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# Real Convergence in Central and Eastern European EU Member States

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## **Abstract**

Central and Eastern European EU Member States have made considerable progress in the economic transition and integration into the European Union. Nevertheless, the challenges of real convergence will remain relevant for these countries in the medium and long term. This paper focuses on the process of the real economic convergence among the five Central European EU Countries: the Czech Republic, Hungary, Poland, the Slovak Republic, and Slovenia. We have analysed both  $\beta$  and  $\sigma$  convergence in the period 1995-2011. The Central European EU countries are well positioned to catch up with the EU-15 average, however, the experience of the EU-15 countries shows that convergence cannot be taken for granted.

## **Keywords:**

Central European EU Countries, European integration, real convergence,  $\beta$ -convergence,  $\sigma$ -convergence

**J.E.L. Classification:** E31, F43, O11, O52

## **1. Introduction**

The European Union consists of 27 member countries, whose economies are very dissimilar both in terms of their size and in terms of their performance. The varying size of individual economies such as these is illustrated by these facts: In the five largest member states being involved in 63% of the total population of the EU, 71% of the European Union's GDP was created in 2011, correspondingly, more than 68% of the European Union's GDP adjusted for purchasing power. In contrast, in the smallest seven member states, in which 2.11% of EU citizens dwell, only 1.31% of the European Union's GDP was generated, or 1.65% of European Union's GDP adjusted for purchasing power.

Moreover, the different performance of economies can be assessed by comparison of the most frequently used economic indicators, such as GDP per capita levels converted into purchasing power standard (PPS). In terms of the economic performance expressed by this indicator, EU countries still show significant differences. GDP per capita is in the most developed EU economy more than 6 times higher than in the economy with the lowest value of this indicator. But generally, the poorer new EU member countries grew faster than the richer, highly developed EU-15 economies. Not only for these reasons the convergence of the economies of EU member states is constantly at the forefront of intense interest by representatives of economic theories and economic policy makers.

In this paper we will first delineate two concepts of real economic convergence as well as the development of GDP per capita in EU Member States in the observed period 1995-2011. In the third part sigma ( $\sigma$ ) and beta ( $\beta$ ) convergences of per capita GDP of EU countries will

be subject to an analysis. Particular attention will be paid to our empirical findings about convergence among the CEC-5. If necessary, the analysis results will be compared for the entire period 1995-2011 with the results for two sub-periods 1995-2003 and 2004-2011.

## **2. Economic convergence and GDP per capita**

Economic convergence can be defined in two concepts: nominal convergence and real convergence. Although the two concepts had received considerable attention in Czech literature in the past, most publications were (and still are) focused on nominal convergence. For instance, the Maastricht criteria are unilaterally directed at it. But Dědek (2001) drew his attention to the need for interaction between real and nominal convergence as early as 2001. Nominal convergence, however, will not be subject to an analysis in this paper. We will attach our attention to real convergence, although in practice it is necessary to monitor the interdependence of real and nominal convergence.

In the materials of the European Commission with regard to real convergence, as noted Žďárek (2006), there is a predominant emphasis on cohesion in individual countries or regions in the European Union, Begg (2006), however, emphasizes the synchronization of economic cycles to the reference territory. However, it is very often the case that real convergence is defined as the process of approaching the level of GDP per capita and comparative price level of the given country to levels that correspond to the long-term steady state.

Being aware of some limited power of expression, the indicator of GDP per capita in purchasing power standard (PPS) will be applied in this paper. Thence for the conversion of GDP per capita from local currency into a common unit, the conversion with exchange rates, which does not take into account the purchasing power of different national currency units, is not used. For international comparisons the artificial created currency unit PPS is used, which reflects purchasing power parity.

