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EU Membership and Economic Growth: Empirical Evidence for the CEE countries

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Abstract

This article aims to answer the question of whether a membership in the European Union contributed to an accelerated economic growth of eleven Central and Eastern European (CEE or EU11) countries, including their real convergence to the economic development level of Western Europe (EU15). The analysis consists of two steps. First, the hypothesis of income level equalization between the CEE countries and the EU15 is verified based on the β and σ convergence concepts. Second, the impact of selected macroeconomic variables related to the EU enlargement on economic growth of the CEE countries is examined with the use of econometric modelling. The analysis covers the 1995-2015 period. The results indicate that the CEE countries displayed a clear-cut income-level convergence toward the EU15 and that variables associated with the EU membership (increasing scope of economic freedom, improving quality of governance, progress of market reforms and more broadly – improvement in the institutional environment of the market, as well as the inflow of EU funds and the rising volume of international trade and foreign direct investment) turned out to be important drivers of GDP growth.

JEL Classification: C33, F43, O16, O43, O47, O52

Keywords: economic growth, convergence, catching-up, European Union, EU enlargement

1. Introduction

In 2004, eight Central and Eastern European (CEE) countries became the European Union members; in 2007 the EU was further enlarged to include Bulgaria and Romania, and in 2013 – Croatia followed suit. Today, more than a decade since the largest enlargement ever of the European Union it is worth attempting to assess the impact of European integration on economic growth of new EU member states from the CEE region and on the process of equalization of income levels within the enlarged European Union. Such an assessment seems particularly desirable in view of the fact that according to theoretical and empirical literature, the phenomenon of real economic convergence (or catching up) does not occur automatically. For example, in the traditional theory of international trade (Viner, 1950) economic integration leads to real convergence in income levels between countries, while some more recent theories (Krugman, 1991) claim that integration may also be conducive to increasing differences in the levels of economic development. Similar conclusions stem from the new models of endogenous growth (Romer, 1986, 1990; Lucas, 1988) where income convergence

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between countries has not been confirmed. Empirical studies show that the tendency toward equalization of income levels usually occurs within homogeneous groups of countries, while more diversified groups tend to exhibit divergence trends. In turn, some most recent empirical studies on the prospects of income convergence in the EU suggest that due to unfavourable future demographic trends and the aging population the next decades may witness a permanent reversal of the hitherto growth trajectories; as a derivative, a new trend, i.e. the process of income divergence between the new and old EU members may unfold (Matkowski, Prochniak, Rapacki, 2013, 2014). As can be inferred from the above, the discussion on real convergence and growth effects of integration is far from being conclusive, and many questions remain still open. This leaves a considerable room for further analyses of main drivers of convergence or divergence in income levels and for empirical research embracing various groups of countries and covering ever longer time series.

This article aims to answer the question of whether a membership in the European Union contributed to an accelerated economic growth of the CEE countries, including their real convergence to the economic development level of Western Europe (EU15). Our analysis consists of two steps. First, the hypothesis of income level equalization between the CEE countries and the EU15 is verified based on the β and σ convergence concepts. Second, the impact of selected macroeconomic variables related with the EU enlargement on economic growth of the CEE countries is examined with the use of econometric modelling. The analysis covers the 1995-2015 period. This article is a follow up and extension of the earlier studies in this field (Rapacki and Prochniak, 2009, 2010, 2014). There was examined the effect of the EU enlargement on economic growth and real convergence of Central and Eastern Europe focusing mostly on the pre-accession period and using a slightly different research method relying on a different set of explanatory variables. This study involves a completely new econometric methodology that is better fit for the analysis of panel data time series. Namely, the Blundell and Bond's GMM system estimator is applied which is the most appropriate tool to estimate dynamic panel regression models.

In the economic literature, studies on the effects of enlargement of the European Union including the income convergence between the EU countries and regions

abound. Obviously, it is not feasible to list here all of them.[1] Among the recent empirical studies devoted to real convergence in the EU particularly worthwhile mentioning are the following: Batóg (2010); Halmai and Vásáry (2010); Szeles and Marinescu (2010); Czasonis and Quinn (2012); Kulhánek (2012); Staňisić (2012); Tatomir and Alexe (2012); Dobrinsky and Havlik (2014). Most of these studies corroborate the trend towards equalization of income levels in the countries examined.

In the aftermath of the recent global financial crunch and the crisis in the euro zone, studies pointing to the emergence of income divergence trends in Europe have become more frequent. Some of these studies confirm the income divergence at the regional level (Herbst and Wójcik, 2012); other suggest divergence tendencies based on the hypothesis of club convergence or occurring within subgroups of countries (Monfort, Cuestas, Ordóñez, 2013; Borsi and Metiu, 2015); while still other – as already mentioned – point to the possibility of real divergence in the future as a consequence of unfolding unfavourable demographic changes.

The article consists of four sections. In section 2 below we verify the hypothesis of β and σ convergence of the CEE countries vis-à-vis the EU15. In section 3 we embark on the econometric modelling of the impact of key variables related with the EU membership on economic growth of the CEE countries. Section 4 concludes.

2. Income-level convergence of the CEE countries toward Western Europe before and after the EU enlargement

The concept of real economic convergence is defined here as the tendency to equalize income levels or otherwise: economic development levels between countries. This section is aimed at the empirical verification of the hypothesis of real convergence between the 11 new EU members in Central and Eastern Europe (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and

[1] Matkowski, Prochniak, and Rapacki (2013) provide a detailed survey of the newest empirical research on income-level convergence in the EU. As the aim of this article is to carry out the empirical analysis rather than to extensively review the literature, we do not describe detailed results of individual studies.

Slovenia – further on referred to as CEE or EU11)[2] and the old EU member states in Western Europe (EU15).[3]

Our approach is based on the neoclassical models of economic growth (Solow, 1956; Mankiw, Romer, Weil, 1992), which confirm the prevalence of real convergence, or more precisely – the conditional β convergence. Such a convergence occurs when less developed countries exhibit a faster economic growth than more developed ones. The catching-up process is conditional because it takes place provided all economies concerned head towards the same steady state, or long-run equilibrium. A common steady-state occurs when the countries involved are homogeneous in terms of their political systems, institutional architectures, economic structures, etc. If less developed countries always recorded a faster growth rate, we would deal with the absolute convergence.

The CEE economies can be deemed relatively homogeneous. This results firstly from the fact that in the transition period, these countries have pursued quite similar systemic transformation strategies, socio-economic policies and structural reforms, geared towards building a fully-fledged market economy, strongly influenced by Western patterns. Secondly, the prospects of and then the actual membership in the EU, and the need to adopt the *acquis communautaire*, combined to make these countries similar in terms of their institutional environment, economic structure, directions of trade and capital flows (so called *external* or *integration anchor*). Thirdly, all CEE countries have been offered similar windows of opportunity to use the EU aid funds. Hence, it can be assumed that all present members of the enlarged European Union face the same long-run equilibrium or steady-state. They should, therefore, tend to equalize income levels as suggested – inter alia – by neoclassical models of economic growth. The process of equalization in GDP per capita levels is further fostered by the objectives of the EU policy, intended to reduce income disparities between countries and regions of the enlarged European Union.

[2] The study does not include Cyprus and Malta, i.e. the new EU members since 2004. As they are not former socialist countries, the process of real convergence vis-à-vis the EU15 has been driven by different mechanisms and forces compared to CEE countries.

[3] This part of the study is a follow up of the earlier research in this field (e.g., Matkowski, Prochniak, Rapacki, 2016).

Another way to measure the catching-up process is the σ convergence. It occurs when differences in income levels between countries tend to decrease over time. Income disparities can be measured by variance or standard deviation of GDP per capita levels between countries. In theoretical terms, the β convergence is a necessary but not the sufficient condition for σ convergence. Moreover, econometric methods used to capture the two types of convergence are different. These factors combined prompt the need of cross-examining both of them.

