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CONVERGENCE TENDENCIES IN THE EU MEMBER STATES – A STATISTICAL STUDY FOR THE PERIOD 1980–2013

Abstract

The aim of the article is empirical analysis of convergence process in the European Union especially after extending it by the groups of less developed countries („cohesion" countries after their accession in the 1980s and Central and Eastern Europe countries after 2004). The econometric methods, based mainly on regression growth models, are implemented, first of all, to verify the hypothesis about the existence of beta convergence and its impact on sigma convergence; secondly, to verify the theoretically proved statement that capital accumulation become less important in convergence processes as compared to the increasing role of technological progress. The results of the investigation point at the existence of beta convergence and its important but decreasing impact on reducing income disparities among European Union Member States. An additional survey on the existence of convergence clubs, conducted using the approach based on polynomial functions, , confirms, that all the analysed countries were approaching the same steady state and creating a common convergence club.

JEL Classification Code: **G10, G15**.

Keywords: convergence, economic growth, convergence club, catching-up process.

Introduction

As early as the mid-eighties of the twentieth century, economic literature started to challenge the hypothesis of real convergence on a global scale and, therefore, the existence of the phenomenon of absolute convergence (Baumol, 1986; Dowrick, Nguyen, 1989; de Long, 1988). Most economists, however, agree with the view on the existence of convergence of per capita income within countries which differ in initial

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capital resources but have identical production functions and levels of savings and strive for the same „goal", i.e. a long-term equilibrium called the steady state. These groups of countries are referred to as convergence clubs.

According to the concept of conditional convergence, a country with low initial capital resources is characterised by larger increments in income due to a high rate of return on investment. The increase in income in richer countries with larger capital resources is lower, leading over time to aligning the income levels in both countries (Barro, Sala-i-Martin, 1991.1992; Mankiw, Romer, Wail, 1992). It has been theoretically and empirically proved, however, that this „catching up" (convergence β) does not guarantee real convergence of income levels in economies in the long term or the reduction of disparities in the level of development, and therefore, it does not guarantee the so-called convergence σ (Friedman, 1992; Quah, 1993). The differences in the level of GDP per capita between countries may even increase if during the process of reaching the steady state random and asymmetric shocks occur (Sala-i-Martin, 1996).

Type β convergence is thus a necessary condition for the existence of convergence σ, but it is not sufficient. Moreover, theoretically speaking, the assumption about the decreasing revenues from capital implies the inability to continuously increase production by expanding capital resources. It turns out that in the long run, the importance of capital accumulation decreases, and the only source of growth of per capita income is technical progress, thanks to which the economy is able to produce more with the same capital resources. The existence of convergence is dependent, inter alia, on differences in total factor productivity or TFP (Hulten, 2000; Caselli, Tenreyro, 2005).

The convergence of countries to a common steady state and belonging in the convergence club is undoubtedly conditioned by their similar level of economic and technological development, complementarity of economic structures and institutional interrelationships. Convergence is therefore more likely in integration groups such as the European Union (Bukowski, 2011). In the history of integration within the European Union, there are cases of accession of countries that are at a relatively lower level of economic development, such as the accession of Greece, Spain and Portugal in the 1980s, or the countries of Central and Eastern Europe in 2004. Taking into account the above theoretical discussion, the logical consequence of the accession of this type of countries should be β convergence, which is a gradual process of „catching up" with relatively richer countries by these countries. Thanks to the process of integration in the „underdeveloped" countries, key channels of accelerating economic growth are opened, i.e. restructuring of the economy, the development of competition, the influx of technology, investments in infrastructure and the liberalisation of trade and the exchange rate regime. These changes manifest themselves even before the official accession as a result of the so-called integration anchor (Rapacki, Próchniak, 2012). The process of „catching up" is also affected by EU policies focused on reducing disparities in the level of development, reflected in intense influx of aid funds to relatively less developed countries (Fayolle, Lecuyer, 2000,

Beugelsdijk, Eijffinger, 2003).The existence of β convergence within EU Member States may, but does not have to, translate into eliminating development disparities within the group (σ convergence). In addition, the existence of a negative correlation between the initial level of GDP per capita and the average growth rate in a group of integrating countries does not guarantee that each of them „moves" toward the same steady state. It may happen that some of them even show divergence. On the other hand, a positive correlation between both economic values within a group as a whole does not exclude the possibility that some of them show convergence of income, thereby forming a convergence club (Bernard, Durlauf, 1996).

The purpose of this paper is to analyse the processes of convergence in the European Union (and EEA), taking place especially during the period of expanding the group with countries which are at a relatively lower level of economic development. Particular attention is paid to the processes of growth occurring after the accession of Greece, Spain and Portugal in the eighties of the twentieth century and in the period of preparation and after the accession of CEE countries. The study verifies the existence of type β convergence and its impact on reducing development disparities in the analysed group of countries, i.e. σ convergence. An attempt is also made to check whether in the case of the European Union, the statement, proved on a theoretical basis, about the declining importance of capital accumulation (β convergence) in the creation of convergence processes is confirmed. In addition, by performing appropriate tests for the existence of convergence clubs, it is examined whether all Member States follow the same path of growth, striving for the same long-run equilibrium point, hence belonging in the same convergence club.