### **2.1 Sigma ( $\sigma$ ) and beta ( $\beta$ ) convergences**

Convergence of GDP per capita levels in EU member states in this paper will be assessed according to two concepts of convergence: sigma ( $\sigma$ ) convergence and beta ( $\beta$ ) convergence. Rey and Montouri (1998) note that beta convergence is a more popular concept among macroeconomists, while sigma convergence is used more in the regional sciences. The convergence terminology was developed in the context of neoclassical theories of economic growth (Solow, 1956) and popularized by Barro (1989), Mankiw et. al. (1992) and Barro and Sala-I-Martin (2003).

Sigma convergence assumes that all countries converge to the same level of economic performance. Sigma convergence thus occurs when the dispersion of GDP per capita diminishes over time. It is therefore defined as a reduction of variance (or the coefficient of variation) of the logarithm of real GDP per capita among countries over time. Once we have measured by means of standard deviations of the natural logarithms of indices used in Figures 2 and 3, then the EU15 average GDP per capita is determined as the 100. Coefficient of variation is given by:

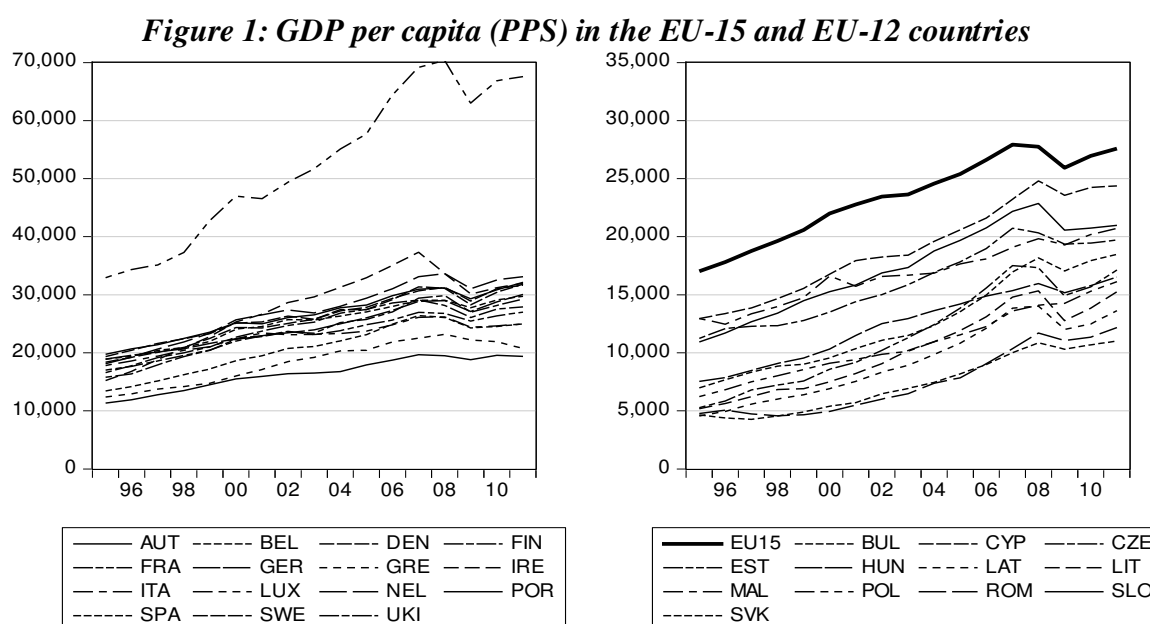
$$CV = (\text{standard deviation}) / (\text{mean value of the set}) \quad (1).$$

Beta convergence is based on the idea that the initially poorer (less developed) countries have a higher growth rate than developed countries, since there is a gradual convergence between countries and differences in their maturity are shrinking. In this concept, the GDP growth is negatively dependent on the initial economic level. Assuming the usual definition

by means of relative distances sigma and beta convergence are equivalent, which means that in the circumstances of a faster economic growth in countries with lower initial GDP per capita levels, the coefficient of variation of GDP per capita among countries surveyed will reduce over time.