To test the hypothesis of the absolute β convergence, we estimate the following equation:

$$\frac{1}{T} log \frac{\text{GDP}(T)}{\text{GDP}(0)} = \alpha + \zeta \, log \, \text{GDP}\,(0) + \varepsilon_t. \qquad (1)$$

The dependent variable is the average growth rate of real GDP per capita between the period T and 0, explanatory variable is the natural logarithm of the initial level of GDP per capita, while ε_t is a random factor. Negative and statistically significant value of the ζ coefficient means the occurrence of β convergence. In this case, the value of the β coefficient, measuring the speed of convergence, can be calculated from the formula (e.g., Barro and Sala-i-Martin, 2003, p. 467):

$$\beta = -\frac{1}{T} log(1 + \zeta T). \qquad (2)$$

Estimating the value of the β coefficient allows quantification of the speed of convergence. For example, when $\beta = 2\%$, it would take 35 years for individual countries – assuming that they stay at their hitherto growth trajectories – to reduce by half the distance to their steady state. This is because the time it takes for a variable with a constant negative growth rate to reduce its value by half, is approximately 70 divided by the growth rate expressed in per cent: $70/2 = 35$ years. More precisely, the half-life (t^*) is a solution of the equation: $e^{-\beta t^*} = 0.5$, where β is the rate of decline (Romer, 1996, p. 22-23). Taking logs of the above formula yields:

$$t^* = -\frac{log\,0.5}{\beta} \approx -\frac{-0.6931}{\beta} = \frac{0.6931}{0.02} = 34.7 \text{ years.} \quad (3)$$

To test the occurrence of σ convergence, one needs to estimate the trend line for the income disparities between countries:

$$\text{st.dev.}(log\ \text{GDP}\ (t)) = \alpha + \theta t + \varepsilon_t. \quad (4)$$

The dependent variable is the standard deviation of the natural logarithms of GDP per capita in various countries in a given year, the explanatory variable is the time (t = 1, ..., 21 for the 1995-2015 period), while ε_t – as before – is a random factor. A negative and statistically significant value of the θ coefficient indicates the occurrence of σ convergence.

The calculations have been carried out on the basis of real GDP per capita time series at purchasing power parity (in international dollars), derived from the International Monetary Fund database (IMF, 2016). When converting nominal GDP per capita at PPP (at current prices) into real GDP per capita at PPP (at constant prices), the GDP deflator for the United States was used. Aggregate data for the two groups of countries (EU11 and EU15) are weighted averages to account for a different size of the economies concerned, and the weights are the population numbers of each country in a given year.

The prevalence of a real convergence of CEE countries vis-à-vis the EU15 group can be explained as a combined effect of multiple factors, including a comparable level of economic development and the structure of economies, similar direction of systemic reforms, mutual economic cooperation, trade liberalization, and dismantling barriers hampering the flows of productive factors (in particular labour and capital) between countries. The income convergence was further fostered by structural and regional EU policies focused on reducing disparities in development levels. Financial aid was mainly directed to poorer countries and regions, which led to acceleration of economic growth. These factors combined enhanced the process of income level equalization between the CEE countries and Western Europe both in the pre-accession period and after their

accession to the European Union, though the impact of these factors on the pace of convergence might have varied in individual years and countries.

This study aims at estimating the rate of convergence in the whole period analysed as well as at determining how the dynamics of this process has changed over time. To this end, the period studied is divided into two sub-periods: 1995-2004, i.e. the years prior to the EU enlargement, and 2004-2015, i.e. the time of eight CEE countries' membership in the European Union. If the convergence process preceding the enlargement was faster than in the subsequent sub-period, it would imply that the 'external or integration anchor' began to operate effectively before the official EU enlargement took place and the CEE countries took advantage of some benefits of integration already in the pre-accession period.

Table 1. Regression results for the β convergence of the EU countries.

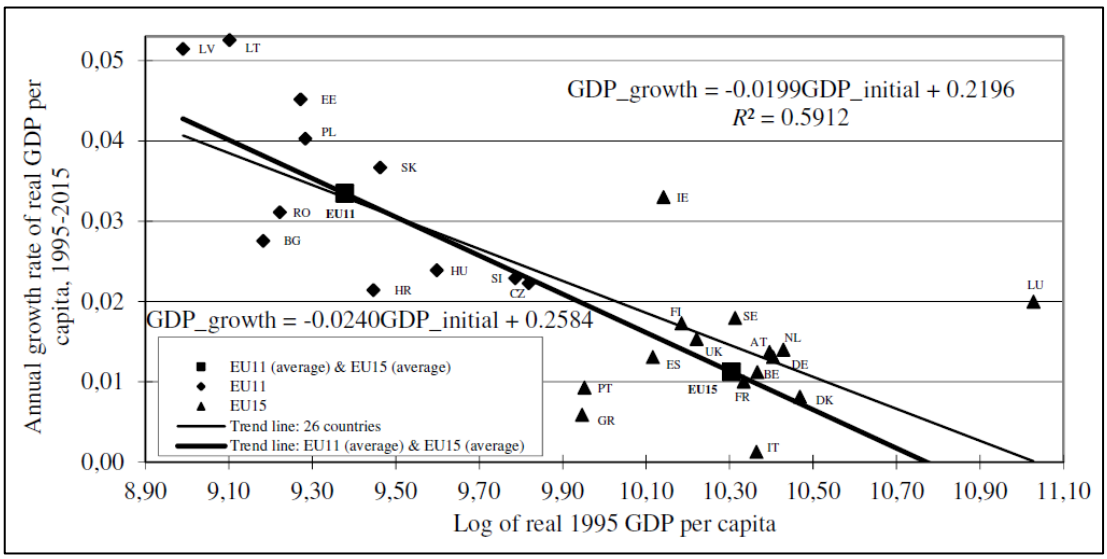
Variable / statistics	26 countries of the enlarged EU		
	1995-2015	**1995-2004**	**2004-2015**
logGDP(0)	–0.0199 (0.000)	–0.0191 (0.001)	–0.0225 (0.000)
Constant	0.2196 (0.000)	0.2234 (0.000)	0.2426 (0.000)
R^2	59.12%	36.73%	45.14%
R^2 adjusted	57.42%	34.10%	42.86%
No. of observations	26	26	26
β convergence	yes	yes	yes
β coefficient	2.01% (2.43%)	1.93% (1.93%)	2.27% (3.44%)
Half-life (in years)	34.5 (28.6)	35.9 (35.9)	30.5 (20.2)

Explained variable: growth rate of real GDP per capita at PPP (annual average).
β-coefficients and half-lives given in brackets correspond to the slope of the line which connects two observations for the EU11 and EU15 groups, respectively.
Source: Own calculations.

Table 1 and Figure 1 show the results of our analysis of β convergence of the CEE countries toward Western Europe. The convergence is analysed here both between the 26 EU countries and between the two regions comprising the EU11 and EU15 areas. The table provides the estimation results of the regression equation (1),

along with estimates of the coefficients of the speed of convergence, calculated according to formula (2), and the half-lives based on formula (3). The β convergence occurs (answer 'yes' in the table) if the pace of economic growth is negatively and statistically significantly dependent on the initial income level. This takes place once the estimated parameter ζ is negative and the corresponding p-value amounts to less than 0.1 (assuming a 10-percent significance level).

Figure 1. β convergence in the European Union, 1995-2015.



Source: Own calculations.

The results confirm a clear-cut income-level convergence of the EU11 countries with regard to the EU15 in the entire 1995-2015 period. The convergence trend has been detected both among the individual countries, i.e. 26 countries of the European Union and between the EU11 and EU15 regions. For the 26 countries of the enlarged EU, the slope of the regression line is negative with p-value standing at 0.000 and the R-squared coefficient equals 59%. This is equivalent to say that countries with lower incomes in 1995 (EU11) recorded – in average – a faster rate of economic growth in the 1995-2015 period compared to (initially) more developed economies (EU15).

The prevalence of β convergence in the 1995-2015 period in the group of 26 EU countries is illustrated in Figure 1. The points representing the EU11 countries are located in the upper left corner whereas those for the EU15 economies – in the lower right corner. This implies that the EU11 countries exhibited a faster rate of economic

growth between 1995 and 2015 while their initial income level was lower. The analysis of data presented in the chart demonstrates that the dispersion of points representing each country is not large in relation to the negatively-sloped trend line. This translates into a relatively high value of the *R*-squared coefficient at almost 60%. Thus, differences in the initial income level explain almost $^{2}/_{3}$ of the variation in economic growth rates during 1995-2015.

Among the countries in our sample, the Baltic states stand out as the best performers in economic growth. Between 1995 and 2015, Lithuania, Latvia and Estonia recorded the rate of economic growth of about 4.5-5% in average per annum, having started from a relatively low initial income level. The results achieved by the Baltic countries have fostered the convergence tendencies in the whole CEE group. Poland performed also well relative to other countries: in terms of economic growth it was ranked fourth among the 26 EU economies while its development level in 1995 was relatively low. This outcome contributed to reinforce the convergence trend in the whole group of CEE countries too. On the other hand, the mean catching-up tendencies of the EU11 countries vis-à-vis Western Europe were adversely affected by the poor growth performance in Romania and Bulgaria. By 1995, these countries featured a relatively low level of GDP per capita and experienced a very slow economic growth over the 1995-2015 period. As a result, the points representing these two countries are well below the trend line and reduce its gradient. Croatia also witnessed an equally slow economic growth, the initial development level of this country however was higher (in 1995, Croatia's GDP per capita was above the levels prevailing in Poland, the Baltic states, Romania, and Bulgaria).

