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**Article**

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# NATIONAL AND REGIONAL COORDINATES OF THE REAL CONVERGENCE PROCESS INTENSITY IN THE ENLARGED EUROPEAN UNION

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**Abstract:** *Real convergence of EU economies can be approached from the perspective of close relations between the state of homogeneity and the existence of conditions that can facilitate it. In this paper we test the hypothesis of beta convergence at national level for the group formed by all 27 EU member states (EU-27), for one of the old Member States (founding members and countries that joined in the first three waves of EU enlargement) (EU-15) and one of the new Member States (EU-10+2) (countries that joined in the last two waves of EU enlargement) and also at regional level for all 271 NUTS 2 regions. For reasons of comparison we will use the same indicator GDP per capita at purchasing power standards (PPS) for analysis of both levels. Given the availability of statistical information, we quantified applying the regression model, the marginal effect from GDP per capita growth caused by the change of condition expressed by the initial development stage.*

**Keywords:** EU member states, NUTS 2 regions, beta convergence, GDP per capita growth rate, regression model

**JEL Classification:** C20, F15, O16

## INTRODUCTION

Among the many endeavours for the development of the scientific methodological apparatus concerning the convergence phenomenon, we must distinguish the econometric research on different transverse or chronological static series which assess, by means of regression equations and estimated parameters, the convergence or divergence trends of the economies on world level as well as on the level of the European Union.

Besides the sigma convergence expressed through the coefficient of variation or through the standard deviation, an important role within the economic studies is played by the *beta convergence*. Although contested by certain economists such as Friedman (1992) and Quah (1993), who believe that the regression pattern can generate erroneous estimations concerning its existence and extent (Galton's false result) (Boyle and McCarthy, 1997) generated by the existence of approximately similar conditions in the countries included in the study group, conditions referring to the population growth, the economic rate, the depreciation rate and the technology, and which are likely to lead to the development of a polarization process (Chatterji, 1992), the beta convergence

appeared in the literature as a requisite tool for the econometric calculation and analysis and for the description of the process. Determining the beta convergence index does not exclude or replace the sigma convergence index (Iancu, 2009, p. 23).

The concept of beta convergence, generated by the regression analysis of the level of development of the countries/regions, can have *three basic aspects* (Iancu, 2009, p. 25), according to the depth of the analysis and to the degree in which it renders the economic reality, within the limitations imposed by the convergent neoclassical growth model:

- *The absolute beta convergence*, which takes into consideration only the hypothesis of the higher growth rates of the poor countries compared to the rich countries and sets aside, during the whole period of time subjected to the analysis (T), the differential evolution of the determinant factors of growth (technological, institutional, behavioural, etc.) for the countries included in the group. Consequently, it is required to adopt those solutions which take into consideration these realities, without however crossing the limits of the neoclassical methodology;

- *The group (clubs) beta convergence*, which aims at including into the study those groups of countries/regions which have a certain homogeneity on the technological and the institutional level as well as in the economic policies, and in which there should be no significant initial differences concerning the GDP per capita;

- *The conditional beta convergence*, which takes into consideration the vector of the determinant factors of growth as additional variables that define the differences between the economies, factors which impose (proxy for) the achievement of balance by introducing into the regression equation certain variables which maintain the balance of the economies.

## **1. THE REGRESSION ANALYSIS AND THE INTENSITY OF THE REAL CONVERGENCE**

Considering Solow's neoclassical economic theory concerning the decreasing productivity of the capital, we can formulate the hypothesis of higher growth rhythms registered in the less developed economies compared to the developed economies, which means a gradual decrease in time of the differences in terms of GDP per capita, as well as the existence of an inverse relationship between the rhythm of economic growth of the GDP per capita within a certain timeframe and the initial level of the GDP per capita. The dependence relationship can be noticed on the level of a group of countries/regions, being more or less intense, according to the period of

time subjected to the analysis or to the social and economical situation specific to that particular period of time.