1. The phenomenon of real convergence of European Union Member States in the different periods of their integration

1.1. Metodology

Studies on the convergence processes can be conducted using panel data, average data obtained from 10 or 5-year sub-periods or averaged data for the entire analysed period. The methods mentioned above have advantages and disadvantages (Rapacki, Próchniak, 2012).

Taking into account a large number of observations and various methods of estimation, it may be said that studies based on panel data are more solid. However, from the economic point of view, an analysis that uses that kind of data is distorted by the influence of business cycles and other irregular fluctuations of the economy.

A better solution is to use average data for sub-periods. The connection between the initial income and middle- and long run growth processes can be then investigated. The longer the sub-period is (e.g. 10 years), the more reliable the results are from the economic point of view (business cycles, lasting usually less than 10 years, are

eliminated), and less significant from the statistical point of view. Furthermore, the following method including relatively short 20-year period is difficult to implement.

Taking into account the method based on average data for the entire analysed period, one should be aware that a limited number of observations influences the statistical credibility of the obtained results. However, from the economical point of view, the mentioned approach seems to be more adequate. It focuses on the long-run relations between variables, in other words, gives an opportunity to investigate the relation between initial conditions of economies and their long-run growth processes. In research based on average (thus stationary) data, the simple linear regression model and the classical least squares method of estimation can be implemented.

The study of real convergence of the European Union Member States in the different periods of their economic integration, used the two most popular measures of real convergence, β convergence and type σ convergence.

The easiest way to verify the hypothesis of conditional β convergence is estimating the structural parameters of the following equation:

$$\frac{1}{T}\ln\frac{Y_T}{Y_0} = \alpha_0 + \alpha_1 \ln Y_0 + \varepsilon \tag{1}$$

The left side of the equation represents the average growth rate of GDP per capita between the period *T* and the base period 0. The explanatory variable is the logarithm of the initial level of per capita income. The negative value of the parameter α_1 means the occurrence of convergence, whose rate is reflected by the coefficient β defined by the following formula:

$$\beta = -\frac{1}{T}\ln(1 + \alpha_1 T) \tag{2}$$

The higher the coefficient β value (between 0 and 1), the higher the convergence rate (Barro, Sala-i-Martin, 2003; Próchniak, 2006).

Due to the fact that the β convergence can be treated as one, but not the only, determinant of the convergence process manifested by a reduction in disparities in GDP per capita of a certain group of countries, i.e. σ convergence, it appears reasonable to investigate the existence and the rate of this type of convergence in the analysed group of countries. A relatively simple way to verify the σ convergence hypothesis is to estimate the trend lines for the difference levels of income between countries (measured by the standard deviation of the GDP per capita logarithm):

$$sd(\ln Y_T) = \alpha_0 + \alpha_1 t + \varepsilon \tag{3}$$

A negative α_1 coefficient value (ranging from -1 to 0) indicates the occurrence of σ convergence.

The above mentioned formulas were used to conduct a study of real convergence in a group of 15 (in the period 1980- 2004) and 27 (in the periods 1993- 2004 and

2004-2013) European Union Member States. Data on GDP per capita in the Member States was obtained from the International Monetary Fund World Economic Outlook Database, 2014 (data in USD, current prices).

1.2. Beta convergence of European Union Member States – results

The analysis of the process of „catching up" (type β convergence) among the European Union Member States was conducted for several periods. This is due to the EU expansion (and earlier EEC) to other countries and the associated difficulties in providing a general overview of convergence in the group. The first studied period covers the years 1980-2004, starting with the accession of the relatively less developed Greece, then Spain and Portugal, and ends before the accession of the next group of countries with relatively lower GDP per capita, i.e. the countries of Central and Eastern Europe. The second area of analysis relates to the period 1993-2013 and is associated with the preparation of the above group of countries for the accession, i.e. after signing association agreements (sub-period 1993-2004) and their functioning in the EU as Member States (sub-period 2004-2013).

The results in Table 1 confirm the existence of a negative correlation between the initial level of wealth and the growth rate of GDP per capita of the EU Member States (EEC) of that time, and therefore, the β type convergence in the period 1980-2004. Greece, Spain and Portugal, which at the time of accession had approximately half the level of GDP per capita compared to the average for the EU-15, in the analysed period approached the most developed EU countries at a rate of about 2% per year. Analysing, on the other hand, the European Union after 1993, i.e. including the then candidate countries, a much faster pace of „catching up" (3.5%) may be observed. CEE countries, which in 1993 were characterised by significantly lower than those „cohesion countries" GDP per capita of only about 30% of the average level of this ratio for the whole group, showed a high rate of developmental catching up, which is fully compatible with the concept of convergence arising directly from Solow's model (1956). The process of „catching up" was particularly evident within the EU-12. These countries, during the period 1993 – 2013, were drifting towards a common steady state at a rate of 5.2%. This observation confirms the validity of the concept of conditional convergence, and therefore the importance of homogeneity of countries in shaping the convergence processes and their dynamics.

