COMPARISON STUDY ON DETERMINANTS OF ECONOMIC GROWTH

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Abstract: *The present economic enviroment is highly volatile and very dynamic, both from the point of view of its financial characteristics, as well as its economical pecularities. This paper comes in an attempt to demonstrate the influences that manifest on growth, studying the correlations between it and its determinants, supporting the original understanding of existing methods for verification of several correlation in the literature, and subsequently retaining three of them, the MRW model in two forms: one under development of authors, one adding other macroeconomic control variables; and a dynamic model of economic growth. Additionally, these models use empirical analysis on two types of countries: OECD developed countries and developing countries in Central and Eastern Europe and Central Asia. In the end the analysis shows that the most significant influence in both areas is the education and, futher, that states under development present greater opportunities to promote growth through macroeconomic policies aimed at developing human capital.*

Keywords: *economic growth, human capital, MRW, OECD*

JEL classifiation: *O41, J24*

INTRODUCTION

In recent previous years worldwide we can see the renewal of interest that people, in general, and economists, in particular, assign to main factors that influence growth. This emphasis was based on the recent financial crisis which maintains economies at a level of emergency, both in terms of the policies they adopt, as well as for their terms of long-term overview. Prior to the recent financial and economic crisis, a limited number of countries, those who were leaders in terms of technology, experienced a significant improvment of GDP growth per capita, while others remained behind in this regard. It is this observation that was developed since the middle of last century, known in the literature under the generic name of economic growth, that we want to analyze in a comparative way, measuring the influence of its determinants in OECD developed countries group[1] and CEECA group of emerging countries[2]. Thus, by comparing influences of economic growth in the two sets of countries, complementary by nature of their development, we want to anticipate certain steps that can be taken, not only at the macroeconomic level through public policies, but by the population itself in developing their personal enviromentand business in which they operate.

[1] 25 of the 34 OECD member countries taken into consideration: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland, United States and United Kingdom..

[2] Central and Eastern European and Central Asian countries taken into consideration: Albania, Armenia, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Poland, Romania, Moldova, Russia, Serbia, Slovenia, Slovakia and Ukraine.

I. THEORIES AND EMPIRICAL ANALYSIS OF GROWTH DETERMINANTS

1.1. From the neoclassical theories to exogenous and endogenous growth

The modern concept of economic growth began with criticism of mercantilism, in principle based on the subsequent arguments of Adam Smith and David Hume. At a theoretical level there can be observed two distinct concepts of the notion of growth and in this respect we mention only general distinctions, following the analysis of the concepts that were the basis and thus allowed evolution to the present enviroment.

Solow's model (1956) is based on a Cobb-Douglas production function $Q = AK^{\propto}L^{\beta}$. Given that it takes into account the Q as the result, then change in this may occur by increasing labor, L, by increasing capital, K, or by increasing the productivity factor, A. In this sense, the model is one that allows the observations of changes that the exogenous variable (saving) has on the endogenous variables (capital and result). If this model is correct, then by the theory that he was trying to demonstrate, the economic growth will be very strong in countries that begin to accumulate capital and will slow in those in which the accumulation process is ongoing. Moreover, by this there will be a decrease between the disparities along countries, in regards with GDP per capita, and thus living standards will align with each other.

Going even further with our analisys, the economic growth related literature review contains a study that correlates not only neoclassical theories and investment in human capital, but also the diffusion of technology to economic growth. In this regard, Nelson and Phelps (1966) note that a higher education growth rate is positively correlated with a higher technological progress in the economy. Moreover, it suggests that the progressivity of technology has implications towards optimal capital structure. Finally he suggest that there is a strong correlation between education and growth, proposing that the integration of the educational indexes in the production function may be of a general specification.

The theory of neoclassical growth considers progress as the existance of a higher level of physical resources, thus encoded first by Solow (1956). Secondly it can be seen that the next current was represented by endogenous growth theories, where, unsatisfied with the explanations offered by Solow (1956), Romer (1986) and Lucas (1988), laying the foundation in the late 1980s, included in the model a mathematical explanation of technological advances. The essence of this model is the inclusion of human capital and the skills and knowledge that make workers more productive.

Even if, according to the results of the aformationed empirical model, more than half of the income variation within a country can be explained by variables saving and population growth, specifically it can be said that the higher the saving rate is within a country, the richer the country is, or the higher the population growth rate is, the poorer the country is. In this sense, to explain this discrepancy, Mankiw (1992) adds to the Solow model the human and physical capital. Thus, through the first, it explains that for any rate of human capital accumulation, a higher saving or lower population growth leads to a higher level of GDP, and so higher levels of human capital.