## 2.2 Development of GDP per capita adjusted for purchasing power

Figure 1 depicts the development of GDP per capita in purchasing power standard (PPS) in EU-15 countries in years 1995-2011. From the figure it is obvious that differences between countries in absolute terms increased. In contrast, differences between countries in relative terms decreased, although in some cases did not change. This fact shows also Figure 2, which shows trends in relation to the EU-15 average.

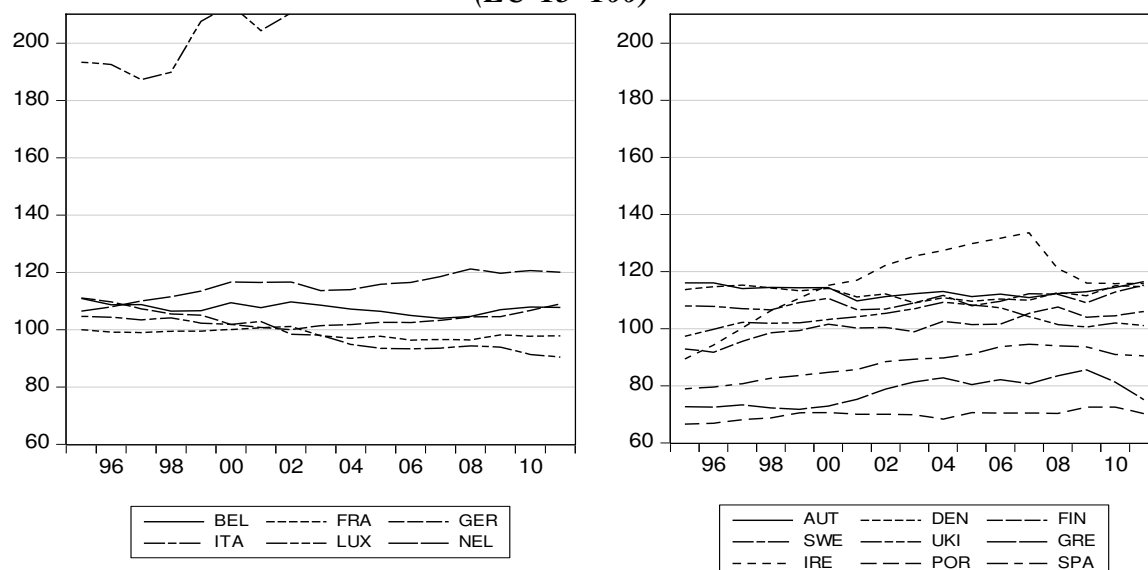


Source: Eurostat (2012).

If we do not take into account the two countries with the highest GDP per capita (Luxembourg and Ireland), the difference between the highest and lowest GDP per capita was in 1995 8423 PPS and 12974 PPS in 2011. In relative terms, however, it remained stable, or decreased slightly from 1.74 times to 1.66 times. When including Luxembourg and Ireland differences are of course much higher. The difference between the lowest and highest GDP per capita rose for this period from 21 588 PPS to 48 190 PPS, that is from 2.9 times to 3.5 times.

Figure 2 proves also evident divergence in the level of GDP per capita between the original six founding members of the EU, which started to appear after 2002. If we draw our attention to the catching-up countries in the EU-15, an extremely high growth rate of GDP per capita was shown by Ireland. The level of 89% reached by the EU-15 in 1995 was outdone in 2007 at the level of 134% above the EU-15 average, but then there was a reduction to values of around 115% of the EU-15, where it is at today. Spain demonstrated also a successful development of GDP per capita up to 2007 and it reached a level of 95% of the EU-15. In the case of Greece the only successful development was recorded in the period 2000-2004 and Portugal came very slightly closer to a level of the EU-15 during the reporting period 1995-2011. Since 2009, the level of GDP per capita in the latter three countries in relation to the EU-15 average has been decreasing, i.e. economies are diverging.

