framework to researchers and policymakers for investigating and uncovering which factors have the most distortion effects to the country's capacity to promote the long-run growth. On the picture below is presented the growth diagnostic decision tree.

Problem: Low levels of private investment and entrepreneurship



Source: Ricardo Hausmann, Dani Rodrik, and Andrés Velasco, "Getting the diagnosis right," *Finance and Development* 43 (2006), available at http://www.inf.org/external/pubs/ft/fandd/2006/03/hausmann.htm. Used with permission.

However, the aim of this paper is focusing on one stage of this decision tree related to productivity, the capacity for technology adaptation and transfer of technology and the capacity to be created and implemented new business ideas (products). The access to appropriate technologies, the performance of national innovation system and the entrepreneurship level determine the private return to domestic investment. Therefore, the researchers should detect if the lack of innovation capacity is binding constraint to economic growth. These insights can be used to derive the policy priorities and to formulate the growth strategy focused on improving the country's innovation capacity and solving the triple helix problem (the relationship among government, firms and academia).

3. THE RESEARCH METODOLOGY FRAMEWORK

To research the main hypothesis and to fulfill the objective of the paper we apply three integrated empirical techniques: growth accounting based on production approach, panel cross-country econometric estimation and international comparative analysis. Each of these methods have different aspects and mechanisms in the process of identifying the most binding constraint to growth of a country.

3.1 Growth Accounting

The first empirical technique of the growth diagnostic literature is growth accounting. In the context of our goal to answer if leak of innovation capacity and as a result low productivity is binding constraint to economic growth we use apply this method to estimate the contribution of factors of production (labor and capital) and total factor productivity to the rate of economic growth. The main equation of growth accounting production approach is presented below:

$$g_Y = g_A + ag_K + bg_L \tag{1}$$

However, our main focus here is to decompose the total factor productivity - TFP (productivity of labor – human capital and productivity of physical capital – technological progress) so as to estimate the relative contribution of technological progress to economic growth.

$$b(\Delta L^* / L^*) = b\left(\frac{L}{L^*}\right)\left(\frac{\Delta L}{L}\right) + b\left(1 - \frac{L}{L^*}\right)\left(\frac{\Delta L}{L}\right) + b\left(\frac{\Delta(L^* / L)}{(L^* / L)}\right) \tag{2}$$

Although growth accounting allows us to identify the growth model and the sources of growth, it is not perfect growth diagnostic technique that is able to identify the causes why country is facing with low productivity and leak of innovation, for example in the case when estimated result indicate that the contribution of labor productivity or technological progress to economic growth is negligible. Even more we should be very careful in the interpretation of the results estimated by applying growth accounting because there are several critiques (first, it is based on two assumptions: a production function with constant returns to scale; perfect competition so that each factor is paid its marginal product) to this method which raises thequestion about the data accuracy.

3.2 International comparative analysis

Another tool that is becoming increasingly popular is the use of international rankings. Many organizations with different objectives create indices to assess the relative importance of countries in a widening set of dimensions.The idea of measuring performance in a comparative manner is in principle very useful, as it provides feedback to a society about its performance relative to what seems feasible. As such, it can trigger a social conversation around the topic at

hand. Moreover, if properly interpreted and used, it can contribute evidence to a diagnostic effort.

The main concept of this tool is to focus on some areas of relative weakness. However, poor performance of a country in an area can be an indication of an inadequate supply, and hence a problem, or just low demand for that particular factor given the country's structure. Countries for example may differ in the importance and effectiveness of R&D expenditures for their pattern of growth. One country may be spending more than another, and yet be under-spending more vis-a-vis its optimal allocation.

In this paper we focus on measuring the innovation capacity(via number of patent's application and firms' capacity for adaptation and transfer of new technology) of Macedonian economy and compare it with the countries in the region.