Figure 1 also shows that there are some differences in economic growth paths among Western European countries. Two countries in particular: Ireland and most notably Luxembourg displayed a relatively rapid output growth compared to their initial income level, which is reflected in their position well above the trend line. The case of Luxembourg, however, is atypical since the high GDP per capita level and fast economic growth of this country – as a tax haven – were to a substantial extent due to the fact that many multinational companies, especially in the financial sector and high-tech industries, are registered there. In contrast, three Mediterranean economies: Italy, Greece and Portugal exhibited a slow economic growth. It can be concluded therefore

that growth trajectories of the individual EU11 and EU15 countries have often deviated from the common trend line for all 26 EU economies.

The aggregate data for two areas: EU11 and EU15 also corroborate the income convergence during 1995-2015. The EU11 group as a whole displayed a faster rate of economic growth compared to the EU15 area, at a much lower initial income level. The data for the EU11 and EU15 areas can be considered as the first level aggregation. Both groups of countries can also be divided into smaller subgroups. In the case of EU11 group, we can distinguish the Baltic states, the Visegrad Group countries, or the euro area and non-euro area members. Western Europe can be divided into core and peripheric countries as well as into euro area and non-euro area economies. For the sake of conciseness, we apply the Ockham razor here and we include only the most aggregated groups (EU11 and EU15 areas).

The β coefficients, measuring the speed of convergence, amount to 2.01% for the 26 countries and 2.43% for the two areas. These outcomes mean that if the average growth patterns witnessed in 1995-2015 continue, the countries of the enlarged EU will need some 30-35 years to reduce by half the distance to a common hypothetical steady-state (half-lives). These results indicate a moderate convergence of the EU11 countries with regard to Western Europe during the entire 1995-2015 period. As it turns out later in the text, the instability of the convergence process over time and its considerable acceleration after the EU enlargement both imply that – under the optimistic scenario – the actual rate of convergence in the future may be faster than suggested by the average outcomes for the whole 1995-2015 period as it comprises the years before the EU enlargement entailing a slower pace of income convergence.

On the other hand, the results should be interpreted with an appropriate caution since the future is very uncertain; our simulation does not include, inter alia, unexpected internal or external shocks that may hit individual countries and change their economic growth paths. A particularly spectacular example of such a shock was the global economic crisis adversely affecting the speed of convergence in average terms for the whole group. This was mostly due to the fact that it triggered a deep recession in the Baltic states, i.e. the economies with a low 1995 GDP per capita level and exhibiting a very rapid economic growth, especially in 2000-2007, which had previously contributed to enhance the convergence trend in the entire CEE group.

When comparing the results for 1995-2004 and 2004-2015, it can be noted that the β convergence took place in both sub-periods. However, after the EU enlargement, i.e. in 2004-2015, the catching-up process accelerated. The relationship between the initial income level and subsequent economic growth is negative and statistically significant (p-values below 0.01) in both sub-periods. This applies to the convergence among the 26 individual countries as well as between the two regions. The accelerated pace of convergence can be inferred from a greater slope of the trend line, and consequently – higher β coefficients. For the EU26 countries, the β coefficient increased from 1.93% in 1995-2004 to 2.27% in 2004-2015, while for the two regions it rose from 1.93% to 3.44% in the same period.[4]

The acceleration of the catching-up process was due to a number of factors, including a further liberalization of trade and capital flows, which resulted in a substantial reduction of tariffs and the growing importance of international trade as well as the increased inflow of foreign direct investment. It was also driven by a liberalization of the labour markets, which led to the migration of workers from regions and countries with lower wage rates to more affluent areas. Still another key driver of an accelerated convergence process stemmed from continued structural and institutional reforms (e.g. an increased scope of economic freedom) as well as from the improvement of both quality and predictability of economic policies (fiscal and monetary policies, and the supply-side policy). A significant role in accelerating the pace of convergence has been played by the EU structural funds aimed to foster the development of poorer countries and regions of the European Union. The inflow of the EU funds has gained momentum after the accession of new member states boosting their economic growth. This is particularly evident in the case of Poland, the largest beneficiary of the EU funds from the 2007-2013 budget among the EU11 countries. The money injected by the EU within the framework of various aid programs (e.g. structural funds) fuelled Poland's economic growth from both the demand-side and the supply-side perspective, significantly contributing to an improved growth performance of the Polish economy in recent years (e.g. Poland was the only EU country that did not suffer a GDP contraction during the global economic and financial crisis of 2008-09). The new EU

[4] Prochniak and Witkowski (2013) apply more advanced econometric models, based on Bayesian averaging of estimates, to analyze the time stability of the β convergence within the EU.

Financial Perspective for 2014-2020, which assumes a continued large inflow of structural funds to the new member states, may be regarded as one of the key preconditions for making the hitherto rapid pace of income-level convergence of the CEE countries toward Western European standards sustainable in the coming years.

In the next section of the text we will embark on a quantitative assessment of the effect of some of the variables mentioned above, associated with the EU membership, on economic growth of the CEE countries. Before doing so however, we will first verify the σ convergence hypothesis, with a view to get a complete picture of the catching-up process.

The σ convergence is measured by changes in the standard deviation of natural logarithms of GDP per capita between the 26 EU countries as well as between the EU11 and the EU15 regions. The estimation results of the trend line for the standard deviation are shown in Table 2 and Figure 2. In the models presented in Table 2, the number of observations is relatively low but the number of explanatory variables is low too. The problem would appear if the number of explanatory variables were large; in such a case the models would lose their degrees of freedom. However, this is not the case of the sigma convergence models estimated in this study.

Table 2. Regression results for σ convergence of the European Union countries.

Variable / statistics	**26 countries of the enlarged EU**			**2 regions (EU11 and EU15)**		
	1995-2015	**1995-2004**	**2004-2015**	**1995-2015**	**1995-2004**	**2004-2015**
Time	–0.0101 (0.000)	–0.0068 (0.008)	–0.0073 (0.000)	–0.0126 (0.000)	–0.0073 (0.001)	–0.0122 (0.000)
Constant	0.5540 (0.000)	0.5423 (0.000)	0.4387 (0.000)	0.5013 (0.000)	0.4776 (0.000)	0.3810 (0.000)
R^2	92.17%	60.16%	85.55%	96.05%	76.44%	95.76%
R^2 adjusted	91.76%	55.19%	84.10%	95.84%	73.50%	95.33%
No. of observations	21	10	12	21	10	12
σ convergence	yes	yes	yes	yes	yes	yes

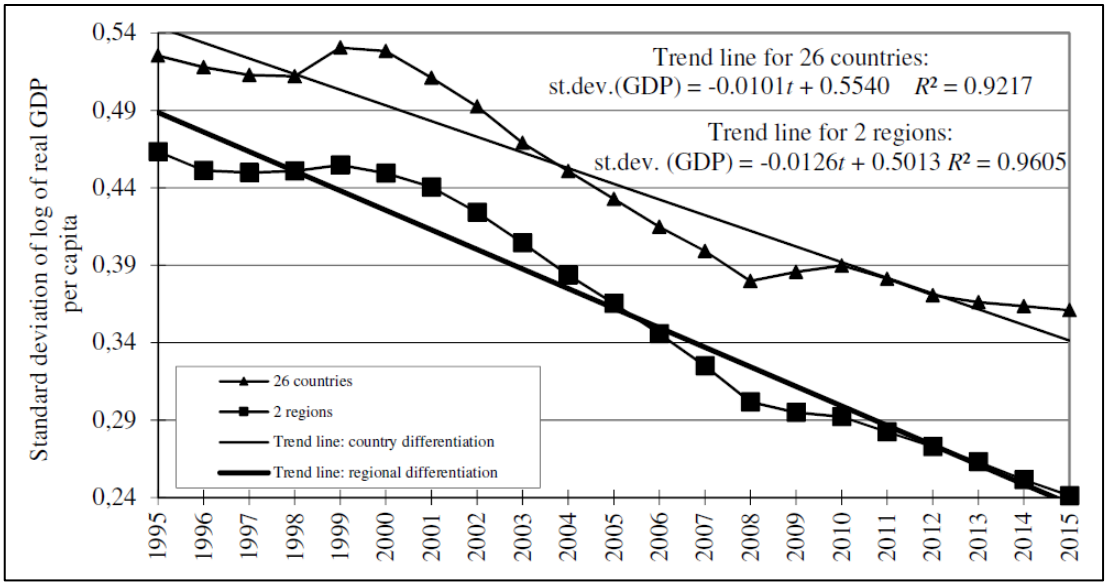
Explained variable: standard deviation of log of real GDP per capita at PPP between countries or regions in a given year. Source: Own calculations.