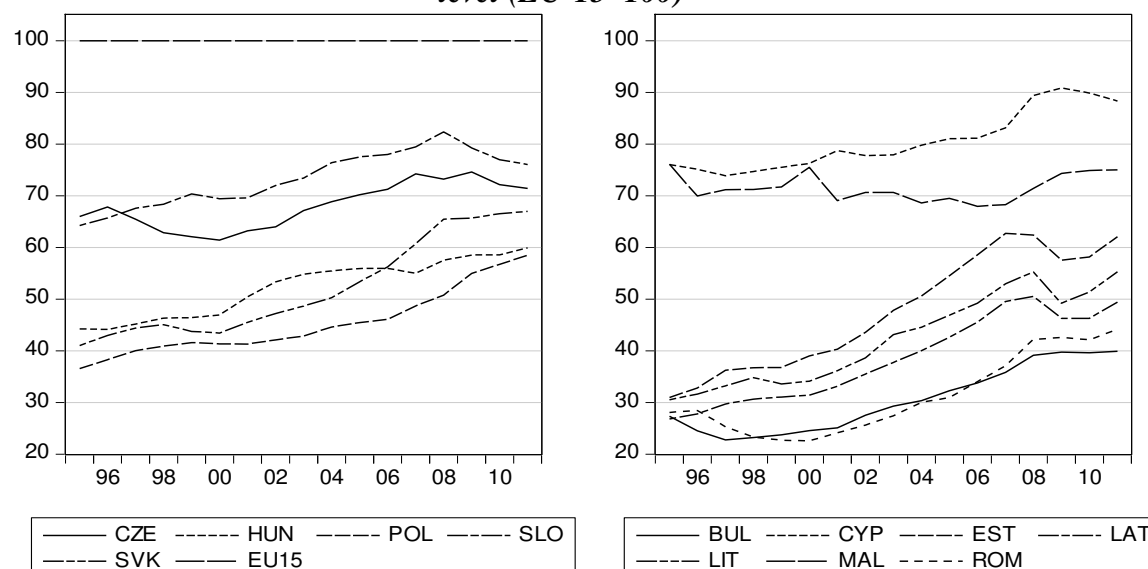
**Figure 2: GDP per capita convergence of EU-15 countries towards EU-15 level (EU-15=100)**



Source: Own calculations based on Eurostat (2012).

New EU member states show a much lower GDP per capita in purchasing power standard. Figure 3 depicts the development of GDP per capita both in CEC-5 and other seven new member states towards EU-15 average. Generally what is valid is that they get closer from below to the level of the EU-15 average. The possibilities of convergence from below are considerable for these countries. At present, they are gradually beginning to approach the level of Portugal or Greece, which these countries demonstrated in 1995. The exceptions among the new EU member states are Cyprus, Malta, Slovenia and the Czech Republic, whose initial level of GDP per capita was higher.

**Figure 3: GDP per capita convergence of new EU member countries towards EU-15 level (EU-15=100)**



Source: Own calculation based on Eurostat (2012).