Can economic growth be kept for a long-term? If yes, what are the determinants that allow it, which countries are likely to grow the fastest and what are the policies that governments can use to accelerate progress in living standards? These questions are the focus of studies between 1950-1960's and remained of key significance until the end of the millennium. Thus, Mankiw, Romer and Weil (1992) argue that the international disparities of national income (per capita) level and its growth rates are consistent with the standard set by Solow (1956), but to which must be added the influence of human capital. In this respect, to prove this assertion they assume that each country has its own production function (Cobb-Douglas) and their own exogenous saving rates and population growth rates.

II. METHODOLOGICAL INSIGHTS OF MODELS USED AND DATA PRESENTATION

2.1. General models of analysis of economic growth determinants

In terms of regression, in correlation with the methodology listed above, we separate the macroeconomic areas of influence according to the theories that already exist in the literature.

2.1.1. The Mankiw-Romer-Weil model

This model stands as a development of Solow's growth model (1956), supplementing it with the influences of human capital. Similar to that, starting from a Cobb-Douglas production function, the overall shape can be highlighted $Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta}$ and, also important is that the model considers an *s* fraction of output invested (savings). Defining the level of capital per unit of production, *k = K/AL*, and *y* as the level of GDP per unit of output, *y = Y/AL*, the evolution of *k* can be expressed as $k(t) = sy(t) - (n + g + \delta)k(t)$, where δ is the depreciation rate of capital.

Integrating in the initial formula the human capital and considering that *g* and *s* are constant over the panel of countries, we can logaritmate the general production function and get to the next growth model of gross domestic product per capita. (Mankiw, Romer and Weil, 1992)

$$\ln Y/L = lnA(0) + gt + \alpha/(1-\alpha-\beta)\ \ln(s\_k\ ) + \beta/(1-\alpha-\beta)\ \ln(s\_h\ ) - (\alpha + \beta)/(1-\alpha-\beta)\ \ln(n+g+\delta) + \varepsilon$$

2.1.2. MRW model with control variables

However, our analysis did not come to an end at this stage. To take into account macroeconomic variables that have a defining influence on growth, we decided to include in the regression model the following items, all in logarithmic form: total consumption of the population as a percentage of GDP, government consumption as a percentage of GDP, international openness as a percentage of GDP, investment as a percentage of GDP, and last but not least the inflation rate. Thus, the final MRW regression model, complete with control variables was developed as follows:

$$\ln Y/L = lnA(0) + gt + \alpha/(1-\alpha-\beta)\ \ln(s\_k\ ) + \beta/(1-\alpha-\beta)\ \ln(s\_h\ ) - (\alpha + \beta)/(1-\alpha-\beta)\ \ln(n+g+\delta) + [\ln(C) + \ln(CG) + \ln(Di) + \ln(I) + \ln(i)] + \varepsilon$$

2.1.3. The dynamic model of economic growth

Through this model we intend to introduce in the regression analysis our own perspective of a timelapse independent indicators. To do this as accurate as possible we used some of the independent variables from the previous equations to which we added gross domestic product per capita in the previous period (laggedTo explain the dependence as a percentage, we used the indicator in a logarithmic form, thus leading to the following dynamic regression model:

$$\log(GDP/capita) = \beta_0 + \beta_1 \log(GDP/capita_{(t-1)}) + \beta_2 \log(tehnologie_{(t)}) + \beta_3 \log(capital\ fizic_{(t)}) + \beta_4 \log(educație_{(t)}) + \varepsilon_t$$

2.2. The conceptual framework

As mentioned, there are a variety of econometric methods of analysis, and in the following we briefly present the ones we used in measuring growth determinants. In this respect, we started from the linear regression model, which is most often used in analyzes, estimating a regression between two variables, where the dependent is affected by the independent. However, the proposed analysis is not limited to regressions between the two sets of data but, more importantly, spanning across several nations over several years.

In this context, the research methodology was based on macroeconomic data, and so we used a panel based macroeconometric model. For understanding and because we used this method consistenly, the basic formula can be expressed as: $Y_{it} = \sum_{k=1}^{k} \beta_{kit} X_{kit_1} + \varepsilon_{it}$. Further on, methods used in the regression models, which we won't detail here due to the vast literature behind them, are based on fixed effects, variable effects and maximum likelihood. They are commonly seen in the literature on hierarchical linear models.

For a proper development, the most significant followed hypotheses in the models were based on the general assumptions for the regression models, such as: (Son, 2012)

a. *Correct definition of the model*, which is based on what we found in the literature on choosing correctly the variables to be used in the analysis, in order to have a sound theoretical consistency and one that can be demonstrated statistically. These hypotheses can be statistically tested by analyzing statistical tests such as: Fischer used for fixed effects models, and Wald used for variable effects models

Additionally we also decided to do a statistical test on checking the stationarity of the variables, which shows that if there is a dependency between variables along the model. A such model can be tested using the Lagrange Multiplier for residual values of the variables used in the regression, this achieved through a Handri LM Stationarity test. Moreover, if the variables of a model are stationary, then it can be shown that the initial assumptions are not valid. In other words, the values may not follow a "t" statistic distribution.

b. *The multiple regression model is not affected by exogenous variables collinearity*
c. *The variance of residual variables is invariable*, thus defining homoskedaticity property, as well as the residual variables are random elements of zero mean.