The results involved indicate that all the time periods singled out witnessed a σ convergence process both among the 26 EU countries and between the EU11 and the EU15 groups. The slopes of all the estimated trend lines are negative and statistically significant at very high significance levels (*p*-values not exceeding 0.01). High *R*-squared coefficients imply a very good fit of empirical points to the trend line. As can be seen from Figure 2, the income disparities between the new and incumbent EU members exhibited, generally, a downward trend. The most visible and systematic decrease in income differentials occurred after 2000. However, in 2009-2010 – as a result of the global crisis and the economic slowdown in many previously fast-growing countries – income-level differentials among the 26 countries augmented, although the mean indicators for the two regions do not support this finding.

When assessing the speed of income convergence as a derivative of European integration, it can be concluded that the EU membership has contributed to shrinking income-level differentials between countries. In the 1990s, when the prospects of the EU accession were still distant, income disparities among the countries in our sample tended to remain roughly constant. The approaching date of the EU entry and the accession itself combined to accelerate the real convergence process between the member states.

A more in-depth analysis of our findings, with special regard to the results presented in Figure 2, shows that convergence is not an automatic process. The trend toward narrowing the prevailing gaps in economic development levels need not be maintained in the future; one may even anticipate the divergence trends to emerge in the years to come. Hence, it is extremely important to pursue an appropriate economic policy (including not only fiscal and monetary policies but also reforms of the institutional environment of the market), which would make the process of income levels equalization between the EU countries more sustainable. Contingent upon the right economic policies and a favourable external environment, it can be expected that – under the optimistic scenario – the coming years will bring a further narrowing of income-level differentials between the EU11 countries and Western Europe.

Figure 2. σ convergence in the European Union, 1995-2015.



Source: Own calculations.

It is necessary to stress that the dispersion of income levels between countries needn't be correlated with the behaviour of income inequalities observed within the given economies. The empirical evidence on regional income-level convergence indicates that while the standard deviation of real GDP per capita was generally declining at the country level, at the regional level it was rising leading to increased dispersion of gross regional product per capita. However, the examination of regional convergence is beyond the scope of this study.

3. Econometric modelling of the impact of the EU membership on economic growth of the CEE countries

The first part of our study showed that between 1995 and 2015 the CEE countries recorded on average a more rapid economic growth than the EU15. Given these results, the following question arises: "Was the fast economic growth of the CEE countries solely a derivative of a pure convergence mechanism (being driven by differences in the marginal productivity of inputs to production), or it was also determined by other factors?". One of such potential sources of a faster GDP growth is the membership in the European Union. The effect of the EU membership on economic growth of the CEE countries may take place through a number of channels. The first one includes the EU actions geared towards accelerating structural reforms in

the countries of Central and Eastern Europe and changing their institutional environment. The second channel stems from the EU policies aimed explicitly at reducing the income-level differentials between pertinent countries and regions, involving the monetary transfers within the framework of aid funds. The third channel is associated with the increased freedom of movement of productive factors (capital and labour) as well as goods and services, which is reflected, among others, by a significant strengthening of trade and capital links within the analysed group.

In this part of the study we empirically test the hypothesis that the EU membership significantly contributed to the acceleration of economic growth of the CEE countries, including their real convergence toward Western Europe. To this end, we apply econometric methods, with special focus on the regression analysis. Namely, we build and estimate empirical models of economic growth (regression equations) where GDP growth is regressed against multiple variables, including factors associated with the EU membership as well as other control variables. If the variables associated with the EU membership prove to be statistically significant, this will imply a positive empirical verification of our hypothesis. In the econometric exercise that follows many variants of the econometric models are tested to achieve stability and robustness of the results with respect to changes in the set of explanatory variables.

The dependent variable is the growth rate of real GDP per capita at PPP.[5] There are 21 explanatory variables presented in Table 3. Their basic descriptive statistics are provided in Table 4. The set of explanatory variables is divided into two groups.

The first group includes variables associated with the membership in the European Union. Seven variables are being tested, representing the following areas: (a) economic freedom (two variables), (b) the quality of governance, (c) European funds, (d) international trade, (e) foreign investment, and (f) the progress of market (structural) reforms. A detailed list of the pertinent variables, along with the source and scale, is provided in the upper part of Table 3.

The scope of economic freedom is measured by economic freedom indicators compiled by the Heritage Foundation and the Fraser Institute. The quality of

[5] As will be explained later in the text, the methodology applied requires a slight transformation of the model toward estimating the regression equation with the level of GDP per capita being the explained variable. The interpretation of the results, however, will be made in terms of the impact on economic growth.

government is assessed on the basis of worldwide governance indicator from the World Bank (calculated by the authors as the average of individual variables). The progress of market reforms is calculated by the authors as the arithmetic mean of EBRD scores assessing the advancement of systemic transformation in individual reform areas.[6] These variables represent the institutional channel through which the EU membership affects economic growth of the CEE countries.

The inflow of European funds is approximated by the volume of total spending from the EU budget allocated to individual member states, a variable that covers a wide range of expenditure categories. The rationale behind the choice of this indicator was to avoid excluding arbitrarily some types of EU funds.[7] Moreover, the present study is envisaged to be the initial stage of a more comprehensive research on the effects of particular kinds of European funds on economic growth. Worth stressing is also the fact that the variable in question was calculated based on the same methodology for all countries and all years involved which makes the results obtained fully comparable.[8]

In the case of foreign trade, we focus on changes (in percentage points) in the value of a gauge measuring openness of an economy (exports plus imports divided by GDP) rather than on its absolute level. This was motivated by the fact that according to economic theory and supported by empirical evidence, the share of exports and imports in GDP depends primarily on the size of an economy. Large countries (e.g. Poland or Romania) display as a rule lower shares of exports and imports in GDP compared to small countries (e.g. the Baltic states). It seems therefore that – seen from the angle of the theoretical structural model involved – the explanatory variable expressed in terms of the growth rate of openness of an economy is better tailored to meet the objectives of our exercise than its absolute level.

[6] Since 2008 the EBRD has ceased publishing data for the Czech Republic. As a result, the calculations based on the EBRD transition scores are carried out on an incomplete group of CEE countries, excluding the Czech Republic.

[7] The impact of EU funds on economic growth takes place from both the demand-side and supply-side perspective. That is why both the EU funds that have direct impact on the demand-side of the economy (like subsidies to farmers) as well as those that in the long-run aim to increase the potential output and affect the supply-side of the economy (like outlays on human capital accumulation) should be included in the analysis.

[8] Data on expenditure from the EU budget are available from 2000. Statistics published for earlier years do not show spending assigned to individual countries and therefore cannot be included in the calculations.

Table 3. The list of explanatory variables.

No.	Name	Variable description	Type[a]
		Variables related with EU membership	
1	econfree_hf	Heritage Foundation index of economic freedom (scale: from 0 to 100)	E
2	econfree_fi	Fraser Institute index of economic freedom (scale: from 0 to 10)	E
3	wgi	World Bank's worldwide governance indicator (scale: from –2.5 to +2.5)	E
4	eu_fund	Inflow of EU funds (overall expenditure from the EU budget to a given member country) (% of GDP)	E
5	delta_open	Change (in percentage points) of the openness rate: Δ(exports + imports)/GDP	E
6	fdi	Net inflow of foreign direct investment (% of GDP)	E
7	tran_ebrd	EBRD transition indicator (scale: from 1 to 4.3)	E
		Other explanatory variables	
8	gdp_initial	Lagged log GDP per capita at PPP (constant 2009 prices)	E
9	inv	Gross fixed capital formation (% of GDP)	E
10	gov_cons	General government consumption expenditure (% of GDP)	E
11	gov_bal	General government balance (% of GDP)	E
12	gov_rev	General government revenue (% of GDP)	E
13	edu_exp	Education expenditure (% of GNI)	E
14	infl	Inflation rate (%)	E
15	nonp_loans	Bank nonperforming loans (% of total gross loans)	E
16	serv	Value added in services (% of GDP)	E
17	life	Log of life expectancy at birth (years)	X
18	fert	Log of fertility rate (births per woman)	X
19	pop_15_64	Population aged 15-64 (% of total population)	X
20	pop_gr	Population growth (%)	X
21	crisis	Global crisis dummy (=1 for the periods covering the year 2009 and 0 otherwise)	X

[a] *E – endogenous variable; X – exogenous variable.*

Source: Own elaboration based on: EBRD (2016), European Commission (2016), Fraser Institute (2016), Heritage Foundation (2016), IMF (2016), World Bank (2016a, 2016b).