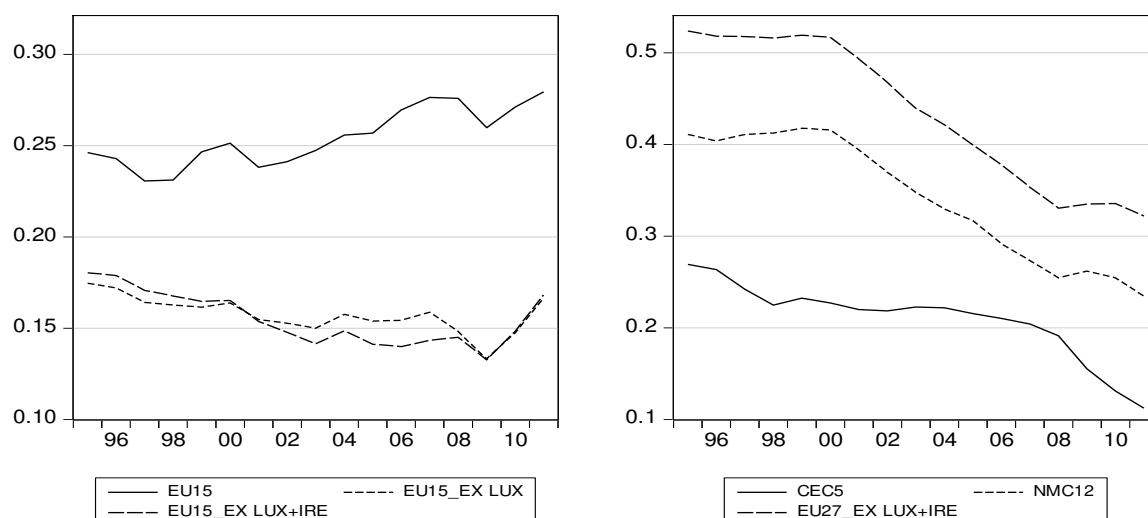
If we did not consider convergence in relation to the EU15 average but to the EU-27 average, besides convergence from below to the average, we could notice convergence from above (to the average), which is the fastest among countries with the lowest GDP growth. Moving away from the European average up above its value (e.g. Luxembourg) implies divergence. Reverse divergence (slower growth than the European average growth and receding from the average downwards) has been then recorded by Portugal since 2002. Among the analyzed CEC-5 only countries with the lowest baseline level of GDP per capita (i.e. Poland, the Slovak Republic, and Hungary) converge towards the EU-15 GDP per capita level throughout the period 1995-2011. The Czech Republic diverged slightly in the late 90s and again after 2009, Slovenia shows a slight divergence from 2008.

Since the given development of the GDP of individual countries can be affected by the economic cycle and output gap, the comparison was made also on the basis of potential product development. The potential product was obtained by filtering the actual values of GDP through the Hodrick-Prescott filter. In this approach, we assume that the potential growth rate is sustainable in nature. In contrast, output gap changes momentarily and cyclically fluctuates around the potential product, and in the long term, the sum of output gaps equals to zero. In this case, convergence can be recorded to the EU-15 average for all countries. It should be noted that in the second half of the first decade convergence slowed considerably in Slovenia and Hungary, while it significantly increased both in Poland and the Slovak Republic. The Czech Republic in this period did not show any significant changes in the trend of convergence towards the EU-15 level.

### 3. Empirical findings

The development of  $\sigma$  convergence in the European Union is portrayed in Figure 4. Convergence of the EU-15 countries is shown in more variants. As GDP per capita of Luxembourg began rising rapidly in the 80's and from 1995 it reached 193% of the EU-15 average, convergence is assessed both for the EU-15, and for the EU-15 without divergent Luxembourg. Similarly, Ireland has become a divergent country that caught up with the EU-15 GDP per capita level in 1997 and in 2007 it exceeded 37%. For that reason, convergence for the EU-15 countries is evaluated without those two countries: EU-15 (excl. LUX+IRE). The figure shows that before 2000 convergence of the EU-15 (excl. LUX+IRE) almost stopped, and then continued up to 2003. The following stagnation was replaced by a sharp  $\sigma$  divergence that returned the EU-15 back to the level achieved in the past in 1997.

**Figure 4:  $\sigma$  Convergence of GDP per capita at PPS in the EU, 1995-2011**



Source: Own calculations.

Sigma convergence of the whole EU-27 (again the variant excluding Luxembourg, possibly Ireland) is shown on the right side of the Figure 4. What is also depicted is the line for the CEC-5 countries, whose downward trend shows the acceleration of  $\sigma$  convergence after 2000, which lasted up to 2009.

In order to verify the  $\sigma$  convergence hypothesis, we estimate the trend line of the coefficients of variation of GDP per capita in Figure 4 for the period 1995-2011. The results for EU-15, EU-15 excluding Luxembourg, EU-15 excluding Luxembourg and Ireland, EU-27 excluding Luxembourg and Ireland, 12 new EU member countries (NMC-12), and CEC-5 are presented in Table 1. In all cases except EU-15 is parameter of trend line slope negative, thus  $\sigma$  convergence exists or more precisely the hypothesis is verified.