4. THE ANALYSIS OF GROWTH SOURCES IN REPUBLIC OF MACEDONIA BASED ON PRODUCTION GROWTH ACCOUNTING APROACH

The growth accounting analysis presented in this section are based on the Cobb-Douglas aggregate production function and Solow Growth Model and is produced for the period 2000-2012. The final result is decomposition of the GDP growth rate into the absolute and relative contribution of the increase in employment, the increase in capital and the increase in the total factor productivity (TFP).

The data about gross value of capital as a common measure of "number of machines", as well as the data about net value of capital do not exist for the country and we approximated it by using perpetual inventory method, based on the data available about investment. Moreover, we approximate the total factor productivity as a residual in the estimation.

Below in the table is presented the results of the absolute and relative contribution of individual factors of production (labor and capital)and total factor productivity

Table 1: The sources of economic growth

	Sources of economic growth	Coef. *a* and *b*	Growth rate, %	Absolute contribution%	Relative Contribution %
A	Labor (L)	0.60	1.40	0.84	35,75
B	Capital (K)	0.40	2.00	0.8	34,03
C	Total factor productivity (TFP/A)			0.71	30,23
	TOTAL	1		**2.35**	100

Source:Authors calculations based on national statistical offices data and on the basis of UN data set.

The growth rate of the TFP is further decomposed into the contribution of human capital (skills), advance in applied knowledge (sometimes referred to as embodied technological progress), the contribution of organizational innovation, structural changes and similar.[1] In one

[1]For more detailed insight into the sources of growth analysis see: Acemogly (2008), Agnion and Howit (2009), Romer (2001), Baro and Sala-i-Martin (1995), Crafts and Toniolo (1996), Mankiw (1995), Mankiw at all (1992), Madison (1982, 1987), Denison E. (1967, 1985), Jorgenson and Griliches (1967).

or the other form, it captures in the long run different kinds of knowledge and this is why the TFP is sometimes referred to as the advance in "broader knowledge".

Table 2: Decomposition of sources of economic growth

	Sources of economic growth	The rate of growth	Absolute contribution	Relative Contribution
A	**Factor accumulation**	**3.40%**	**1,64**	**69,78%**
B	„Unqualified" labor	1.40%	0,84	35,75
C	Capital	2.00%	0,8	34,03%
D	**Total factor productivity - TFP**	**0,71%**	**0,71**	**30,23**
E	Technological progress	0,19%	0,19	8.5%
F	Improvement in education structure	0,52%	0.52	21,7%
	Gross Domestic Product	**2.35%**	**2,35**	**100**

Source: Authors calculations based on national statistical offices data and on the basis of UN data set.

Looking at the estimated results for the analyzed period, it can be noticed that "unqualified labor" has the larger absolute and relative contribution to average rate of economic growth which to some extend is obvious having in mind that Republic of Macedonia has high rate of unemployment in the whole period. On the other side, the contribution of capital to economic growth in the same period is almost equal such as labor's contribution, indicating that the main driver of Macedonian growth in the last period is factors accumulation (labor and capital).