Table 4. Descriptive statistics of the variables used (1995-2015).

No.	Variable	No. of observations	5th centile	Mean	Median	95th centile	Standard deviation
1	econfree_hf	227	50.0	63.0	64.4	75.1	7.4
2	econfree_fi	209	5.2	6.7	6.9	7.7	0.8
3	wgi	209	0.0	0.6	0.7	1.0	0.3
4	eu_fund	165	0.2	2.1	1.9	5.5	1.7
5	open[a]	220	61.1	107.3	100.6	166.9	32.1
6	fdi	219	0.5	5.0	3.7	11.8	6.0
7	tran_ebrd	198	3.2	3.7	3.7	4.1	0.3
8	gdp[b]	242	9498	18070	18080	27453	5489
9	inv	231	18.5	25.1	24.9	34.5	5.6
10	gov_cons	220	14.9	19.1	19.0	22.8	2.3
11	gov_bal	225	-8.0	-3.2	-3.1	1.1	2.8
12	gov_rev	225	30.9	37.7	38.1	45.2	4.5
13	edu_exp	209	3.1	4.4	4.4	5.6	0.8
14	infl	229	-0.1	12.3	3.9	28.1	71.1
15	nonp_loans	206	1.0	8.8	5.4	23.1	9.4
16	serv	220	57.3	63.3	63.8	71.2	4.9
17	life[c]	209	69.7	73.5	73.4	77.8	2.5
18	fert[c]	209	1.2	1.4	1.4	1.6	0.1
19	pop_15_64	220	66.1	68.3	67.9	71.5	1.6
20	pop_gr	218	-1.7	-0.4	-0.3	0.3	0.7

Descriptive statistics have been calculated on the basis of the whole range of values of a given variable for the entire sample of countries. The maximum number of observations (except the variable gdp) is 231 (21 years × 11 countries). The starting year for GDP is 1994 and the maximum number of observations for this variable is 242.

[a] *The level of the openness rate (not the change).*

[b] *The level of GDP per capita at PPP at constant 2009 prices (not logarithmized). Statistics calculated for the period 1994-2015.*

[c] *Not logarithmized.*

Source: Own calculations.

We realize that the set of variables of our choice aimed to approximate the impact of the EU membership is not perfect. For example, we do not know exactly to what extent the inflow of foreign direct investment (FDI), the development of foreign trade, the increase in the scope of economic freedom and the progress of market reforms have been determined by the 'integration anchor' and to what degree they have stemmed from broader changes taking place in the global economy. However, in our view the integration anchor associated with the EU membership was an important driver of change in these areas. This view has been shared by many other economists (e.g., IMF, 2002, p. 102).

The second group of explanatory variables is made up of those growth factors that are assigned the role of control variables in the regression equations. Their function

is to account for the fact that the sources of economic growth are multidimensional and it is difficult to disentangle them and capture separately each of the growth factors. Hence, the regression equations must embrace many variables, which more or less directly affect the dynamics of output.

In the empirical exercise below we take into account 14 control variables. They are listed in the bottom part of Table 3. Control variables can be grouped into several categories including, *inter alia*, investment (in physical capital), human capital, fiscal policy (government budget), monetary policy, the structure of the economy, and the demographic situation. These are all factors/areas which play a vital role as determinants of economic growth. In addition, the group of control variables comprises a dummy variable, which is related to the global economic and financial crisis. The dummy assumes the value of 1 for the periods covering the year 2009, and the value of 0 for the remaining periods. It enables a quantitative assessment of the effect of the recent adverse external shock or global crisis on economic growth deceleration in the countries being examined.[9]

The choice of control variables in our study is rooted in economic theory and the pertinent empirical research. Yet, such a choice is always a kind of compromise between a limited number of potential drivers of economic growth and the completeness of the model. Since the set of variables that directly or indirectly determine the dynamics of output is practically unlimited, in empirical studies it needs to be confined to a reasonable size. The analyses, which aim to identify multiple determinants of GDP dynamics, tend to encompass a large number of potential growth drivers.[10] In the present study however, that focuses on the impact of the EU membership on economic growth, allowing for such a large data set is not necessary. As a consequence, the set of variables has been limited to the most important (in our view) determinants of the GDP dynamics.

[9] Similar approach was adopted by Dobrinsky and Havlik (2014) in the study of conditional convergence of 27 EU countries, who introduced dummy variables for the years 2008 and 2009, and in some models also for 2011.

[10] Some econometric methods are even specially designed to test a large set of explanatory variables. For example, Sala-i-Martin, Doppelhofer, and Miller (2004) use Bayesian averaging of estimates to analyze more than 60 factors of economic growth. A large number of variables can be found in some other studies (e.g., Moral-Benito, 2012).

This part of the study covers eleven Central and Eastern European countries[11] and the 1995-2015 period. The calculations have been carried out on the basis of a 'moving' panel with overlapping observations. Therefore, the whole period has been split into seventeen 5-year sub-periods: 1995-1999, 1996-2000, 1997-2001, ..., 2010-2014, and 2011-2015. The rationale behind our choice of a moving panel with overlapping sub-periods is due to several reasons. First, while using this technique we avoid the arbitrary division of the period studied into shorter sub-periods. Hence, the results are less sensitive to the influence of business cycles and other irregular fluctuations resulting from various demand- and supply-side shocks, both internal and external. Second, the number of observations for each country is now greater, thus improving the statistical properties of the results. Third, the use of overlapping observations entails quite long (5-year) sub-periods that allow to capture at least medium-run relationships, which is a desirable property in empirical studies on economic growth.[12]

The economic growth determinants are taken as the average values over all years in a given sub-period (in the case of incomplete data, the average covers a shorter period[13]). GDP growth rates are calculated as a difference between the natural logarithm of GDP per capita in the last year of a given sub-period and log GDP per capita in the last year of the previous sub-period. Initial GDP per capita is the natural logarithm of the GDP per capita level in the last year of the previous sub-period.

In order to capture the effect of the EU membership on economic growth we use the so-called Barro regression (Barro and Sala-i-Martin, 2003). The estimated regression equations have the following general form:

[11] The study includes the following countries: Bulgaria, the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

[12] In an earlier study (Prochniak and Wasiak, 2017), a detailed robustness analysis was carried out with respect to the length of a single sub-period. The cited study examines the relationship between the financial sector and economic growth on the basis of models estimated for 3-year sub-periods and 5-year sub-periods (overlapping observations in both cases). It turns out that the results do not differ much as a function of the length of the sub-period.

[13] In the case of missing data, a given sub-period is included in the calculations when at least three yearly observations are available. For example, as the statistics on European funds have been available since 2000, the first observation that is included in the calculations for this variable covers the 1998-2002 sub-period.

$$g\_gdp_{it} = \alpha_0 + \alpha_1 EU\_mem_{it} + \alpha_2 gdp\_initial_{it} + \beta_1 x_{1it} + \cdots + \\ + \beta_n x_{nit} + \beta_{n+1} crisis + \theta_i + \varepsilon_{it}. \quad (5)$$

The explained variable *g_gdp* is the growth rate of real GDP per capita at purchasing power parity (PPP). *gdp_initial* is the initial log GDP per capita level. This variable represents the impact of initial conditions on the subsequent rate of economic growth and appears in each estimated regression equation. The inclusion of initial GDP per capita allows us to verify the occurrence of conditional β convergence. As the process of β convergence was earlier confirmed in our sample of countries (see the previous section), the absence of this variable would result in a considerable omitted variable bias. *EU_mem* is the variable associated with the EU membership. This variable appears in each regression equation. $x_1 - x_n$ are other economic growth determinants that are selected from our set of potential growth factors (see: Table 3). θ_i is the individual country effect while ε_{it} is the random factor.