The development of  $\sigma$  convergence measured in terms of the potential GDP per capita for the EU-15, EU-15 (excl. LUX), EU-15 (excl. LUX and IRE) and the CEC-5 (not displayed) demonstrates very similar features to Figure 4. What clearly follows from the comparison of  $\sigma$  convergence of GDP per capita and potential GDP per capita is that the economic cycles in EU member states are not synchronized. Therefore, it is advisable to monitor both short-term and long-term development trends.

**Table 1: Estimations of trend lines for development of  $\sigma$  convergence**

	Adj. R2		Parameter	t-Statistic	Probab.
<b>EU-15</b>	0,71	Interc.	0,2301	53,53	0,000
		Slope	0,0027	6,36	0,000
<b>EU-15 ex LUX</b>	0,40	Interc.	0,1691	42,92	0,000
		Slope	-0,0013	-3,39	0,004
<b>EU-15 ex LUXIRE</b>	0,46	Interc.	0,1736	31,71	0,000
		Slope	-0,0021	-3,85	0,002
<b>EU-27 ex LUXIRE</b>	0,93	Interc.	0,5719	55,02	0,000
		Slope	-0,0153	-15,06	0,000
<b>NMC-12</b>	0,92	Interc.	0,4577	45,74	0,000
		Slope	-0,0130	-13,27	0,000
<b>CEC-5</b>	0,79	Interc.	0,2765	28,70	0,000
		Slope	-0,0074	-7,92	0,000

Source: Own calculations.

Beta convergence occurs when less developed countries grow faster than more developed countries, meaning that there is a negative relationship between initial GDP per capita level and its growth rate. In order to verify  $\beta$  convergence hypothesis, we estimate regression:

$$1/T \ln(y_{i,T}/y_{i,0}) = \alpha_0 + \alpha_1 \ln y_{i,0} + \epsilon_t \quad (2),$$

where  $y_{i,T}$  and  $y_{i,0}$  are GDP per capita at PPS in country  $i$  in the last year and the first year of the analysed period.

The regression equation was estimated by using the method least squares. Estimates were again performed alternatively for four groups of EU member states: the EU-27, the EU-27 excluding Luxemburg and Ireland (EU-27[LI]), CEC-5 along with EU-15 (CEC-5\_EU-15), and CEC-5 along with EU-15 excluding Luxemburg and Ireland (CEC-5\_EU-15[LI]). The results for  $\beta$  convergence for the period 1995-2011 are shown in Table 2 and Figure 5.

The fourth column in Table 2 shows the estimates of the regression equation. The  $\beta$  coefficients are negative, which indicates  $\beta$  convergence for both the EU-27 and CEC-5 along with EU-15. In the case of the EU-15 (not displayed in Table 2)  $\beta$  coefficient is positive, in the case of the EU-15 excluding Luxembourg and Ireland (not displayed in Table 2) it is

negative but statistically insignificant. Therefore, it can be stated that  $\beta$  convergence in the EU-15 does not occur.