For a more detailed analysis of the convergence process, which, as has been proved above, took place in the European Union after 1993, new models were constructed for the EU-27 and EU-12 in the periods 1993-2004 and 2004-2013. Results of the estimation and evaluation of the quality of the models are presented in Table 2.

Generally, the official membership of the so-called „new" EU Member States, whose accession took place in 2004 and 2007, did not significantly influence their catching up process in terms of developmental distance to both the richest countries in the Union and to one another. The rate of convergence in the EU-27 and EU-12

after 2004 was even lower than in the period of intensive preparation of the CEE countries for the EU membership.

Table 1. Estimation results of growth regression models describing absolute convergence β among the European Union Member States (EU-15, EU-12, EU-27) in the period 1980-2013; dependent variable: ln $(Y_t/Y_0)/T$; classical least squares method estimation

Variable / model diagnostics	EU-15	EU-27	EU-12
	1980-2004	1993-2013	
constant	0,20101	0,29035	0,342989
stand. error	0,0466337	0,0190009	0,030827
Student's t	4,3104	15,2809	11,1262
p value	0,00085	<0,0001	<0,00001
significance	***	***	***
ln GDP per capita in 1980/1993	-0,0163375	-0,0256328	-0,0324152
stand. error	0,0050789	0,00209429	0,00386027
Student's t	-3,2167	-12,2394	-8,3971
p value	0,00675	<0,00001	<0,00001
significance	***	***	***
F- Snedecor's test[1]			
F-statistic	10,34743	149,8023	70,51188
critical value	4,66146	4,2417	4,9646
p value	0,006747	4,70e-12	7,68e-06
result	rejection of H_0	rejection of H_0	rejection of H_0
White's test[2]			
test's statistic	0,064508	1,01952	4,66443
critical value	5,99146	5,99146	5,99146
p value	0,9682	0,60064	0,0970804
result	acceptance of H_0	acceptance of H_0	acceptance of H_0
Adjustment of models			
R^2	0,443194	0,856981	0,875795
Adjusted R^2	0,400362	0,851261	0,863374
Convergence analysis			
β convergence	yes	yes	yes
β coefficient[3]	0,0210 (2,1%)	0,035939 (3,5%)	0,052249 (5,2%)
Number of observations	15	27	12

1 – F-Snedecor's test: H_0: $\alpha_1 = \alpha_2 = ... = \alpha_k$; rejection of hypothesis H_0 indicates that the estimated model includes significant variables.
2 – White's test: H_0: random component is homoscedastical; acceptance of the hypothesis H_0 indicates the existence of homogeneousness of variance.
3 – calculated according to formula (2).

Source: own calculations using GRETL software.

Table 2. Estimation results of growth regression models describing absolute convergence β among the European Union Member States (EU-27, EU-12) in the period 1993-2013; dependent variable: ln $(Y_t/Y_0)/T$; classical least squares method estimation

Variable / model diagnostics	EU-27		EU-12	
	1993-2004	2004-2013	1993-2004	2004-2013
constant	0,368147	0,338949	0,405581	0,419077
stand. error	0,055004	0,0636833	0,0547132	0,0608094
Student's t	6,6332	5,3224	7,4128	6,8917
p value	<0,00001	0,00002	0,00002	0,00004
significance	***	***	***	***
ln GDP per capita in 1993/2004	-0,0318587	-0,029632	-0,03956	-0,0396535
stand. error	0,00587952	0,00625495	0,0068514	0,00671979
Student's t	-5,4186	-4,7374	-5,7740	-5,9010
p value	0,00001	0,00007	0,00018	0,00015
significance	***	***	***	***
F- Snedecor's test[1]				
F-statistic	29,36106	22,44269	33,3391	34,82195
critical value	4,2417	4,2417	4,9646	4,9646
p value	0,000013	0,000074	0,000179	0,000151
result	rejection of H_0	rejection of H_0	rejection of H_0	rejection of H_0
White's test[2]				
test's statistic	1,79256	2,28403	1,64721	1,36035
critical value	5,99146	5,99146	5,99146	5,99146
P value	0,408085	0,319175	0,438847	0,506527
result	acceptance of H_0	acceptance of H_0	acceptance of H_0	acceptance of H_0
Adjustment of models				
R^2	0,540112	0,473048	0,769262	0,776895
Adjusted R^2	0,521716	0,451970	0,746188	0,754585
Convergence analysis				
β convergence	yes	yes	yes	yes
β coefficient[3]	0,040147 (4%)	0,03446 (3,4%)	0,053652 (5,4%)	0,049047(5%)
Number of observations	27		12	

1 – F-Snedecor's test: H_0: $\alpha_1 = \alpha_2 = ... = \alpha_k$; rejection of hypothesis H_0 indicates that the estimated model includes significant variables.
2 – White's test: H_0: random component is homoscedastical; acceptance of the hypothesis H_0 indicates the existence of homogeneousness of variance.
3 – calculated according to formula (2).