When estimating the regression equation made explicit in formula (5), there are some problems related e.g. to the fact that some variables (such as the initial GDP per capita) are endogenous. Given the autoregressive character of the model, a proper method of estimation is necessary. Firstly, classical estimators such as fixed or random effects are inconsistent. However, an instrumental variables approach can be used if model (5) is transformed to the following form:

$$gdp\_final_{it} = \alpha_0 + \alpha_1 EU\_mem_{it} + (1 + \alpha_2) gdp\_initial_{it} + \beta_1 x_{1it} + \cdots + \\ + \beta_n x_{nit} + \beta_{n+1} crisis + \theta_i + \varepsilon_{it}. \quad (6)$$

Model (6) is equivalent to formula (5). The only difference is that the coefficient standing on initial GDP per capita in equation (6) is the β convergence coefficient augmented by 1. Thus, in order to get the standard coefficient on initial income level in the untransformed β convergence regression, where the growth rate is the explained variable, it is necessary to subtract 1 from the coefficient $(1 + \alpha_2)$ in model (6). However, model (6) can be estimated using the instrumental variables method or – more frequently – the generalized method of moments. The most popular estimator

from the latter group is the Blundell and Bond's GMM system estimator (Blundell and Bond, 1998). It is free from some weaknesses of the (being widely used earlier) Arellano and Bond (1991) estimator, including e.g. a strong bias in small samples, especially in the case of high autoregression of the β-type convergence models (e.g., Goczek and Witkowski, 2016 for more discussion and applications). Bearing in mind these problems, in this study we apply the Blundell and Bond's GMM system estimator.[14]

The estimation technique involved calls for a division of the set of explanatory variables into three groups: endogenous, predetermined, and strictly exogenous variables. Bearing in mind the prevailing economic theory, we assume that all macroeconomic variables, including the ones related with the EU membership, are endogenously given (see the last column of Table 3). Instead, variables related to population and health of the society (life expectancy, fertility rate, population growth, and the share of population aged 15-64) as well as the dummy variable (crisis) are exogenous.

The reliance on the 'moving' panel technique does not imply data redundancy because the GDP per capita from a given year is used only twice in the calculations of final time series: once as the initial GDP per capita and once as the final GDP per capita. For example, since the (cumulative) growth rate for the 1995-1999 period is calculated as ($\log GDP_{1999} - \log GDP_{1994}$), then the 1999 GDP per capita is used once to calculate the 1995-1999 growth rate (as the final value) and once to calculate the 2000-2004 growth rate (as the initial value).

In order to account for autocorrelation, the Arellano and Bond tests for first- and second-order autocorrelation in the first-differenced errors were performed for each regression equation. The null hypothesis in this test is no autocorrelation of the given order. For the model of interest to be valid, there cannot be second-order autocorrelation (while the first order of autocorrelation is not an issue given the fact that the equation is in first differences and the first order autocorrelation of $\Delta\varepsilon$ stems directly from the non-zero variance of ε, while the second order autocorrelation in $\Delta\varepsilon$ would imply the first order autocorrelation in ε and, as a result, inconsistency of the GMM estimator in the used form). The tests performed after regression estimation suggest that there is no second-order autocorrelation in the models presented in this section. To

[14] See also: Prochniak and Wasiak (2017) for another application of this method in the nonlinear models.

account for heteroskedasticity, the heteroskedasticity-robust errors were computed instead of the non-robust typical standard errors.

The results of the regression analysis are presented in Tables 5-11. Each table corresponds to one of the variables associated with the EU membership. The respective variable is placed in the title of the pertinent table. Since the variables involved assume values coming from different scales, the magnitudes of their coefficients vary from one specification to another.

To avoid biased results due to the arbitrary choice of a set of explanatory variables, several alternative variants of the model have been estimated for each variable associated with the EU membership. Each model contains the initial income level as a derivative of the findings of the first part of the analysis, namely a clear confirmation of the trend towards a real economic convergence in the EU. The first equation presented in the tables embraces two variables: the initial income level and a variable associated with the EU membership. The second equation is extended to include a variable *crisis*, the aim of which is to account for economic slowdown or recession resulting from the global crisis. Other models encompass more explanatory variables. The selection was based on economic criteria and economic significance. Most equations comprise the investment rate – except models with foreign investment in order to avoid duplication of two variables with a similar coverage (i.e. foreign direct investment and total investment). Many models include one variable related with fiscal policy (government expenditure or revenue, or government balance). Exogenous population variables also appear in a number of regression equations.

Table 5. Regression results for the Heritage Foundation index of economic freedom (*econfree_hf*), EU11 countries.

Estimated coefficient (*p*-value)	**[1]**	**[2]**	**[3]**	**[4]**	**[5]**	**[6]**
econfree_hf	0.0162 (0.000)	0.0157 (0.000)	0.0103 (0.014)	0.0049 (0.126)	0.0064 (0.001)	0.0067 (0.112)
gdp_initial	0.4944 (0.000)	0.6097 (0.000)	0.7140 (0.000)	0.7218 (0.000)	0.6442 (0.000)	0.5720 (0.000)
inv			0.0143 (0.000)	0.0115 (0.000)	0.0081 (0.000)	0.0088 (0.003)
gov_cons					–0.0108 (0.013)	
gov_bal						0.0099 (0.129)
edu_exp				0.0290 (0.070)		
infl				–0.0004 (0.119)		
nonp_loans					–0.0068 (0.000)	
serv						0.0100 (0.001)
life					0.6311 (0.452)	0.6186 (0.466)
fert					0.0679 (0.459)	0.1585 (0.262)
pop_15_64				0.0496 (0.000)	0.0262 (0.000)	0.0551 (0.000)
pop_gr				–0.0857 (0.008)	–0.0281 (0.318)	
crisis		–0.0914 (0.000)	–0.1098 (0.000)	–0.1195 (0.000)	–0.1218 (0.000)	–0.1247 (0.000)
constant	4.0433 (0.000)	2.9845 (0.000)	1.9603 (0.000)	–1.2575 (0.009)	–1.2388 (0.681)	–3.3843 (0.267)
No. of obs.	187	187	187	187	185	185
Obs. per country:						
– min.	17	17	17	17	16	16
– avg.	17	17	17	17	16.8	16.8
– max.	17	17	17	17	17	17

Regression equations are estimated using the Blundell and Bond's GMM system estimator. Explained variable: the level of real GDP per capita at PPP (in the final year of a given observation). To obtain a standard regression coefficient in the untransformed convergence model where GDP growth rate is the explained variable it is necessary to subtract 1 from the coefficient standing on gdp_initial (and divide by 5 to express it on a yearly basis). gdp_initial is the level of real GDP per capita at PPP in the final year of the preceding observation (period t – 5).
Estimated coefficients and p-values (in brackets) are given for the explanatory variables.
Source: Own calculations.

Table 6. Regression results for the Fraser Institute index of economic freedom (econfree_fi), EU11 countries.

Estimated coefficient (p-value)	[7]	[8]	[9]	[10]	[11]	[12]
econfree_fi	0.1677 (0.000)	0.1704 (0.000)	0.1283 (0.000)	0.1111 (0.000)	0.0547 (0.026)	0.0987 (0.008)
gdp_initial	0.4473 (0.000)	0.5629 (0.000)	0.6129 (0.000)	0.6317 (0.000)	0.7116 (0.000)	0.6264 (0.000)
inv			0.0106 (0.000)	0.0088 (0.000)	0.0085 (0.000)	0.0082 (0.000)
gov_cons					–0.0044 (0.246)	
gov_bal						0.0065 (0.179)
gov_rev				0.0018 (0.516)		
infl				–0.0001 (0.379)		
nonp_loans					–0.0055 (0.000)	
serv						0.0019 (0.680)
life			0.5051 (0.576)		0.1373 (0.844)	0.0515 (0.950)
fert					0.0407 (0.625)	0.1040 (0.274)
pop_15_64				0.0310 (0.000)	0.0233 (0.000)	0.0371 (0.000)
pop_gr				–0.0129 (0.519)	–0.0250 (0.284)	
crisis		–0.1062 (0.000)	–0.1165 (0.000)	–0.1171 (0.000)	–0.1262 (0.000)	–0.1230 (0.000)
constant	4.3725 (0.000)	3.2675 (0.000)	0.6310 (0.847)	0.5881 (0.264)	0.3342 (0.891)	0.0470 (0.988)
No. of obs.	187	187	187	185	185	185
Obs. per country:						
– min.	17	17	17	16	16	16
– avg.	17	17	17	16.8	16.8	16.8
– max.	17	17	17	17	17	17

Notes as in Table 5.
Source: Own calculations.

Table 7. Regression results for the worldwide governance indicator (wgi), EU11 countries.