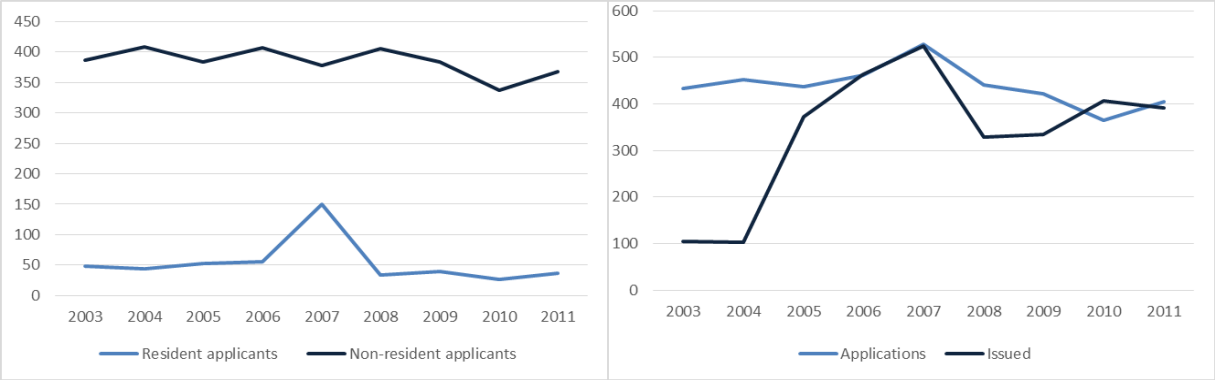
But, the main interest in this analysis is the contribution of Total Factor Productivity (human capital and technological improvements), precisely the contribution of technological progress to economic growth which is significantly lower compere with the larger capital's contribution, giving us an argument that the capital accumulation based on recent investment (pre-dominantly formed by construction) is not appropriate to promote the long-run growth. This is not suppressing if we know that the policy makers have not spent much attention and efforts directed toward developing effective and functional national innovation system (NIS) capable to create new business ideas and for attracting "green-field" foreign investment with a high degree of technological knowledge and with a strong "spill over" effect on productivity of domestic resources. Additionally, inconsistent and inactive industry policy in the whole period (starting from the first years of the transition process) was one of the main reason why many companies were unable to transformed and adopted in accordance with the competitive world and the reason why the market was unable to create new business ideas and to promote new domestic investments.

5. THE ANALYSIS OF NATIONAL INOVATION CAPACITY

The number of applications and the number of registered patents are significant indicators that measure the innovation capacity of a country.The number of registered patents is much larger than expected from a country with such a size and development level as Republic of Macedonia. But, if we analyze the structure of the applicants, it is obvious that non-resident applicants are a bit larger than the resident applicants, indicating that domestic science and R&D

sector is not enough competitive. For illustration, in 2011 the total number of patent application is 405, from which, only 37 were from resident applicants.

Figure 1: Number of applications and issued patents, by the origin of applicants



Source: www.ippo.gov.mk/

Figure 1 shows the evolution of the number of requests for patents and the number of patents issued by the origin of applicants. The number of applications from residents has got a stable upward trend, while the number of applications from non-residents dropped substantially during the global economic crisis period.

Table 5: Matrix of correlation

	Number of Patents	Journal Articles	GERD	Tertiary Enrollment	GDP per capita
Number of Patents	1.0000				
Journal Articles	0.7334	1.0000			
GERD	0.8601	0.8943	1.0000		
Tertiary Enrollment	0.4718	0.6973	0.6209	1.0000	
GDP per capita	0.7846	0.8313	0.8067	0.6189	1.0000

Since we consider specifically the domestic capacity to innovate, we will focus on applications filled out by residents. In order to assess the performance of Macedonia on a global scale, we can use the following regression:

$$\ln Patents = \alpha_o + \alpha_1 \ln(GDP/capita) + \alpha_2 \ln(GERD) + \alpha_3 Education + e_i$$

The exogenous parameters of this regression are GDP per capita, population, human capital measured by the average years of education and the R&D spending measured by General expenditure of Research and Development as a percent of GDP. The results are displayed in Table 4.