Source: own calculations using GRETL software.

A slight decrease in the rate of „catching up" in the period 2004-2013 can be partly explained by the effects of the economic crisis which started in 2007. However, the downward trend in the value of coefficient β may also be evidence that the passage of time and the catching-up of developmental distance also in the case of the „new"

EU countries capital accumulation ceases to be the main cause of convergence and its place is gradually overtaken by changes in total factor productivity (TFP). The above hypothesis is confirmed by the fact that significantly lower coefficient β was observed in the EU-15 and the entire EU-27.

The diagnostic tests of individual models included in Table 1 and Table 2, i.e. the F-Snedecor test and White's test for heteroscedasticity[2], allow to consider them sufficient in studying the phenomenon of convergence. Also satisfactory values of determination coefficients were obtained (R^2 and adjusted R^2).

1.3. Sigma convergence of European Union Member States – results

In light of the results of the study on the existence of σ convergence presented in Table 3, it can be concluded that developmental disparities between Member States decreased during the analysed 34-year period of the operation of the group.

Negative values of the structural parameters of the time variable t in each of the estimated equations indicate a gradual decrease in the standard deviation of the logarithm of per capita GDP in the analysed groups. Neutralising developmental differences was particularly evident in the expanded European Union (EU-27) and in the group of the „new" Member States. It was observed to a much lesser extent in the „former fifteen". Therefore, in the case of the European Union one can observe a clear correlation between the rate of „catching up" and type σ convergence. A higher rate of β convergence translates into faster reduction of the disparities in income per capita in the analysed groups of countries and vice versa.

Table 3. Estimation results of models describing sigma convergence among the European Union Member States (EU-15, EU-27, EU-12) in the period 1980-2013; classical least squares method estimation

Variable / model diagnostics	EU-15	EU-27	EU-12
Dependent variable	sd_UE_15_1980_2004	sd_UE_27_1993_2013	sd_UE_12_1993_2013
constant	0,457403	1,17749	0,874513
stand. error	0,00814288	0,0181603	0,0115022
Student's t	56,1722	64,8386	76,0299
p value	<0,00001	<0,00001	<0,00001
significance	***	***	***
t variable	-0,0048227	-0,0287946	-0,0262944
stand. error	0,0005477	0,00151599	0,00103293
Student's t	-8,8046	-18,9940	-25,4561
p value	<0,00001	<0,000001	<0,00001
significance	***	***	***

[2] In the case of models based on cross-sectional data, there is a suspicion of the existence of heteroskedasticity, because the variance of the random component may depend on the size of GDP in a given country. Therefore, a desirable feature of the model is heteroskedasticity.

Table 3 continued.

Variable / model diagnostics	EU-15	EU-27	EU-12
F- Snedecor's test[1]			
F- statistic critical value	77,52050 4,27934	360,7705 4,41387	648,0133 4,41387
p value	7,97e-09	2,34e-13	9,34e-14
result	rejection of H_0	rejection of H_0	rejection of H_0
White's test[2]			
test's statistic critical value	5,07429 5,99146	8,30839 9,21034	7,17272 9,21034
P value	0,0790919	0,0156985	0,0276989
result	acceptance of H_0	acceptance of H_0	acceptance of H_0
Adjustment of models			
R^2	0,771191	0,952478	0,977376
Adjusted R^2	0,761243	0,949838	0,975868
Convergence analysis			
Sigma convergence	yes	yes	yes
Number of observations	25	21	

1 – F-Snedecor's test: H_0: $\alpha_1 = \alpha_1 = ... = \alpha_k$; rejection of hypothesis H_0 indicates that the estimated model includes significant variables.
2 – White's test: H_0: random component is homoscedastical; acceptance of the hypothesis H_0 indicates the existence of homogeneousness of variance.
3 – calculated according to formula (2).

Source: own calculations using GRETL software.

The study achieved high significance of the structural parameters. Diagnostic tests included in Table 3 indicating a relatively good quality of the models allow to consider the adopted method of testing this type of convergence as sufficient.

2. Test on the existence of convergence clubs among European Union Member States in the different periods of their integration

The concept of convergence clubs refers to the notion of the existence of the multiple equilibria in the global or regional range. Similar countries converge in the long–run towards each other and their initial conditions move towards the same stationary equilibrium (Galor, 1996). The cross-country regressions, implemented above, do not account for the existence of multiple equilibria. If we estimate a negative correlation between the average growth rate and initial GDP per capita, it's impossible to know if all the countries are converging (and creating a convergence club) or only some of them. Moreover, the conducted study on sigma convergence in UE Member States concerns the analysis of income dispersion mostly by looking at the

development of income standard deviation over time, not at the relative income levels. The hypothesis of the convergence club can be more efficiently tested using nonparametric methods, e.g. introducing polynominal functions in the growth equation (Chatterji,1992; Quah, 1996).