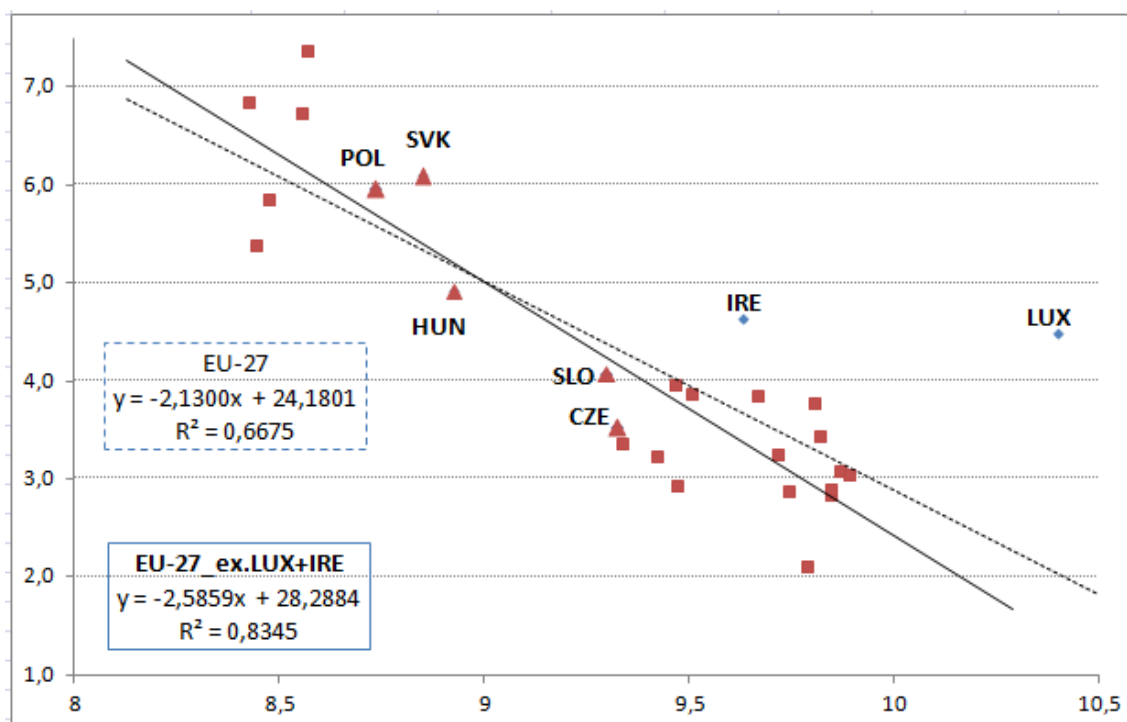
The graphical representation of  $\beta$  convergence in the EU-27 in Figure 5 also shows that the exclusion of Luxembourg and Ireland from the analysis affects the results. The beta coefficient in absolute value increases and the speed of convergence increases. The coefficient of determination increased to 83%, which means that the initial level of income in this model can account for 83% variation in growth rates between countries. Slavík (2007) came to similar results, too.

**Table 2:  $\beta$  convergence in the European Union, 1995-2011**

	R2 Adj.R2		Parameter	t-Statistic	Probab.
EU-27	0,6675	Slope	-2,1300	-7,0844	0,0000
	0,6542	Interc.	24,1801	8,5746	0,0000
EU-27[LI]	0,8345	Slope	-2,5859	-10,7673	0,0000
	0,8273	Interc.	28,2884	12,6300	0,0000
CEC-5_EU-15	0,4075	Slope	-1,6173	-3,5184	0,0025
	0,3746	Interc.	19,2431	4,3702	0,0004
CEC-5_EU-15[LI]	0,7577	Slope	-2,4316	-7,0734	0,0000
	0,7426	Interc.	26,8281	8,1899	0,0000

Source: Own calculations.