Consequently, the beta convergence can be estimated by means of a regression model, thus quantifying the marginal reaction of the effect (GDP per capita) to the modification of the cause, more exactly the modification of the condition expressed through the relatively low level of development in the initial phase (Pecican, 2009, p. 15):

$$\frac{1}{T} \log \left( \frac{y_{i,T}}{y_{i,0}} \right) = \alpha + \beta \log y_{i,0} + \varepsilon_i$$

*Where: T – the number of time units (years);*

*i – The element (state/region) of the whole group;*

*y<sub>i,0</sub> – the level of development (GDP per capita) in the reference year (the base);*

*y<sub>i,T</sub> – the level of development (GDP per capita) after T units of time;*

*α – constant;*

*β – The regression parameter estimated for the slope of the regression equation;*

*ε<sub>i</sub> – residual value.*

This relationship expresses the theoretical hypothesis which is going to be econometrically tested based on the statistic data gathered from the states/regions in question. The regression parameter β (the slope of the regression equation) shows the potential, the speed (rate) at which the countries achieve the convergence and tend towards the state of balance. Such potential, expressed through the level and the sign of the β estimation, works as an average and it can differ from one country/region to another. However, an inclination towards convergence can be emphasized. The estimated result for β is compatible with convergence provided that its sign is minus, and its level is significant (at least for the T-test).

Thus, the tendency of poor economies to make up for the economic gaps compared to the rich economies is reflected through the reduction of the degree of dispersion of GDP per capita (sigma convergence) as well as through the negative beta convergence rate for the GDP per capita registered in the states in question.

## 2. THE INTENSITY OF THE REAL CONVERGENCE IN THE 27 MEMBER STATES OF THE EUROPEAN UNION

In this unit, we are going to test the hypothesis of beta convergence concerning the 27 member states of the EU (EU-27), as well as the EU-15 (the founding states and the ones that joined the EU during the first three waves of adherence) and EU-10+2 (the states that joined the EU during the last two waves of adherence) groups, using as indicator the GDP per capita expressed based on the purchasing power standard (PPS), thus ensuring the comparability of the data gathered in all the countries.

Considering three different periods of time: 1999-2010, 2004-2010 and 2007-2010, we quantified the marginal reaction of the effect, given by the growth rate of GDP per capita, to the modification of the condition expressed through the level of development in the initial stage, applying the regression model. The data used in the regression analysis concerning the average annual growth rate of the GDP per capita, as well as the level of the indicator during the basic year for each period (data available at Eurostat), we made a logarithm in order to create a data base within the kit of programmes meant for the statistic analysis *SPSS for Windows*.

The results achieved concerning the extent to which the average annual growth rate of GDP per capita (the dependent variable) can be explained through the initial level of the GDP per capita during the basic year, for each separate period of time in the case of the member states included in the groups in question are presented in *Table 1* and the figures below and interpreted from the point of view of the manifestation of the convergence or the divergence based on the parameters of the regression equation.

**Table 1 – The results of the regression calculation for EU-27, EU-15 and EU-10+2 groups, during 1999-2010, 2004-2010 and 2007-2010**

Parameters	1999-2010			2004-2010			2007-2010		
	EU-27	EU-15	EU-10+2	EU-27	EU-15	EU-10+2	EU-27	EU-15	EU-10+2
<b>MODEL</b>									
<b>R</b>	0.866	0.272	0.939	0.743	0.222	0.769	0.398	0.161	0.299
<b>R<sup>2</sup> (R Square)</b>	0.750	0.074	0.882	0.552	0.049	0.592	0.158	0.026	0.089
<b>ANOVA</b>									
<b>F-Test</b>	75.190	1.037	75.016	30.837	0.673	14.499	4.708	0.347	0.982
<b>F-Test Significance (Sig.)</b>	0.000	0.327	0.000	0.000	0.427	0.003	0.040	0.566	0.345
<b>COEFFICIENT</b>									
<b>Beta Coefficient (<math>\beta</math>)</b>	-0.027	0.007	-0.036	-0.024	0.006	-0.033	-0.014	-0.006	-0.020
<b>Constant (<math>\alpha</math>)</b>	0.130	-0.017	0.164	0.111	-0.022	0.150	0.060	0.025	0.084