Estimated coefficient (p-value)	**[13]**	**[14]**	**[15]**	**[16]**	**[17]**	**[18]**
wgi	0.3933 (0.004)	0.1475 (0.040)	0.1688 (0.013)	0.0985 (0.084)	0.0993 (0.099)	0.1212 (0.025)
gdp_initial	0.5467 (0.000)	0.7832 (0.000)	0.6740 (0.000)	0.7530 (0.000)	0.6880 (0.000)	0.6158 (0.000)
inv		0.0164 (0.000)	0.0167 (0.000)	0.0116 (0.000)	0.0085 (0.000)	0.0073 (0.002)
gov_cons					–0.0112 (0.002)	
gov_bal						0.0101 (0.059)
gov_rev				–0.0050 (0.182)		
infl				–0.0007 (0.040)		
nonp_loans					–0.0070 (0.000)	
serv						0.0142 (0.000)
life			1.2121 (0.336)		0.4545 (0.333)	–0.1314 (0.886)
fert					0.1276 (0.344)	0.2395 (0.023)
pop_15_64				0.0390 (0.000)	0.0270 (0.000)	0.0576 (0.000)
pop_gr				–0.0764 (0.008)	–0.0579 (0.013)	
crisis		–0.1093 (0.000)	–0.1025 (0.000)	–0.1141 (0.000)	–0.1205 (0.000)	–0.1246 (0.000)
constant	4.3283 (0.000)	1.7984 (0.000)	–2.3805 (0.573)	–0.2617 (0.480)	–0.6423 (0.710)	–0.6598 (0.843)
No. of obs.	187	187	187	185	185	185
Obs. per country:						
– min.	17	17	17	16	16	16
– avg.	17	17	17	16.8	16.8	16.8
– max.	17	17	17	17	17	17

Notes as in Table 5.
Source: Own calculations.

Table 8. Regression results for the inflow of European funds (eu_fund), EU11 countries.

Estimated coefficient (p-value)	**[19]**	**[20]**	**[21]**	**[22]**	**[23]**	**[24]**
eu_fund	0.0144 (0.247)	0.0232 (0.003)	0.0200 (0.021)	0.0245 (0.010)	0.0178 (0.000)	0.0235 (0.043)
gdp_initial	0.4884 (0.000)	0.6802 (0.000)	0.7075 (0.000)	0.6154 (0.000)	0.7415 (0.000)	0.6221 (0.000)
inv		0.0170 (0.000)	0.0082 (0.000)	0.0139 (0.000)	0.0070 (0.000)	0.0113 (0.000)
gov_cons					–0.0117 (0.044)	
gov_bal						0.0080 (0.285)
edu_exp				0.0435 (0.104)		
infl			–0.0014 (0.398)	–0.0040 (0.159)		
nonp_loans			–0.0106 (0.000)		–0.0103 (0.000)	
serv						0.0040 (0.314)
life					–0.3311 (0.748)	
fert					–0.0540 (0.637)	0.0471 (0.769)
pop_15_64				0.0497 (0.000)	0.0204 (0.007)	0.0515 (0.000)
pop_gr				–0.0366 (0.265)	–0.0080 (0.814)	
crisis		–0.1168 (0.000)	–0.1204 (0.000)	–0.1232 (0.000)	–0.1252 (0.000)	–0.1238 (0.000)
constant	5.1297 (0.000)	2.8460 (0.000)	2.8995 (0.000)	–0.0480 (0.952)	2.8549 (0.432)	–0.2275 (0.819)
No. of obs.	154	154	154	154	154	154
Obs. per country:						
– min.	14	14	14	14	14	14
– avg.	14	14	14	14	14	14
– max.	14	14	14	14	14	14

Notes as in Table 5.
Source: Own calculations.

Table 9. Regression results for the changes in the openness rate (delta_open), EU11 countries.

Estimated coefficient (p-value)	**[25]**	**[26]**	**[27]**	**[28]**	**[29]**	**[30]**
delta_open	0.0023 (0.000)	0.0014 (0.026)	0.0009 (0.121)	0.0007 (0.128)	0.0010 (0.088)	0.0009 (0.067)
gdp_initial	0.5935 (0.000)	0.7638 (0.000)	0.7660 (0.000)	0.7472 (0.000)	0.6948 (0.000)	0.6580 (0.000)
inv		0.0174 (0.000)	0.0149 (0.000)	0.0141 (0.000)	0.0187 (0.000)	0.0101 (0.000)
gov_bal						0.0111 (0.092)
edu_exp				0.0478 (0.027)		
infl			–0.0007 (0.070)			
serv						0.0127 (0.000)
life					1.4981 (0.141)	
fert						0.1031 (0.469)
pop_15_64				0.0532 (0.000)		0.0530 (0.000)
pop_gr				–0.1149 (0.000)	–0.0696 (0.062)	
crisis		–0.0867 (0.000)	–0.0895 (0.000)	–0.1119 (0.000)	–0.0964 (0.001)	–0.1095 (0.000)
constant	4.0758 (0.000)	2.0210 (0.000)	2.0783 (0.000)	–1.6202 (0.027)	–3.8086 (0.297)	–1.1899 (0.050)
No. of obs.	182	182	182	182	182	181
Obs. per country:						
– min.	16	16	16	16	16	16
– avg.	16.5	16.5	16.5	16.5	16.5	16.5
– max.	17	17	17	17	17	17

Notes as in Table 5.
Source: Own calculations.

Estimates of regression equations confirm the hypothesis that the EU membership has contributed to the acceleration of economic growth of the CEE countries and their rapid income-level convergence toward Western Europe. Regression coefficients for the variables related with the EU membership are positive and statistically significant in most cases.

Tables 5 and 6 provide the results for the index of economic freedom. It turns out that almost all the regression coefficients on the variable: index of economic freedom are positive and statistically significant (at the 10% significance level). This means that a wider scope of economic freedom, *ceteris paribus*, is conducive to a faster growth of output. It has to be added that the differences in the magnitudes of the coefficients result from the fact that Fraser Institute index of economic freedom ranges from 0 to 10 while the index devised by Heritage Foundation takes the values between 0 and 100.

Similar results were obtained for the worldwide governance indicator (Table 7). All the regression coefficients for this variable are positive and statistically significant at the 10% significance level (i.e. with *p*-values less than 0.1). Thus, countries and periods characterized by a higher quality of governance tended to witness, *ceteris paribus*, a faster GDP growth. These results show that a good institutional environment is crucial for economic growth. Hence, the EU policy aiming to improve the quality of institutions, was one of the crucial factors contributing to income-level convergence of CEE countries vis-à-vis Western Europe.

The present study enables also a positive verification of our hypothesis that the European funds were an important source of economic growth of the CEE countries (Table 8). Despite some criticism being raised regarding the effectiveness of the use of EU funds, the findings of our analysis do not corroborate such criticism. On the contrary, the estimates of regression models show that the variable *eu_fund*, measuring the total expenditure of the EU budget allocated to a given country, has a positive sign in all the models and is statistically significant in most of them (exception being model [19]). It should be noted, however, that it is hard to unequivocally establish whether the resulting impact of EU funds on the dynamics of output illustrates demand-side interrelationships of a short-run nature, or rather longer-run supply-side interdependencies. Answering this question would require a further, more in-depth research on this subject.

The data in Table 9 shows in turn that the sources of economic growth in the CEE countries embraced the expansion of foreign trade too, the relevant yardstick being the dynamics of the economy's openness indicator. In most of the models, the parameter standing on this variable is positive and statistically significant at 10% significance level. When assessing the growth effect of this variable, it should be borne in mind that there are many factors influencing the volume of exports and imports (in the CEE countries they also include determinants of a political nature, especially in the case of trade with the East), and that this variable is partially endogenous (imports depend on income). Hence, it is hard to predict if in the future economic growth in the EU11 countries will continue to gain from a continued development of international trade.[15]

In the case of foreign direct investment (Table 10), the results are less unequivocal. This variable is statistically insignificant at the 10% significance level (in model [33] *p*-value for FDI stands at 0.269, in model [34] – at 0.294, in model [35] – at 0.332, and in the remaining three models *p*-values are close to 0.15). The main reasons behind a lower significance of FDI may be seen in a poor investment performance, its long gestation period (especially in the case of greenfield investment) as well as in the fact that this variable reflects the net FDI whereas a more reliable gauge would be the FDI volume in gross terms.[16]

[15] The future is very uncertain and there may appear some unanticipated shocks that will adversely affect the volume of international trade. A good example of such a shock is a decision made recently by the Russian government to ban imports of many goods and services from the EU.

[16] In the case of net investment, 'victims' are those CEE countries (mostly well-performing and rapidly growing economies) that invest considerable funds overseas. The reason for this is that the volume of outward investment made by the CEE countries is deducted from the inward FDI inflows; as a result, the net FDI inflow is smaller than otherwise and it can even be negative.

Table 10. Regression results for the inflow of foreign direct investments (*fdi*), EU11 countries.

