IS THE RATE OF ECONOMIC CONVERGENCE IN CENTRAL, EASTERN AND SOUTHEASTERN EUROPEAN COUNTRIES REALLY THAT HIGH?

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Abstract

This paper uses the augmented version of the Solow growth model and the determinants-of-growth regressions approach to examine the convergence in standards of living among Central, Eastern, and Southeastern European (CESEE) countries. For different variables that are held constant in order to proxy country's steady state level the results of our exercise show unexpectedly high rates of economic convergence that range from 4.2% to 8,2% per year. It might imply that our first-differenced GMM estimator is seriously biased downwards.

Key words: *Economic convergence, CESEE countries, first-differenced GMM estimator.*

1. Introduction

To estimate the magnitude of economic convergence in Central, Eastern, and Southeastern European (CESEE) countries (Albania, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Russian

Federation, Serbia, Slovak Republic, Slovenia, Turkey and Ukraine), we use two standard theoretical frameworks - the augmented Solow growth model, that is, its Mankiw-Romer-Weil (M-R-W) version, and the determinants-of-growth regressions approach.

We consider panel-data including five 4-years non-overlapping periods, from 1997 to 2016. All variables are taken as deviations from period means. The used variables, their definitions and sources, are presented in the Appendix, Table A1.

2. Models

Our first theoretical framework is the M-R-W's version of the Solow growth model. It is well known that this model uses a Cobb-Douglas production function with three inputs - physical capital, human capital and labour. There are constant returns to scale and decreasing returns to all capital. The rates of population growth n, labour-augmenting technological progress g, depreciation d and saving s, are exogenous and constant.[1] It is also well known that: 1) approximating around the steady-state M-R-W's model results with the equation where the real GDP per capita growth is a function of the steady-state determinants and the initial level of real GDP per capita (see Mankiw et al., 1992), and 2) the convergence in M-R-W's model appears only in conditional sense, with a magnitude of approximately 2% per year (see Mankiw et al., 1992).

Our second theoretical framework is the determinants-of-growth regressions approach. It is worth noting that this approach is consistent with the M-R-W's growth model, as well as with any other neoclassical growth model that accepts similar log-linearization around the steady state (for more details see, Caselli et al., 1996; Barro, 2001; Barro and Sala-i-Martin, 1992, amongst others).

[1] Note that Mankiw et al., (1992) assess the value of $(g + d)$ to 0.05.

3. Empirical background

To address the growth regressions' problems, such as the problems of endogeneity and omitted variables bias, we use the first-differenced generalized method of moments (GMM) estimator, proposed by Arellano and Bond (1991). In this respect, we apply the following three-step procedure: *first*, we write the growth regression as a dynamic panel-data model; *second*, we take first-differences in order to eliminate unobservable time-invariant country-specific effects, and *third*, we instrument the right-hand-side variables using their lagged levels.

Our baseline specification takes the following form:[2]

$$y_{i,t} = v_i + \lambda y_{i,t-1} + \theta x'_{i,t} + \varepsilon_{i,t} \text{ for } \quad i = 1, \ldots, N \text{ and } t = 2, .., T \tag{1}$$

where $\varepsilon_{i,t}$ represents the idiosyncratic error term; $y_{i,t}$ is the logarithm of real GDP per capita over a 4-year period t; $y_{i,t-1}$ is the logarithm of real GDP per capita at the beginning of that period; $x'_{i,t}$ is a vector of the steady-state determinants measured during, or at the start of the period; v_i represents the country-specific time-invariant effect (that is, the differences in technology among countries).[3]

In M-R-W's version of the Solow growth model, the logarithm of the initial level of real GDP per capita $y_{i,t-1}$, and the logarithm of the secondary-school enrolment rate (which is used as a proxy for the rate of investment in human capital) are measured at the start of the period, while the logarithm of the investment rate in physical capital and the logarithm of the population growth rate are measured during the period. The lagged real GDP per capita and the enrolment variable are assumed as predetermined variables, and are instrumented with their first and all

[2] Note that eq.(1) can be written equivalently with a growth rate as a dependent variable.

[3] Note that $\theta x'_{i,t} + v_i$ is a proxy for the steady-state output.

further lagged levels, while the investment rate and population growth rate variables are treated as potentially endogenous variables, and are instrumented with their second lagged level and all further lagged levels.