2.1. The model of convergence clubs- an approach based on polynominal functions

To test the existence of the convergence club among the EU Member States the approach of Chatterji and Dewhurst (1996) has been implemented. The starting point of the model construction is the following equation proposed by Barro and Sala-i-Martin[3] (1995):

$$\ln\left(\frac{Y}{L}\right)_{i,t} - \ln\left(\frac{Y}{L}\right)_{i,o} = a_i + b \ln\left(\frac{Y}{L}\right)_{i,o} + \varepsilon \tag{4}$$

In the model constructed by Chatterji and Dewhurst, the development of income dispersion is analysed by determining all variables in equation (4) as gap forms by subtracting all the logarithmic levels from the maximal level and rearranging the same year gaps to the same side (equation 5).

$$\ln\left(\frac{Y}{L}\right)_{max,t} - \ln\left(\frac{Y}{L}\right)_{i.t} = (1 + b)\left[\ln\left(\frac{Y}{L}\right)_{max,o} - \ln\left(\frac{Y}{L}\right)_{i,o}\right] + \varepsilon \tag{5}$$

Ln (Y/L)$_{max,t}$ and *ln(Y/L)$_{max,0}$* are GDP per capita in the richest country in the terminal year *t* and the initial year *0*. *Ln (Y/L)$_{i,t}$* and *ln(Y/L)$_{i,0}$* are GDP per capita in all other economies in the terminal year *t* and the initial year *0*, respectively. To model the possibility of multiple equilibria, Chatterji and Dewhurst included in the above equation variables measuring wideness of the gap between the initial income of the „leader" country and that of the country *i*. Describing this gap as $GAP_{GDP} = ln(Y_{max}) - ln(Y_i)$, the convergence model can be written as:

$$GAP_{GDP,t} = \sum_{k=1}^{k} A_k \left(GAP_{GDP,0}\right)^k + \varepsilon \tag{6}$$

The number of convergence clubs will depend on the value of k. When k=3 a cubic function is taken into account that stands for two mutually exclusive convergence clubs. The convergence model is the following:

$$GAP_{GDP,t} = A_1 \left(GAP_{GDP,o}\right) + A_2\left(GAP_{GDP,o}\right)^2 + A_3 \left(GAP_{GDP,o}\right)^3 \tag{7}$$

[3] where: $a_i = x_i + (1 - e^{\beta}) ln\,(y_i^* + x_{i,o})$; $b = -(1 - e^{\beta})$; x_i – the speed of technological process, y^*-steady state point, β – the speed of beta convergence.

In the equilibrium of function (7) the gap is constant ($GAP_{GDP,t} = GAP_{GDP,0}$). Therefore, three possible equalibria exist[4] and two different cases may appear (see Fig. 1).

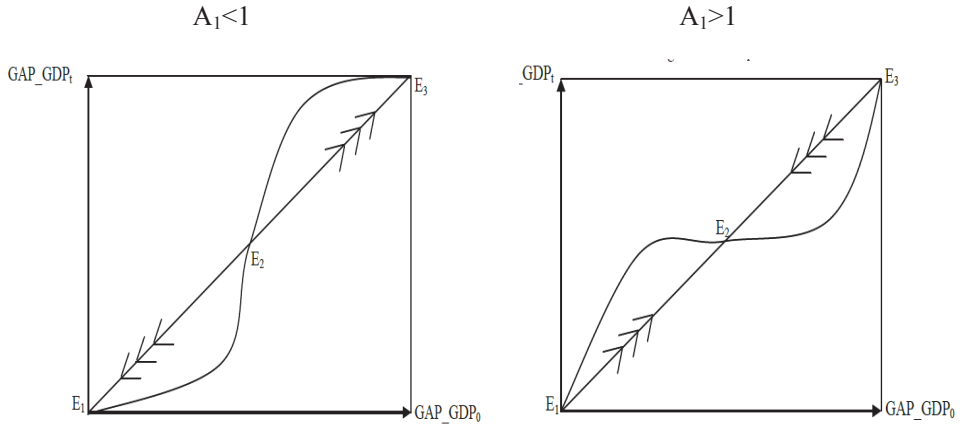

Figure 1. Possible convergence clubs: case A1<1 , case A1>1

Source: own work.

If A1 <1 the solving of equation (7) leads to three different equilibria (two stable E_1 and E_3 and one unstable E_2). Countries that have a gap of GDP per capita with the „leader" country below the E_2 level will converge towards the E_1 income level. These countries converge to the same income level as the „leader" in the long term. When the gap is too large (above E_2), then countries diverge from the level of the „leader" country and converge to the lower income level (E_3).