Table 6: Estimated regression results: Dependent variable: Number of patents

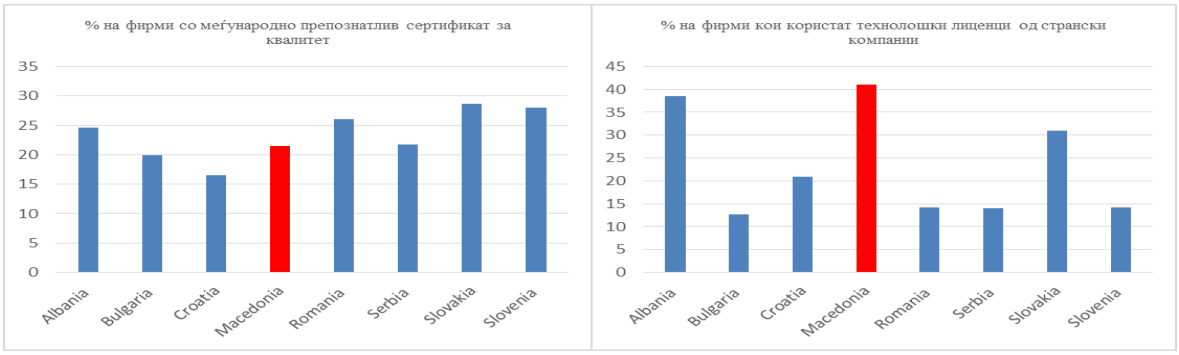
Variable	Coefficient	Standard Error	T-stat
Ln GDP per capita, PPP$	0.8304339	0.240312	3.46
Human capital measured as average years of education	1.172034	0.6201607	1.89
General expenditure of Research and Development (GERD), % of GDP	0.7557995	0.2922528	2.59
Constant	-21.24028	2.052689	-10.35
			R^2=0.6817

The estimated OLS regression results show positive and statistical significant correlation between the level of GDP per capita, human capital and R&D spending, regarding to the number of issued patents.

6. INNOVATIONS AT THE ENTERPRISE LEVEL

The innovation capacity of a country is just a precondition; a major importance belongs to the ability to introduce relevant changes, and to implement the international practices and technologies at enterprise level. Republic of Macedonia is roughly at the same level as other countries from the region in terms of the percentage of firms with international certificate for quality and among the leaders in terms of the percentage of firms with international technological license, compare with countries in the region in 2012. [Picture 2]

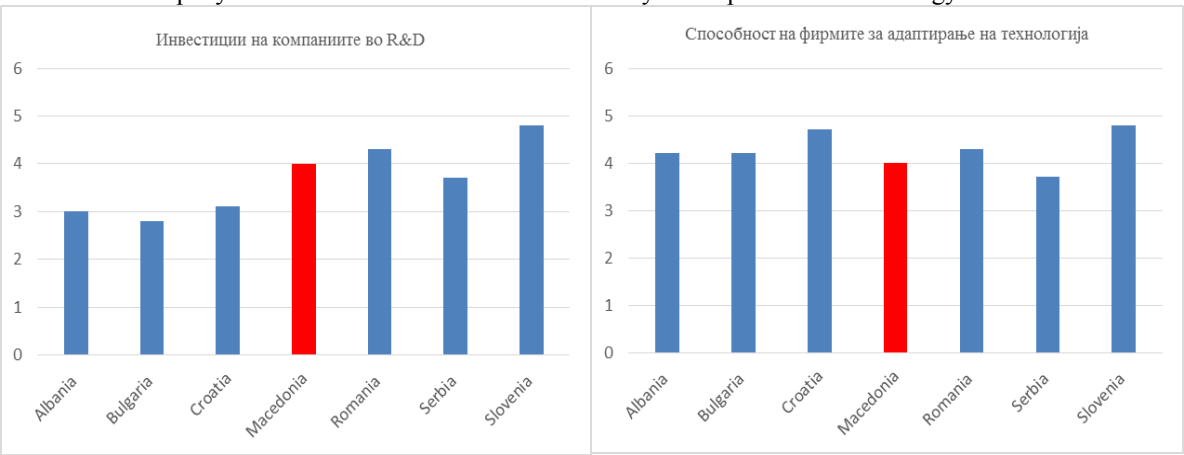
Picture 2: % of firms with international certificate for quality and % of firms with international technological license



Source: *Enterprise Survey Index 2012*

The expenditure on R&D incurred by the Macedonian enterprises is higher than the average, behind Romania and Slovenia as a countries where firms spend much more for R&D activities. But, on the other side, the Macedonian firm's ability in adoption new technology is weaker than other countries in the sample. [Picture 3]

Picture 3: Company's investment in R&D and firm's ability in adoption new technology



Source: *Global Competitiveness Index, 2013-14*

7. CONCLUSION

The main goal of the paper is to answer the question if the leak of innovation capacity and low productivity is binding constraint to economic growth of Macedonian economy. To fulfill this goal we use two empirical techniques: growth accounting decomposition production approach and international benchmarks analysis.