In determinants-of-growth regressions approach, we use two sets of explanatory variables: 1) the state variables (the logarithm of the initial level of real GDP per capita $y_{i,t-1}$, and the secondary-school enrolment rate) - that are measured at the start of each period, and 2) the other control variables such as: the investment rate, democracy, financial development, government consumption, population growth, trade and inflation – that are measured as annual averages for each period. The lagged real GDP per capita, enrolment, financial development, government consumption, population growth, trade and inflation variables are assumed as a predetermined variable, and are instrumented with their first and second lagged levels. The investment rate variable is treated as potentially endogenous variable and is instrumented with its second and third lagged levels, while the democracy variable is assumed to be strictly exogenous, and is used as its own instrument.[4]

4. Results

In this section we present the results of our exercise.

Table 1 displays the results of unrestricted version of the M-R-W's growth model. The coefficient on the initial value of real GDP per capita variable (-0.136) has a negative sign, and is statistically significant. The Hansen test of over-identifying restrictions confirms the validity of instruments. Moreover, the Arellano – Bond test of autocorrelation shows that there is no second-order autocorrelation in the first-differenced residuals. The implied value of the

[4] Note that we "collapse" the instrument matrix, when the number of instruments is too large (see Roodman, 2009), in both of our frameworks.

convergence rate is 2.9%, and suggests that CESEE countries converge to their steady-state levels of real GDP per capita at the rate of 2.9% per year. It is also obvious that all right-hand variables have the right sign, as predicted by the augmented Solow growth model.

Table 1. M-R-W model (unrestricted version)

$\ln(y_{i,t-1})$	-0.136*** (0.046)
$\ln(s^k_{i,t})$	0.315*** (0.060)
$\ln(s^h_{i,t})$	0.245 (0.176)
$\ln(n_{i,t}+g+d)$	-0.164 (0.547)
Implied λ	0.029*** (0.010)
Observations	76
Countries	20
AR(1): p-value	0.073
AR(2): p-value	0.932
Hansen test: p-value	0.540
Test of restriction: p-value	0.567
Instruments	14

Notes: Standard errors in parenthesis below the coefficients. The estimation method is two-step first-differenced GMM with Windmeijer (2005) finite-sample correction. α and β are the shares of physical and human capital in GDP, respectively. s^k and s^h denote the rates of investment in physical and human capital. λ is the convergence rate. Dependent variable: growth rate of real GDP per capita.

In addition, we have conducted two tests of the M-R-W's model. First, we have tested the restriction that the coefficients on $\ln(s^h_{i,t})$, $\ln(s^h_{i,t})$ and $\ln(n_{i,t}+g+d)$ sum to zero, and, second, we have run a restricted version of the model where λ, α and β are just identified.[5] We have found that we cannot reject the hypothesis that the sum of the aforementioned three coefficients equals to zero (see Table 1, p-value 0.567), while, our second test has shown that the

[5] Note that, α and β denote the shares of physical and human capital in GDP, respectively.

estimate of the implied value of the physical capital share is larger than expected (0.475), as well as that the estimate of the implied value of the human capital share is insignificant, which implies an "instant" rejection of the M-R-W's model (see Table 2).

Table 2. M-R-W model (restricted version)

$\ln(y_{i,t-1})$	-0.117* (0.065)
$\ln(s^k_{i,t}) - \ln(n_{i,t} + g + d)$	0.323*** (0.087)
$\ln(s^h_{i,t}) - \ln(n_{i,t} + g + d)$	0.240 (0.256)
Implied λ	0.024* (0.014)
Implied α	0.475* (0.262)
Implied β	0.353 (0.238)
Observations	76
Countries	20
AR(1): p-value	0.055
AR(2): p-value	0.967
Hansen test: p-value	0.565
Instruments	10

Notes: Standard errors in parenthesis below the coefficients. The estimation method is two-step first-differenced GMM with Windmeijer (2005) finite-sample correction. α and β are the shares of physical and human capital in GDP, respectively. s^k and s^h denote the rates of investment in physical and human capital. λ is the convergence rate. Dependent variable: growth rate of real GDP per capita.

From aforementioned, one can conclude that the M-R-W's model is not consistent with the data, and that cannot explain the differences in standard of living among the CESEE countries.

Once we have rejected the augmented version of the Solow growth model, we have proceeded with a more general specification based on the determinants-of-growth regressions approach. The results are displayed in Table 3.