In the case where A1>1, the only one stable equilibrium is E_2. All countries that have an income gap with the „leader" below the E_3 level E_3 converge to the E_2 level E_2. Countries with the initial gap between E_2 and E_3 actually also converge to the „leader" country. In turn, countries that have a gap between E_1 and E_2 diverge from the „leader", similarly to the economies with the gap greater than E_3. The last group of countries diverges from all other economies.

2.2. Results

To test the existence of a convergence club among the EU Member States in the different periods of their integration the following equations are estimated:

$$\mathrm{GAP}_{\mathrm{GDP},2004} = \mathrm{A}_1 \left(\mathrm{GAP}_{\mathrm{GDP},1980}\right) + \mathrm{A}_2\left(\mathrm{GAP}_{\mathrm{GDP},1980}\right)^2 + \mathrm{A}_3 \left(\mathrm{GAP}_{\mathrm{GDP},1980}\right)^3 \qquad (8)$$

[4] in the points where function (7) line cuts 45 degree line (benchmark line).

$$GAP_{GDP,2013} = A_1 \left(GAP_{GDP,1993}\right) + A_2\left(GAP_{GDP,1993}\right)^2 + A_3 \left(GAP_{GDP,1993}\right)^3 \quad (9)$$

$$GAP_{GDP,2004} = A_1 \left(GAP_{GDP,1993}\right) + A_2\left(GAP_{GDP,1993}\right)^2 + A_3 \left(GAP_{GDP,1993}\right)^3 \quad (10)$$

$$GAP_{GDP,2013} = A_1 \left(GAP_{GDP,2004}\right) + A_2\left(GAP_{GDP,2004}\right)^2 + A_3 \left(GAP_{GDP,2004}\right)^3 \quad (11)$$

Equation (8) tests the existence of a convergence club within „the former UE-15" in the period 1980- 2004. The gap variable (for the year 1980 and 2004) was formed by taking a natural logarithm of GPP per capita in the leader country (in that case Luxembourg) over the GDP per capita in each other country. Models (9), (10) and (11) test the club convergence of 27 members of the EU (respectively in the periods 1993-2013, 1993-2004 and 2004- 2013). The gap variables in the analysed year t and initial year 0 were constructed with Luxembourg as a benchmark country. The obtained results of the regressions are included in table 4. Each row of the table reports the coefficients, t-statistics, the fit of the regression and the equation standard errors.

Table 4. Convergence clubs in the European Union from 1980 to2013 (classical least squares method estimation)

Model	GAP_{GDPt}	GAP_{GDPo}	A_1 (stand. error) Student's t	A_2 (stand. error) Student's t	A_3 (stand. error) Student's t	F-statistic (p value)	R^2 Corr. R^2
(8)	$GAP_{GDP2004}$	$GAP_{GDP1980}$	2,8902*** (0,4592) 6,2944	-3,11322*** (0,8877) -3,5072	1,1383** (0,3916) 2,9069	72,1423 (1,61e-07)	0,9516 0,9428
(9)	$GAP_{GDP2013}$	$GAP_{GDP1993}$	1,6881*** (0,1189) 14,2019	-0,5263*** (0,0924) -5,6960	0,0640*** (0,0167) 3,8236	610,7661 (4,65e-22)	0,9876 0,9865
(10)	$GAP_{GDP2004}$	$GAP_{GDP1993}$	1,14319*** (0,1408) 8,1166	-0,137537* (0,1095) -1,2562	0,0089* (0,0198) 0,4484	498,2717 (4,67e-21)	0,9848 0,9835
(11)	$GAP_{GDP2013}$	$GAP_{GDP2004}$	1,60713*** (0,09364) 17,1625	-0,50026*** (0,09582) -5,2208	0,0820067*** (0,02303) 3,5607	1823,991 (1,76e-27)	0,9958 0,9955

***/**/* statistically significant at the level of 1%, 5%, 10%

Source: own calculations using GRETL software.

Based on a preliminary analysis of the results, it can be concluded that in the case of the EU Member States at different stages of integration, there exists one steady state (values of A_1 coefficients for each of the estimated equations are higher than 1) to which the analysed countries converge or (possibly) from which they diverge. A graphical interpretation of the results broken down by sub-periods is shown below.

Fig. 2 shows the creation of the convergence club within the 15 EU in the period 1980-2004. The equilibrium points (E_1, E_2, E_3) were determined by intersecting the estimated function (8) with a 45-degree line.