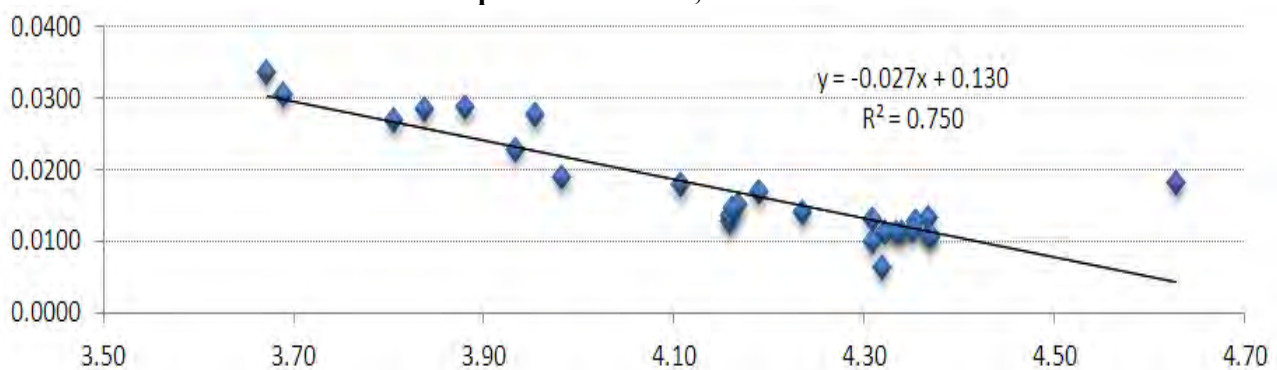
<b>T-Test</b>	-8.671	1.018	-8.661	-5.553	0.821	-3.808	-2.170	-0.589	-0.991
<b>T-Test Significance (Sig.)</b>	0.000	0.327	0.000	0.000	0.427	0.003	0.040	0.566	0.345

Source: Own calculations using Eurostat data

The value of the regression coefficient  $R$  shows the existence of a connection between the two variables considered for analysis, the intensity of this connection and its direction. In all the cases, we notice that  $R$  is different from 0 and is positive, which means that there is a connection between the variables, and that it is a positive (direct) one. The absolute value allows us to assess the intensity of this connection – it becomes stronger as it gets closer to +1. Consequently, on the whole EU-27 group and on the level of the countries included in the EU-10+2, we identify a quite strong connection during the first two periods of time subjected to the analysis,  $R$  being 0.866, and 0.939 respectively between 1999 and 2010, and 0.743 or 0.769 respectively between 2004 and 2010; however, the intensity of this connection decreases from one period of time to another - between 2007 and 2010  $R$  being 0.398 and 0.299 respectively. As to the EU-15 group of states, we estimate a weak connection during the three periods of time subjected to the analysis,  $R$  being 0.272, 0.222 and 0.161 respectively.

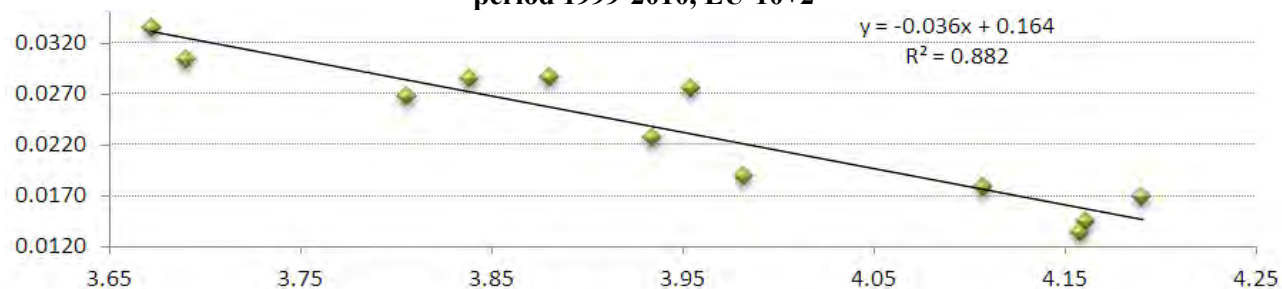
The value of the coefficient of determination  $R^2$  shows us the proportion of the variation in the dependent variable explained by the regression model applied. After the analysis that we carried out here, we got a value of  $R^2$  of 0.750 for the period of time 1999-2010 in the case of EU-27 (Figure 1) and of 0.882 in the case of EU-10+2 (Figure 2), which shows that there is a direct linear.

**Figure 1 - The connection between GDP per capita in 1999 and GDP per capita growth rate during the period 1999-2010, EU-27**