Column 1 represents our benchmark specification. The rate of convergence is approximately 8% per year, which implies about nine years for the economy to cover half of the distance between its starting position and its steady-state, on average. One can realize that this rate of convergence is unexpectedly high, and that is at odds with the prevailing "wisdom" that the speed of convergence should range between 2% and 3% per year.

Table 3. Determinants-of-growth regressions

	(1)	(2)	(3)	(4)
$\ln(y_{i,t-1})$	-0.338***	-0.285***	-0.202**	-0.191**
	(0.090)	(0.111)	(0.111)	(0.086)
Investment	1.282***	1.523***	1.566**	1.455***
	(0.305)	(0.312)	(0.724)	(0.339)
Education	0.185***	0.175*	0.160	0.221**
	(0.079)	(0.102)	(0.182)	(0.121)
Democracy	0.095***	0.105***	0.096***	0.066***
	(0.027)	(0.032)	(0.027)	(0.020)
Financial sector development	0.201***	0.250***	0.227**	0.176***
	(0.056)	(0.078)	(0.089)	(0.066)
Government consumption	-1.558*	-2.063***	-1.893**	-1.673***
	(0.900)	(0.765)	(0.766)	(0.528)
Population growth	7.974**	7.911	-	-
	(4.267)	(5.954)		
Trade	0.138	-	-	-
	(0.094)			
Inflation	-0.093***	-0.100***	-0.077	-
	(0.028)	(0.038)	(0.047)	
Implied λ	0.082***	0.067***	0.045*	0.042**
	(0.027)	(0.031)	(0.028)	(0.021)
Observations	68	68	68	68
Countries	20	20	20	20
AR(1): p-value	0.059	0.100	0.034	0.046
AR(2): p-value	0.130	0.154	0.222	0.233
Hansen test: p-value	0.672	0.358	0.339	0.982
Instruments	17	15	13	11

Notes: Standard errors in parenthesis below the coefficients. The estimation method is two-step first-differenced GMM with Windmeijer (2005) finite-sample correction. λ is the convergence rate. Dependent variable: growth rate of real GDP per capita.

In the remaining models (columns 2, 3 and 4) we "refine" our benchmark specification. This causes the rate of convergence to fall by approximately 4 percentage points.

There is a rational explanation for the unexpectedly high rates of economic convergence that appear in our exercise. It is related with the first-differenced GMM estimator. Namely, this estimator exhibits poor behavior when the number of time series observations is small, and the time series are highly persistent or close to random walk processes. In these cases the instruments for the subsequent first-differences, that is, the lagged levels of the variables might be weak, which can result with undesirable finite sample properties, in terms of bias and imprecision (see Staiger and Stock, 1997; Blundell and Bond, 1998; Bond et al., 2001). Consequently, it is very plausible that, in our exercise, the first-differenced GMM estimator provides an estimate of the parameter λ (see eq.1) that is biased downwards, which translates into an upward bias in the estimate of the convergence coefficient.

5. Conclusion

To assess the magnitude of economic convergence in CESEE countries, we have applied two standard theoretical frameworks: 1) the M-R-W's version of the Solow growth model, and 2) the determinants-of-growth regressions approach. We have found that the rates of economic convergence in CESEE region range from 4.2% to 8,2% per year, depending on the variables that are used to proxy country's steady state level. However, one has to be aware that the first-difference GMM estimator may exhibit a poor performance when the number of time series observations is small, and the time series are highly persistent or close to random walk processes. In these cases the instruments might not be valid, which can result with large finite sample biases. Therefore, the answer of the question: Is the rate of economic convergence in CESEE countries really that high (from 4.2% to 8,2% per year)?, - stays ambiguous. The use of a more sophisticated estimator (such as the system GMM estimator) might improve the analysis.

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Appendix

Table A1. Definition and sources of the variables

Variables	*Definition*	*Source*
Real GDP per capita	Logarithm of real GDP per capita, constant 2010 US$	World DataBank
Growth rate of real GDP per capita	First difference of the logarithm of real GDP per capita, constant 2010 US$	
Investment	Gross capital formation, (% of GDP), constant 2010 US$	
Inflation	Consumer price index, annual (%)	
Financial sector development	Domestic credit to private sector (% of GDP)	
Trade	The sum of exports and imports of goods and services (% of GDP)	
Education	Logarithm of enrolment in secondary education.	
Government consumption	General government final consumption expenditure (% of GDP)	
Population	Population growth, annual (%).	
Democracy	Freedom House Political Rights Index. Ranging from 1 to 7, where 1 is most free and 7 least free.	Freedom House