The used test was Breusch-Pagan Lagrangian Multiplier, which tests whether the estimated variance of the regression residual variables are dependent on the independent variables. From the aformentiond dependence point of view the Wald test for group heteroscedasticity is also used in the fixed effects models. For this the null hypothesis is similar to the Breusch-Pagan one.

d. *Residual variables should not be autocorrelated*, a problematic that can be also stated as the absence of serial correlation of the residual variables in the panel data. Although this is not a significant problem for small data sets, serial correlations can cause the standard errors of the coefficients to be lower than they are in reality, thus increasing the regression coefficients. This analysis was conducted in Stata12 econometric package using a Wooldridge Lagrange Multiplier test.

2.3. Data used for the empirical analysis

In developing the methodological complementary part of the project we start with the presentation of the data that was used for the empirical analysis. Thus, the data with which we want to develop the empirical study can be separated into the dependent indicator and independent indicators, the latter being in turn separated into five main areas:

a. *The dependent indicator for measuring the growth effects*: economic growth, in the analyzed countries, was taken into account by the evolution of GDP/capita.
b. *Independent indicators, determinants of economic growth*

- *Level of physical capital,* observed by gross capital formation. The database used was the World Bank's DataBank.
- *The composite index of education,* consisting of merged enrollment rates, graduation and inclusion in the workforce indicators. The values for this indicators were taken from the BarroLee database with sets of data available between 1950-2010, records being made 5 to 5 years. Thus, to obtain annual data we performed a linear interpolation between the ranges available.

In this regard, data availability and the desire to integrate the education level in a more comprehensive form in a single indicator, was the desiderate of composite indicator. At its core were the indicators that relate to the education and employment rates of labor force in the total population. Regarding the first of these, we can distinguishe: secondary school graduation rate and the tertiary cycle graduation rate.

Moreover, the composite index of education, due to the lack of data covering employment rate, both for the 15-24 and 24-total age range for the period, was done by weighting the secondary and tertiary graduation rates normalized according to the formula below:

$$I_{qc}^{t} = \frac{X_{qc}^{r} - X_{qc=\bar{c}}^{r}}{\sigma_{qc=\bar{c}}^{t}} = Ieducation$$
$$= (1 * Secundary\ graduation\ rate + 2 * Tertiary\ graduation\ rate)/3$$

- *The composite index of technological progress*, based on the number of patents, specialized journals and research investment. The used databases were those of the World Bank and the Penn World Table.
- *Macroeconomic indicators,* revealing the level of states development, policies that governments adopt, international openness degree etc. With regard to those who were included in the regressions, data availability forced us to use only inflation, consumption, government consumption and the international openness. The used databases are the same as for the composite index of technological progress.

III. ANALYSIS OF RESULTS FOR DEVELOPED MODELS

The assertion from which we started and that we are trying to analyze is definitely not new by nature. However we wanted to add to the already confirmed literature some new improvementes in some models, as well as renew the proven ones.

Following the order of steps that need to be taken for demonstrating statistic correlation, we defined here in this paper different concepts that were used in the form of basic theory, alongside the macroeconomic data. Combining these two we managed to create statistic regresions that tries to demonstrate and thus to prove the correlation between the different macroeconomic indicators and economic growth.

Taking a deeper look on the results in Table 1, with reference to OECD countries, we see the confirmation of the results presented by Bassanini and Scarpetta (2000, 2001) in their study about a decade ago, where they measure the independent variables considered influences on the variation of GDP per capita, specifically by using the MRW model. Thus, our analysis shows similar results, although not all variables entered in the model used the same set of data, and in this respect the level of technological progress and the intrinsic growth rate of it manifests with low probability and have weak influences, while the physical capital and education level are influences that manifest with high probability. Our results show that a change of 1% of physical capital affects economic growth, as measured by gross domestic product per capita with 0,12%, while the level of education has an impact of about 0,42%. We can state in this case that the developed countries have a decresed impact trend from the study mentioned above, but still education being a more important factor than physical capital.

Similarly, on CEECA countries, the results are pointing in the same direction, but the impact of the considered variables are different. In this regard, the technological progress has a high probability of impact, but the impact is minimal, while physical capital and education level have the same maximum probability of influence, but their coefficient shows that a change of 1% influences gross domestic product per capita by 0,49% in the first, namely 1,34% in the latter. However we didn't compare these results with other studies on the same group of countries, but still can see the general rising trend for the developing countries, where the impact on the GDP is of the same direction, but of different magnitude.