Source: Own calculations using Eurostat data

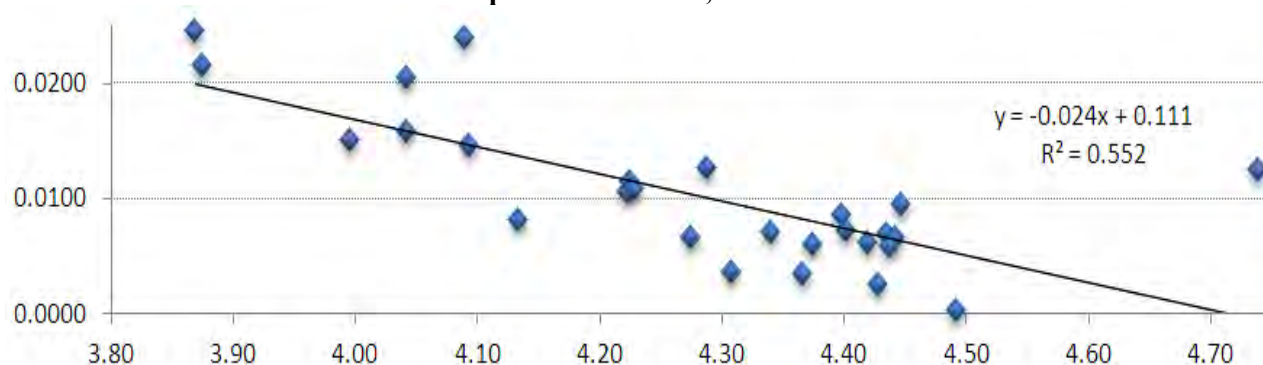
**Figure 2 - The connection between GDP per capita in 1999 and GDP per capita growth rate during the period 1999-2010, EU-10+2**



Source: Own calculations using Eurostat data

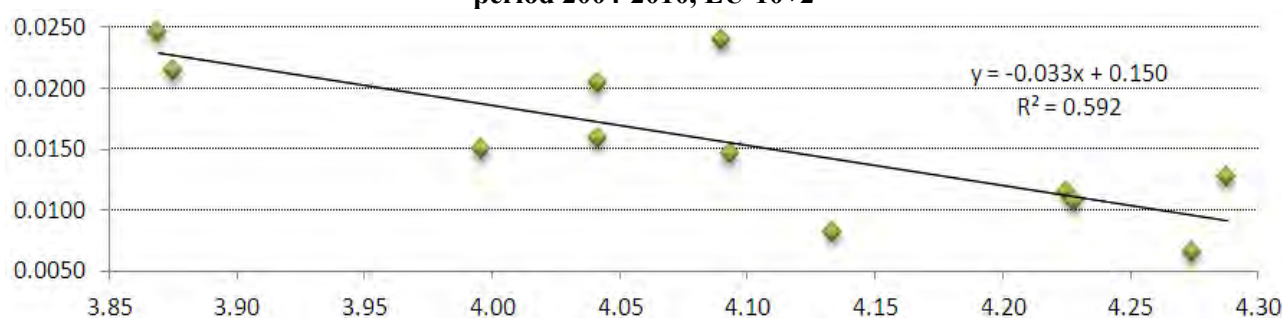
We also obtained a quite strong connection and a reduced degree of determination of the economic growth by the initial starting level, degree showed by the value of 0.552 (*Figure 3*) of the same coefficient in the case of EU-27 and of 0.592 (*Figure 4*) in the case of EU-10+2 in the period of time 2004-2010, fact which also signals the existence of other possible determinants.

**Figure 3 - The connection between GDP per capita in 2004 and GDP per capita growth rate during the period 2004-2010, EU-27**



Source: Own calculations using Eurostat data

**Figure 4 - The connection between GDP per capita in 2004 and GDP per capita growth rate during the period 2004-2010, EU-10+2**