The estimated results by applying growth accounting based of decomposition production approach show that the capital accumulation has significant contribution to growth of Macedonian economy. But, what is more worrying here is the fact that capital accumulation based on recent investment is not appropriately followed by technological progress, giving us a strong argument that this capital structure is not capable to promote the long-run economic growth. For illustration, our estimated results show that the contribution of technological progress as a part of total factor productivity is negligible (only 8,5% of the average rate of economic growth in the analyzed period is based on technological progress) compare with its contribution in more developed countries.

The number of registered patents is much larger than expected from a country with such a size and development level as Republic of Macedonia, but the analyze of applicants structure show that non-resident applicants are a bit larger than the resident applicants, indicating that domestic science and R&D sector is not enough competitive. Additionally, the analysis indicates the Macedonian companies lagging behind the companies in more countries in the region regarding the expenditure on R&D and the abilities to adopt new technology.

The general results of the paper cannot reject the hypothesis that the low level of productivity and entrepreneurship, lack of firms' capacity for technology adaptation and transfer of technology, underdeveloped national innovation system is binding constraint to economic growth of Macedonian economy. These insights can be used by policy makers to derive the policy priorities and to formulate the growth strategy which will improve the country's innovation capacity and will solve the triple helix problem (the relationship among government, firms and academia).

REFERENCES

1. Agion, P., Howitt, P. (1998), "Endogenous Growth Theory", Cambridge: MIT Press;
2. Agnion, P. and Howit, P. (2009), "Economics of Growth", Massachusetts Institute of Technology;
3. Baro, R. J. (1991), "Economic Growth in a Cross Section of Countries", Quarterly Journal of Economics 106 (2);
4. Barro, R., Lee, J-W. (1994), "Sources of economic growth". Carnegie Rochester Conference Serieson Public Policy 40;
5. Grossman, G. and Helpman, E. (1991), Innovation and Growth in the Global Economy, Cambridge, MA: MIT Press;
6. Lucas R. E. (1988), "On the Mechanics ofEconomic Development", Journal of Monetary Economics, 22(1);
7. MankiwN., Gregory (2003), Macroeconomics, fifth edition, Worth Publishers;
8. Mankiw, N. G., Romer, D., and Weil D. N. (1992), A Contribution to the Empirics of Economic Growth, Quarterly Journal of Economics 107(2);
9. Milenko Popovic (2006), "Old and New Theories of Economic Growth" (I part), Montenegrian Journal of Economics, Volume 2;
10. Milenko Popovic (2006), "Old and New Theories of Economic Growth" (II part), Montenegrian Journal of Economics, Volume 2;
11. Helpman, Elhanan (1993), "Innovation, Imitation and Intellectual Property Rights". Econometrica, 61, pp. 1247-1280;
12. Howitt, Peter (2000), "Endogeous growth and Cross-Country Income Differences". American Economic Review, 90;
13. Romer, P. M. (1990), "Endogenous Technological Change", Journal of Political Economy;
14. Romer, P. M. (1994), "The Origins of Endogenous Growth", Journal of Economic Perspectives 8(1);
15. Schumpeter, Joseph A. (1934), The Theory of Economic Development. Harvard University Press, Cambridge, MA;
16. Wooldridge, Jeffrey (2002), Introductory Econometrics A Modern Approach, Thomson;
17. Wooldridge, Jeffrey (2002), Econometric Analysis of Cross Section and Panel Data, MIT press;