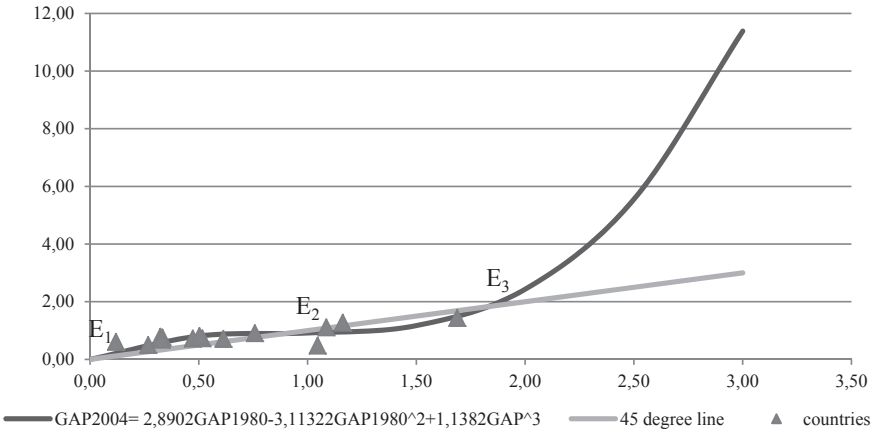

Figure 2. Convergence clubs from 1980-2004

Source: own calculations

All the Member States form that period drifted towards the common long-run equilibrium E_2, thereby creating a convergence club. In the base period, none of them showed a gap in GDP per capita (compared to the most developed Luxembourg) with values higher than 1.83 (corresponding to point E_3). Portugal got closest to this point (the gap in 1980 was 1.69). Despite moving towards the same steady state the countries of the EU-15 can be clearly divided into two groups, i.e. converging upward and converging downward. The former includes countries with the GDP per capita gap in the range of (0.91, 1.83]. They were characterised by a smaller gap in 2004 as compared to 1980 (the line of the estimated function is below the line of 45 degrees). Therefore, they were catching up with relatively richer countries. Countries in this group, i.e. Greece, Spain, Portugal and Ireland, not only converged among themselves, but showed convergence to the leader (Luxembourg). The latter group includes countries with the gap in the range of (0, 0.91], to which countries of the „former 15" may be included, characterised by an increase in the GDP gap relative to the leader (the line of the estimated function (8) is above the line of 45 degrees). They showed both internal convergence and divergence with respect to Luxembourg.

A similar study was conducted for the period 1993-2013 and the European Union expanded with the next 12 member states. In the light of the obtained results, presented in Fig. 3, all countries covered by the study showed convergence to a common long-run equilibrium at point E_2 (the border level of the gaps that guarantees being in the club was 6.59, and the highest level in the group was 4.30 for Bulgaria).

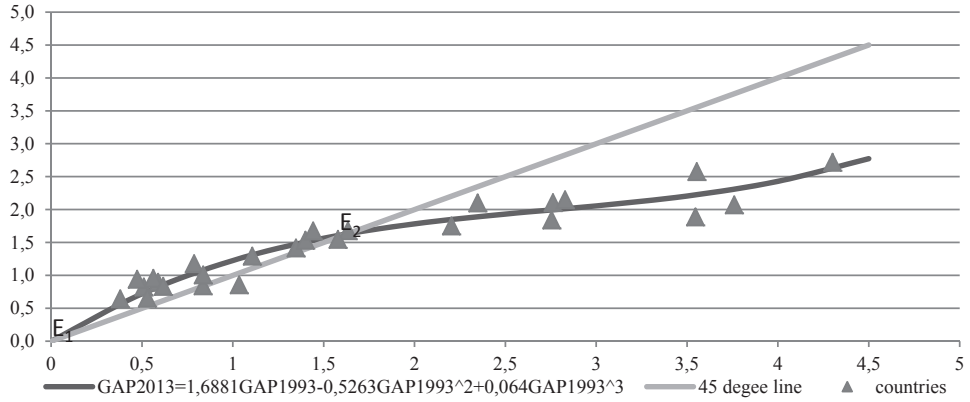

Figure 3. Convergence clubs from 1993-2013

Source: own calculations.

In the analysed period, the group of the „catching up" countries (with the size of the gap falling between (1.63, 6.59]) were Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Romania. The greatest progress in reducing this gap was showed by the countries with its highest levels in the base year, which is consistent with the high rate of β convergence of the „new" Member States. Other EU states with the size of the gap in relation to the leader in the base period in the range of (0, 1.63] showed no significant progress in reducing the gap and low intensity upward convergence in moving towards the long-term equilibrium. Ireland was an exception in this group, in the case of which a lower level of the gap compared to the base year was observed in 2004.

The results of a detailed analysis of these phenomena for the period 1993-2013 broken down into the periods before and after the official accession of the 12 relatively less developed countries to the EU is presented in the graphs below. They clearly confirm the importance of downward convergence in reducing the disparities between countries, especially in the period 1993 - 2004 (Figure 4). Fourteen of the 27 analysed countries (i.e. Bulgaria, Cyprus, the Czech Republic, Estonia, Greece, Hungary, Ireland, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia, and even Finland) had lower levels of the gap in GDP per capita in 2004 as compared to the base year of 1993.