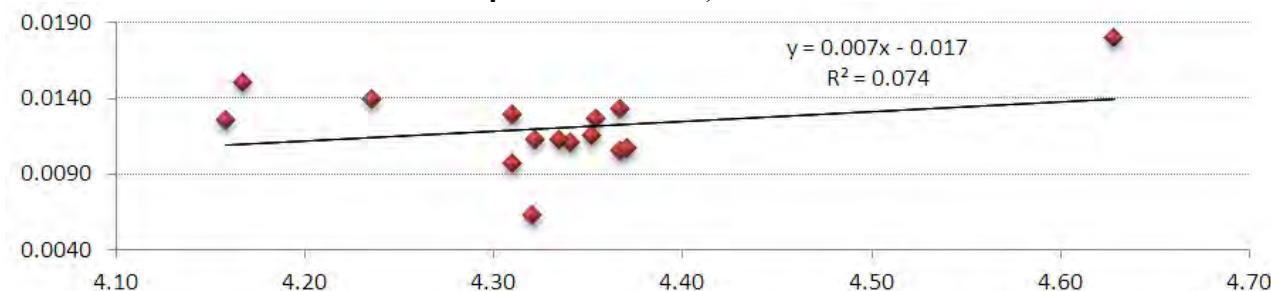


Source: Own calculations using Eurostat data



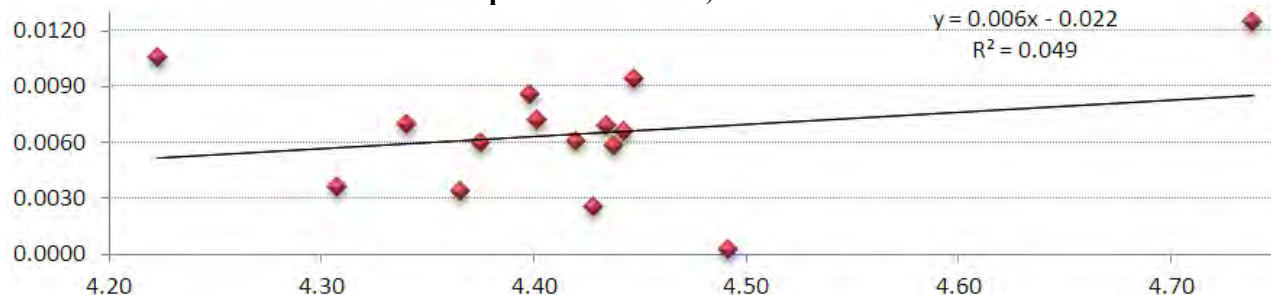
By contrast, the very low value of the coefficient within the EU-15 group, which is 0.074 for the period of time 1999-2010 (*Figure 5*), 0.049 for the period of time 2004-2010 (*Figure 6*) and 0.026 for the period of time 2007-2010 (*Figure 7*), values which do not reflect the connection between the two variables, thus actually rejecting the existence of beta convergence, at least from the point of view of the GDP per capita.

**Figure 5 - The connection between GDP per capita in 1999 and GDP per capita growth rate during the period 1999-2010, EU-15**



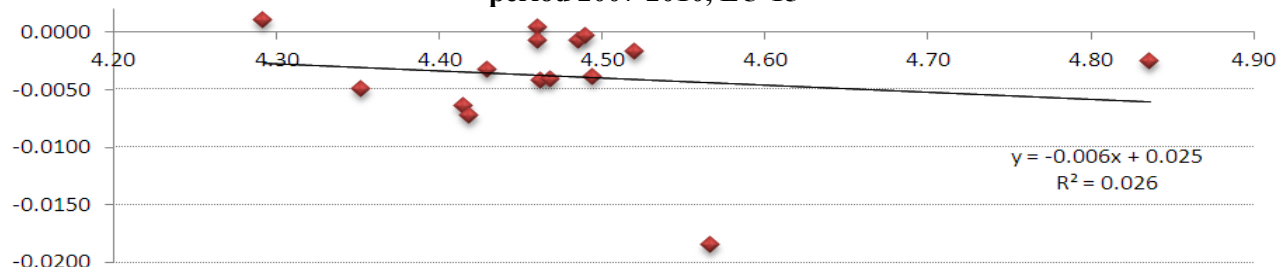
Source: Own calculations using Eurostat data

**Figure 6 - The connection between GDP per capita in 2004 and GDP per capita growth rate during the period 2004-2010, EU-15**



Source: Own calculations using Eurostat data

**Figure 7 - The connection between GDP per capita in 2007 and GDP per capita growth rate during the period 2007-2010, EU-15**



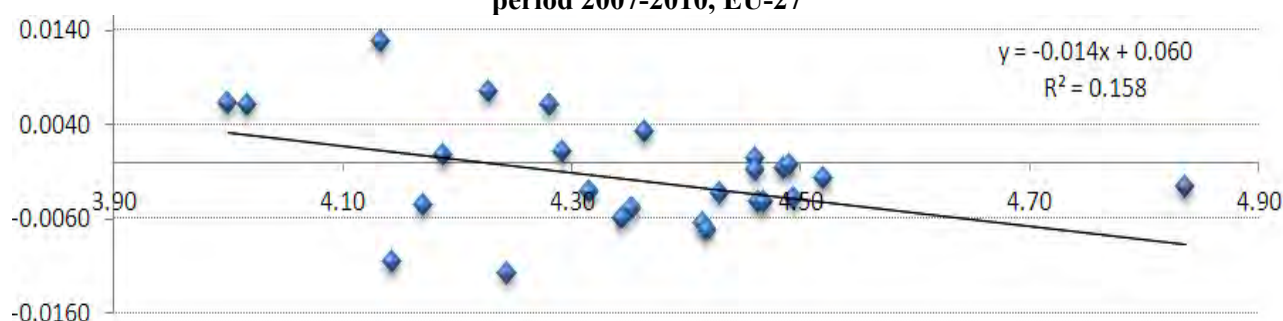
Source: Own calculations using Eurostat data