For the second analysis, which is a development of the first by introducing control variables, the results on the OECD countries are different, namely with decreased influence of fixed capital and level of education, with clear negative influences of overall consumption, government consumption and investment, and positive influences of international openness and inflation that are inconclusive. Similarly, performing the same analysis for CEECA developing countries, there are less influences of the variables included in the base MRW model but complemented by overall positive influences of consumption and investment of the population, as well as negative influences of government consumption, international openness and inflation. However, the differences we found in the first model, namely that human capital influences manifest more strongly in the developing countries than in developed countries, confirms us that these latter countries have lower development possibilities by increasing human capital, the reason being an already high level of education in these countries.

The third model, the last one we implemented, captures the dynamic view, measuring the influence of the GDP/capita in period t-1, thus reducing the level of influence of other independent variables. However, human capital still stands as most important, having also a high probability of influence on economic growth.

Finally we can say that the results that suggest significant differences in GDP per capita over time and across OECD and CEECA countries can be generally explained by different economic and social policies. In this respect, we can understand the measures that countries can take to have an optimal growth strategy through various policies already tested in similar countries, and thus most countries have made significant progress toward price stability and avoid excessive macroeconomic fluctuations. More, we can say that the present changes in their policies are going towards improving and increasing economic growth. However, even if there have been significant efforts to reduce public deficits, certain tax policies tend to remain at a high level. Additionally, from the structural point of view, most OECD and CEECA countries register significant increases in the level of their human capital, much of which is channeled through state policies, whilst the resources allocated to research and development increased significantly between 1980-1990 in the OECD countries and a little later in the CEECA countries trough the business sector, and so the private sector has played a significant role in this growth.

In addition to these considerations, there remain significant structure differences in OECD and CEECA countries, both in terms of growth and in terms of its determinants, but the differences tend to flatten and reach a balance level. In other words, human capital has a smaller and smaller relative impact in developed countries, but the rate in which developing countries grow will reduce the current high impact to an almost equal level, where other influences will arise and manifest manifest more on economic growth.

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Table 1. Regression results for the OECD and CEECA countries

MRW Model **MRW Model with control variables**

Dyamic Model

OECD	b/se	p	t	b/se	p	t	b/se	p	t
logtechnology	0.027**	0.004	2.906	-0.002	0.812	-0.237	0.005	0.068	1.830
logfixcapital	0.120**	0.007	2.710	0.100	0.054	1.930	0.033*	0.014	2.470
logeducation	0.419***	0.000	21.610	0.330***	0.000	14.612	0.020**	0.009	2.614
g	0.013	0.837	0.205	-0.029	0.632	-0.478			
logrptd	-0.007	0.467	-0.727	0.003	0.719	0.359			
logconsummption				-0.270***	0.000	-4.071			
logguvconsmuption				-0.274***	0.000	-8.933			
logintlopen				0.138***	0.000	4.965			
loginvestments				-0.088**	0.001	-3.180			
loginflation				-0.005	0.492	-0.687			
loglGDPcapita							0.922***	0.000	91.638
Constant	10.774***	0.000	74.700	12.077***	0.000	31.748	0.755***	0.000	6.542
R-squared	0.366			0.404			0.956		
(Wald)/F	(1040.90)			(1325.00)			4847.093		
N observations	893.000			857.000			918.000		

CEECA	b/se	p	t	b/se	p	t	b/se	p	t
logtechnology	-0.079*	0.019	-2.339	-0.073*	0.027	-2.213	-0.039*	0.013	-2.493
logfixcapital	0.495***	0.000	6.424	0.324***	0.000	3.772	0.169***	0.000	4.242
logeducation	1.340***	0.000	7.318	1.023***	0.000	4.051	0.623***	0.000	6.539
g	-0.001	0.934	-0.082	0.004	0.760	0.305			
logrptd	0.016	0.365	0.905	0.015	0.378	0.882			
logconsummption				0.057	0.765	0.298			
logguvconsumption				-0.127	0.148	-1.447			
logintlopen				-0.190*	0.012	-2.512			
loginvestments				0.234***	0.000	4.424			
loginflation				-0.054***	0.001	-3.478			
loglGDPcapita							0.718***	0.000	24.588
Constant	8.721***	0.000	16.861	9.028***	0.000	9.798	2.758***	0.000	8.305
R-squared	0.055			0.093			0.794		
(Wald)/F	(149.93)			(227.75)			323.584		
N observations	284.000			276.000			358.000		

* p<0.05, ** p<0.01, *** p<0.001

These statistics, similar with the entire regression analyzes, were made with the help of *Stata 12* econometric package