**Figure 5:  $\beta$  convergence in EU-27**



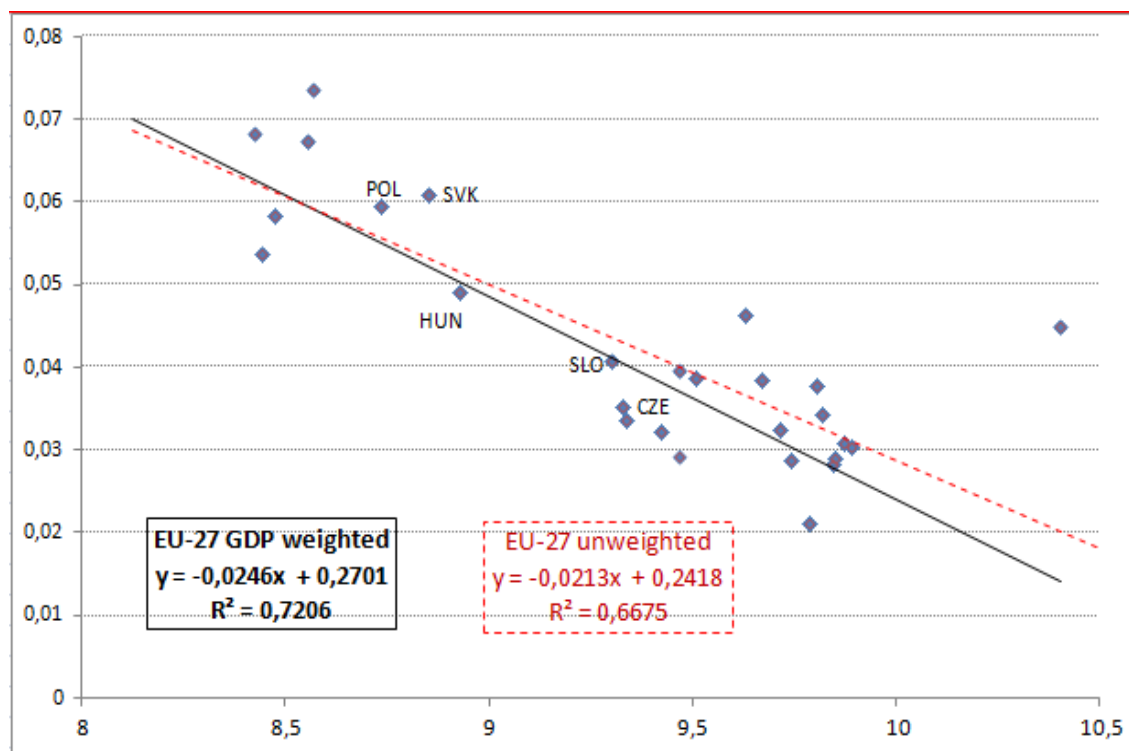
Source: Own calculations.

These calculations of  $\beta$  convergence for comparability with other studies were conducted on unweighted data. In the introduction, however, the significantly heterogeneous structure of the EU was stated. The same weight that is attributed to the economies of Germany, France, and the United Kingdom on one side and Luxembourg or Malta on the other hand, can significantly skew results. Therefore, the Figure 6 captures the results for “GDP-weighted“  $\beta$  convergence obtained by recording weights for individual countries while taking into account



each country's share of GDP across the whole EU. The speed of  $\beta$  convergence in this case is higher.

**Figure 6: GDP-weighted  $\beta$  convergence in EU-27**



Source: Own calculations.

The Figure 6 shows the following facts:

- The Czech Republic is (like Slovenia) well below the regression line. An average growth of 2.6% would therefore correspond to the achieved level of income, i.e. considerably higher than that reported;
- The Slovak Republic and Poland lie above the regression line. A lower growth than that reported would therefore correspond to the level of income of these countries;
- When investigating  $\beta$  convergence on samples of other countries, the slope of the regression line changes. While the Czech Republic remains below the regression line (it should therefore grow faster than it actually grows), Poland crosses the threshold of the regression line. Thus, if in the first case the economy grew faster than its income, which is not the case in the latter case, in addition Poland's economy has a lower growth than it would have with regard to achieving its income.

Findings a) to c) can of course also be interpreted so that the Czech Republic is growing at a pace which it should grow only at a higher level of income. Slovakia and Poland are growing at a pace which less developed economies with lower incomes should grow.

#### 4. Conclusion

Based on the analysis, we can state that the CEC-5 countries converge to the EU-15 average. Their convergence rate is somewhat lower than the speed of convergence of the new EU member states as whole. This is probably due to a higher initial level of GDP per capita in PPS in CEC-5 countries. The speed of convergence and difference in GDP per capita as

compared with the EU-15 imply that convergence to the EU-15 average will be a long-term process.

From the analysis of convergence of the EU-15 countries we can draw conclusions about some divergence tendencies. These are smaller, once the outlying observations (Luxembourg, Ireland) have been excluded from the analysis. In our opinion, we can only proceed in this way in the case of relatively small economies, whose share of GDP across the whole EU is very small.

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