This situation confirms the results achieved by testing the sigma convergence for the group of 15 states, on the level of which the spreading phenomenon has accentuated gradually during the



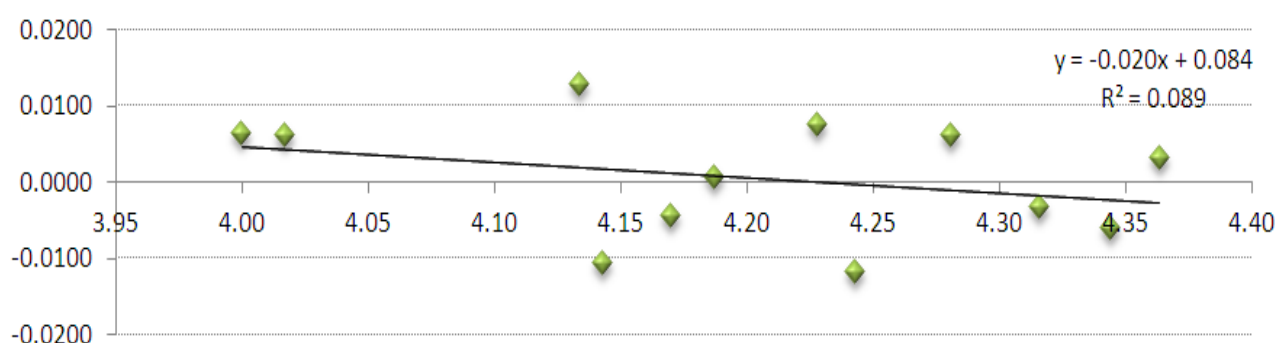
period of time 1999-2010. We notice the same situation for the period of time 2007-2010 in the case of the states included into the last two waves of adherence ( $R^2=0.089$ ) (Figure 8), and thus for the whole EU-27 group ( $R^2=0.158$ ) (Figure 9).

**Figure 8 - The connection between GDP per capita in 2007 and GDP per capita growth rate during the period 2007-2010, EU-27**



Source: Own calculations using Eurostat data

**Figure 9 - The connection between GDP per capita in 2007 and GDP per capita growth rate during the period 2007-2010, EU-10+2**



Source: Own calculations using Eurostat data

The results of the variation analysis for the dependent variable under the influence of the regression coefficient and of the residual coefficient, results achieved by means of the *F test* confirm, due to the *Sig. value of F* lower than 0.05 in the case of EU-27 and EU-10+2 in the periods of time 1999-2010 and 2004-2010 and only in the case of EU-27 in the period of time 2007-2010, the fact that the connection between the two variables is significant. The situation is different in the case of the EU-15 group during all the periods of time subjected to the analysis, as well as for the EU-10+2 group in the period of time 2007-2010.

The values of the non-standardized coefficients of the estimated regression model help us write the regression equation for each separate case listed in the graphical representations.

The testing of the parameters of the regression equation confirms, due to the value *Sig. for t* lower than 0.05 in the case of EU-27 and EU-10+2 for the periods of time 1999-2010 and 2004-

2010 and only in the case of EU-27 for the period of time 2007-2010, the existence of a significant connection between the two variables; in other words, the slope of the regression equation  $\beta$  corresponds to a significant connection between the initial level of the GDP per capita and the growth rate of the indicator during a certain period of time. Just as in the case of the F-test, it is not confirmed in the case of the EU-15 group for any of the periods subjected to the analysis, nor for EU-10+2 during the period of time 2007-2010.

The results achieved through the estimation of the unconditional convergence presented here show, due to the negative value of the coefficient  $\beta$ , the manifestation of the real convergence in the case of EU-27 and EU-10+2 during all the periods of time subjected to the analysis, in contrast with the positive value of the same parameter in the case of EU-15, fact which shows a divergent trend for this group. This allows us to assess that the new member states had a higher economic growth compared to the first 15 states which became members of the EU (except for Luxemburg and Ireland). Using the methodology applied by Kaitila (2004), according to which the convergence speed is given by the slope of the regression equation – that is the value of the coefficient  $\beta$  – we can make assessments on the intensity of this process.