Estimated coefficient (*p*-value)	**[31]**	**[32]**	**[33]**	**[34]**	**[35]**	**[36]**
fdi	0.0070 (0.136)	0.0044 (0.140)	0.0030 (0.269)	0.0018 (0.294)	0.0015 (0.332)	0.0047 (0.141)
gdp_initial	0.8294 (0.000)	0.7771 (0.000)	0.7082 (0.000)	0.6529 (0.000)	0.7196 (0.000)	0.7699 (0.000)
gov_bal					0.0207 (0.005)	
edu_exp		0.0105 (0.550)	0.0314 (0.080)	0.0573 (0.010)		
infl		–0.0015 (0.004)	–0.0014 (0.004)	–0.0009 (0.018)	–0.0013 (0.001)	–0.0014 (0.001)
serv						0.0071 (0.111)
life	–0.0715 (0.945)					
fert				0.4694 (0.010)	0.2434 (0.043)	
pop_15_64			0.0463 (0.000)	0.0756 (0.000)	0.0535 (0.000)	
pop_gr				–0.1050 (0.003)	–0.0522 (0.077)	
crisis	–0.1201 (0.000)	–0.1065 (0.000)	–0.1080 (0.000)	–0.1458 (0.000)	–0.1240 (0.000)	–0.1171 (0.000)
constant	2.1323 (0.551)	2.3094 (0.000)	–0.2844 (0.596)	–2.0453 (0.012)	–0.7655 (0.166)	1.9710 (0.000)
No. of obs.	187	187	187	187	185	187
Obs. per country:						
– min.	17	17	17	17	16	17
– avg.	17	17	17	17	16.8	17
– max.	17	17	17	17	17	17

Notes as in Table 5.
Source: Own calculations.

The results of the regression analysis point to a clear-cut positive impact of the progress in transition on economic growth (Table 11). In all regression equations, the coefficients standing on this variable are positive and statistically significant at 5% significance level (*p*-values do not exceed 0.051). This implies that the market and structural reforms, such as privatization, enterprise restructuring, price liberalization, enhanced competition and the exchange rate liberalization, are all important determinants of economic growth of the former socialist countries in Central and Eastern Europe. It can be claimed that under a hypothetical alternative scenario, i.e. without the EU membership (the external anchor), the pace of market reforms would have probably been slower, which would translate into lower rates of economic growth and slower income convergence toward Western Europe. This claim gains a strong empirical foundation when (based on the EBRD data) one compares the progress in transition in the CEE countries (EU11) – on the one hand – and in other former socialist economies in the CIS, South-eastern Europe and Central Asia, on the other. It turns out that in the EU11 countries the progress of market reforms was on average much faster and the quality of pertinent institutions – higher than in the remaining transition countries, not subject to the effect of 'external anchor'. Similar, and even more revealing conclusions can be found in a study by Rapacki (2012) who compared the EU10 economies (excluding Croatia) with a different reference group that is the GIPS countries (Greece, Italy, Portugal and Spain), representing (except for Italy) the sample of earlier, less developed EU entrants from the European periphery. His analysis shows that the EU10 countries made a better use of the 'integration anchor' than the GIPS economies – the level of institutional development in the former group was on average comparable or – on several counts – even higher than that in Greece, Italy, and Portugal, i.e. more economically advanced countries.

Table 11. Regression results for the transition indicator (*tran_ebrd*), EU10 countries (EU11 without the Czech Republic).

Estimated coefficient (*p*-value)	**[37]**	**[38]**	**[39]**	**[40]**	**[41]**	**[42]**
tran_ebrd	0.7215 (0.000)	0.7252 (0.000)	0.4679 (0.007)	0.1634 (0.038)	0.1586 (0.019)	0.2222 (0.051)
gdp_initial	0.3050 (0.019)	0.4220 (0.003)	0.5724 (0.000)	0.7102 (0.000)	0.6826 (0.000)	0.5808 (0.000)
inv			0.0122 (0.000)	0.0126 (0.000)	0.0092 (0.000)	0.0097 (0.001)
gov_cons					–0.0072 (0.043)	
gov_bal						0.0105 (0.168)
edu_exp				0.0287 (0.050)		
infl				–0.0004 (0.221)		
nonp_loans					–0.0062 (0.000)	
serv						0.0079 (0.038)
life					0.4040 (0.589)	0.3904 (0.601)
fert					0.0374 (0.742)	0.1079 (0.344)
pop_15_64				0.0434 (0.000)	0.0224 (0.002)	0.0463 (0.000)
pop_gr				–0.0875 (0.003)	–0.0389 (0.246)	
crisis		–0.1015 (0.001)	–0.1086 (0.000)	–0.1306 (0.000)	–0.1264 (0.000)	–0.1221 (0.000)
constant	4.2106 (0.000)	3.0986 (0.000)	2.2962 (0.000)	–1.0393 (0.034)	–0.6464 (0.821)	–2.1625 (0.476)
No. of obs.	169	169	169	169	167	167
Obs. per country:						
– min.	16	16	16	16	15	16
– avg.	16.9	16.9	16.9	16.9	16.7	16.7
– max.	17	17	17	17	17	17

Notes as in Table 5.
Source: Own calculations.

As a concluding remark in this section it is worth adding that most of the models involved display correct parameters for the remaining variables. The parameter standing on the variable: initial income level amounts to less than 1. This is equivalent to say that in the standard β convergence model, where the growth rate is the explained variable, the coefficient on initial income would be negative. By the same token, all our models confirm the conditional β convergence.

The negative parameter for the variable *crisis* implies that the models correctly account for the slowdown in economic growth during the global economic and financial crisis of 2008-2009. In most models (though not all) positive and statistically significant parameter estimates for the investment rate and the variable measuring human capital accumulation (mainly education expenditure) have been obtained. These outcomes confirm the crucial role of physical and human capital as economic growth factors. The variables representing economic policy suggest that – seen from the angle of a fast and sustainable economic growth – governments should pursue fiscal policies featuring low budget deficits, low tax burden, and low government spending (which is also consistent with other results of the present study pointing to the importance of economic freedom as growth determinant). Similarly, the monetary policy should be focused on ensuring low inflation and a sound financial sector (with a low volume of nonperforming loans).

The impact of the global crisis on the examined countries can be analysed in two ways. The first one is a direct impact on a GDP slowdown while the second one is the influence on the permanently changed environment. The first effect is analysed in this study by the inclusion of a dummy variable (*crisis*). The second effect is considered indirectly on the basis of institutional variables, like the index of economic freedom or the worldwide governance indicator, that take into account the changed environment of the countries concerned. As the result, the calculations are not biased by the impact of the global crisis.

Wrapping up, the foregoing analysis has shown that the impact of the EU membership on economic growth of the CEE countries has come to pass – with varying strength – through the following major channels: (i) broadening scope of economic freedom, (ii) improving quality of governance, (iii) the progress of market reforms, (iv) the inflow of EU funds, (v) increasing volume of international trade, and (vi) the inflow of foreign direct investment. Good statistical properties of the majority

of the regression equations being estimated confirm the reliability of the results and their robustness to different model specifications. As a consequence, it appears that the present study shed some new light on the hitherto picture of the effect of EU membership on economic growth of the CEE countries, contributing to make it sharper and more comprehensive.

4. Conclusions

The key findings of the present study can be summarized under four major headings.

1. The results of our research indicate that the membership in the European Union significantly contributed to the acceleration of economic growth of eleven Central and Eastern European countries. This conclusion has been supported both by the analysis of real convergence and the econometric tests of economic growth determinants.
2. The CEE countries (EU11) displayed a clear-cut income-level convergence toward the EU15. During 1995-2015, the EU11 economies recorded on average a faster pace of economic growth while their initial income level was much lower. The process of catching up with Western Europe accelerated in the second part of the period under study, i.e. after their EU accession. This process was adversely affected by the global economic and financial crisis, which in 2009-2010 brought about some weakening of the convergence tendencies.
3. The econometric analysis of economic growth factors proved that variables associated with the EU membership (increasing scope of economic freedom, improving quality of governance, progress of market reforms and more broadly – improvement in the institutional environment of the market, as well as the inflow of EU funds and the rising volume of international trade and foreign direct investment) turned out to be important drivers of GDP growth. Good statistical properties of regression equations ensure the reliability of the results and their robustness to changes in model specifications.
4. Our results yield also a number of policy implications. First of all, they imply that catching up is not an automatic process and it is necessary for policy makers – both at the national and EU levels – to undertake actions aimed to make the real

convergence tendencies in Europe sustainable. Secondly, institutional reforms are very important to achieve this goal, and in particular - promoting economic freedom and improving the quality of governance. Thirdly, continuation of the EU funds transfers from Western to East Central Europe is also essential for the sustainability of income-level convergence in Europe. The signals from Brussels suggesting a possible reduction of the aid funds to be allocated for the CEE region in the coming years may be seen as a threat to the catching-up process. Fourthly, actions aimed at maintaining or even increasing the openness of the CEE economies and their involvement in international flows of goods, services, and capital should also be a priority for policy makers.

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