Sala-i-Martin identified a rate of convergence for the real income per capita of 2% per year (Sala-i-Martin, 1996, p. 1032), result criticised by Quah, who states that the convergence takes place at a rate more or less uniform than 2% per year, no matter what geographical region is being analyzed (Quah, 1997). Indeed, the research in this field proved that there are many regions in the world, as well as among the countries included in the EU, which have quite different convergence rates (Kaitila, 2004, p. 4).

In our analysis, the convergence speed for the whole European group is decreasing in time, so that between 1999 and 2010 it was of 2.7%, between 2004 and 2010 it was of 2.4%, while during the period of time 2007-2010 it got to only 1.4%. On the other hand, a higher convergence rate for the GDP per capita can be noticed within the EU-10+2, although it also diminishes in time as follows: in the period of time 1999-2010 it was of 3.6%, in the period of time 2004-2010 it was of 3.3% while in the period of time 2007-2010 it was of 2% (this value must be interpreted cautiously due to the Sig. value for the t-test). In contrast, the positive slope of the regression equation registered within the EU-15 group, and even the insignificant value of -0.006 of  $\beta$  during the period of time 2007-2010 (it is very close to 0, and the value Sig. for the t-test is higher than 0.05), show the presence of a divergence process on the level of these states.

### 3. THE INTENSITY OF THE REAL CONVERGENCE ON THE LEVEL OF THE 271 NUTS 2 REGIONS OF THE EUROPEAN UNION

In this unit we are going to test the hypothesis of the beta convergence in the 271 NUTS 2 development regions of the EU using, for comparison reasons, the same indicator as the one used for the analysis performed on the level of the member states – the GDP per capita expressed by the purchasing power standard (PPS) for all the regions.

Considering the statistic information available, we chose the period of time 2000-2008 to quantify the marginal reaction of the effect, given by the growth rate of the GDP per capita, when changing the condition expressed by the level of development in the initial stage, applying the same regression model. The data used in the regression analysis concerning the average annual growth rates of the GDP per capita, as well as the level of the coefficient in the basic year for each period available at Eurostat, are introduced into logarithms and, based on them, we will create the data base in SPSS.

The results achieved concerning the extent to which the average annual growth rate of the GDP per capita (dependent variable) can be explained by the initial level of the GDP per capita in the basic year 2000, on the level of the NUTS 2 regions, are presented in *Table 2* and in *Figure 10* and are interpreted from the point of view of the manifestations of convergence or divergence based on the parameters of the regression equation.

**Table 2 – The results of regression calculation in the NUTS 2 regions, during 2000-2008**

PARAMETERS	VALUES
<b>MODEL</b>	
R	0.692
R <sup>2</sup> (R Square)	0.478
<b>ANOVA</b>	
F-Test	240.137
F-Test Significance (Sig.)	0.000
<b>COEFFICIENT</b>	
Beta Coefficient ( $\beta$ )	-0.025
Constant ( $\alpha$ )	-0.118
T-Test	-15.496
T-Test Significance (Sig.)	0.000

Source: Own calculations using Eurostat data

The value of the regression coefficient *R* shows the existence of a connection between the two variables considered for analysis, the intensity of the connection and its direction. We notice that *R*

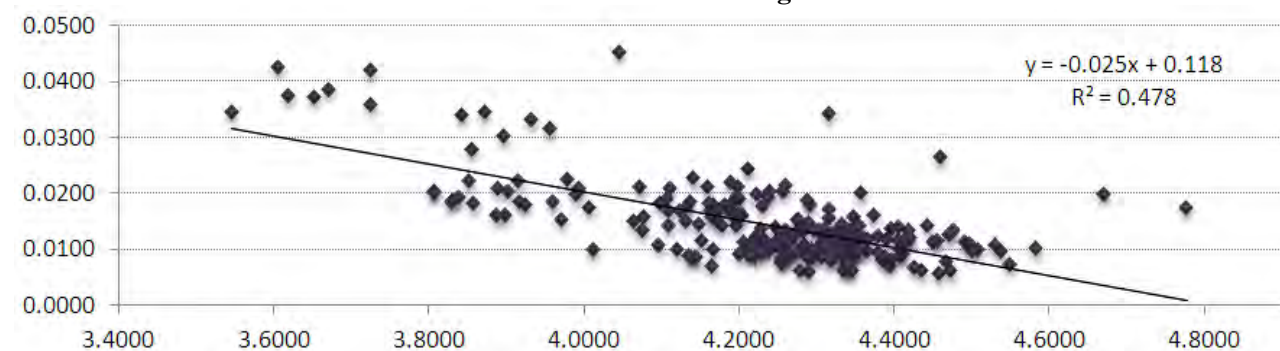
is different from 0 and is positive, which means that there is a connection between the variables, and that it is a positive (direct) one. The absolute value allows us to assess the intensity of this connection – it becomes stronger as it gets closer to +1. Consequently, on regional level we notice quite a strong connection during the period of time subjected to the analysis,  $R$  being 0.692.

The value of the coefficient of determination  $R^2$  shows us the proportion of the variation in the dependent variable explained by the regression model applied. After the analysis that we carried out here, we got for  $R^2$  a value of 0.478 in the period of time 2000-2008 for the NUTS 2 regions, which shows that there is a direct linear connection and a reduced degree of determination of the economic growth by the initial starting level, fact which also signals the existence of other possible determinants.

The results of the analysis for the evolution of the dependent variable under the influence of the regression coefficient and of the residual coefficient, results achieved by means of the  $F$  test, confirm, due to the high value of  $F$  which is 240.137 and to the *Sig. value of  $F$*  which is 0.000 (lower than 0.05), the fact that the connection between the two variables is significant on regional level.

The values of the non-standardized coefficients of the estimated regression model help us write the regression equation which is also listed in the graphical representation (Figure 10).

**Figure 10 - The connection between GDP per capita in 2000 and GDP per capita growth rate during 2000-2008 for NUTS 2 regions**



Source: Own calculations using Eurostat data

The testing of the parameters of the regression equation confirms, due to the *value Sig. for  $t$*  which is 0.000 (lower than 0.05) in the case of the EU regions in the period of time 2000-2008, the existence of a significant connection between the two variables; in other words, the slope of the regression equation  $\beta$  corresponds to a significant connection between the initial level of the GDP per capita and the growth rate of the coefficient during the period of time taken into consideration.

The results achieved through the estimation of the unconditional convergence show, due to the negative value of the coefficient  $\beta$ , the manifestation of the real convergence on the level of the EU regions for the period of time 2000-2008. The intensity of the real convergence process, appreciated by the pace at which the convergence was achieved, given by the slope of the regression equation (the value of the  $\beta$  coefficient) is 2.5%.

## CONCLUSIONS

The results of our research prove the fact that the new member states (the EU-10+2 group) enjoyed a higher rate of convergence compared to the old member states (the EU-15 group). This situation actually confirms the neoclassical theory concerning the economic growth which supports the convergence within the countries with similar elements, as well as Heckscher-Ohlin-Samuelson theory of international trade according to which the poorer economies have certain advantages in terms of economic growth compared to the richer countries, advantages which allow them to grow more rapidly and to make up for the existing gaps. According to the neoclassical theory of economic growth, the decreasing efficiencies of the factors of production involve capital flows from the more developed countries towards the less developed ones, where the efficiency rates are higher. These capital flows, which often materialize through foreign direct investments (FDI), are the foundation for the growth of the real production capacity in the destination countries.

The results achieved are also based on the status of the application of the same structural, institutional and political reforms by most of the states included in the last two waves of adherence to the European Union during the period of transition from the centralized economic system to the market economy. Among these states, the ones that applied the reforms after 1990 had a low level of development until the mid '90s, but managed to have high growth rates by the end of the '90s and after 2000.

Another argument supporting the convergence of the states in the EU-10+2 group refers to the extent of the transition crisis and the effect of returning to the previous income level. Thus, the countries which suffered deep recession in the early '90s had to go through much faster growth than the ones that suffered less because of the recession, in order to reach again the level of income they had in 1989.

Last but not least, the differences between the economies require special investment efforts which only a small number of developed countries can support financially so that, in order to achieve real economical convergence through the European cohesion policy, the member states and

the candidates situated on a lower level of development benefited from structural funds, fact which allowed them to have higher growth rates compared to the developed economies. Thus, on the level of the EU-27 group, there was a slight process of levelling the discrepancies pertaining to the economic development.

Moreover, we must consider the fact that the market liberalization increases the mobility of the factors of production and their contribution to the economic growth, especially in the countries with higher economic, scientific and technological potential, generating effects such as: decreasing the costs for the production factors, intensifying the competition on larger markets, increasing productivity and so on.

On regional level, although some of the developed regions are starting to have very low or even negative rates of economic growth, there is a quite slow overall process of real economic convergence.

From a methodological point of view, the unifactorial regression model for estimating the  $\beta$  parameter can be extended by adding other variables, as well as by applying some new suitable convergence models which should record as accurately as possible the influence of all these aspects on achieving the real convergence of the states included in the European Union.

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