After 2004, the group of the so-called „catching-up" countries clearly shrank (Figure 5). It comprised Bulgaria, the Czech Republic, Estonia, Lithuania, Latvia, Poland, Romania and Slovakia. The rate of reduction of the gap in GDP per capita in these countries before and after the accession to the EU dropped considerably. In the period 1993-2004 the group of the abovementioned countries decreased its distance in relation to the most developed Luxembourg by an average of 22%, while in the period 2004-013 only of about 12%.

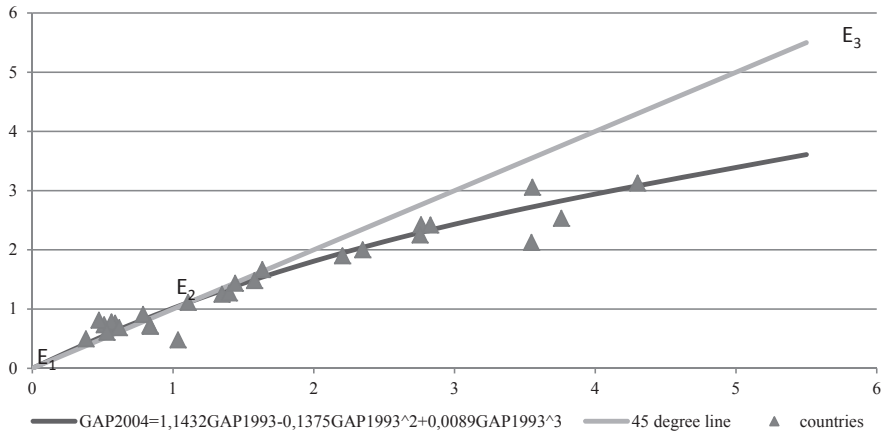

Figure 4. Convergence clubs from 1993-2004 Fig.4 Convergence clubs from 1993-2004

Source: own calculations.

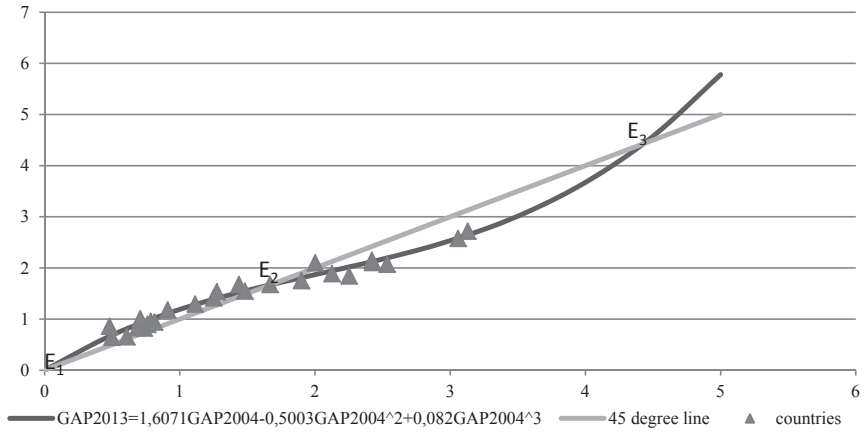

Figure 5. Convergence clubs from 2004-2013

Source: own calculations.

Other EU Member States were characterised by a slight increase in the development gap in relation to Luxembourg, while demonstrating internal convergence. All countries „moved", however, towards a common steady state designated in point E_2, thus constituting one convergence club.

Conclusions

According to the conducted analysis, one can undoubtedly state, that the mechanism of absolute convergence (resulted directly from Solow's neoclassical model) was and still is an important determinant of growth of the European Union Member States, especially of those „new" ones with a relatively lower level of economic development. So far, the mentioned mechanism has supported the elimination of income disparities among integrating countries (sigma convergence).

The role of capital accumulation as an „engine" of convergence has been incrementally decreasing. Results of the survey on the existence of beta convergence conducted for the most developed UE members in the period 1980-2004 confirm the above statement. The first symptoms are also noticeable in the extended UE in the period 1993-2013. While the integration connections are strengthening, the catching-up processes that are characteristic for less developed(in the pre-accession period) countries, are not enhancing, just the opposite- are staring to fade out in the post- accession period. Thus, the results of the analysis conducted using econometric methods seem to confirm the theoretically proved thesis on the declining importance of capital accumulation in creating convergence processes and the increasing role of productivity changes resulting from technological progress. Consequently, one can suppose that the positive changes in TFP will become more and more important in eliminating income disparities among EU member states.

In the light of the conducted surveys, the dynamics of convergence depend on how homogenous the group of analysed countries is. A higher pace of beta convergence is observed among the „new" member states, and much lower -among all the UE members. That regularity is evidence that conditional convergence among the EU member states exists.

Due to the fact, that cross-sectional regressions are used in the surveys, they do not provide detailed information whether all the countries of the sample are converging or only some of them. Since the estimation of club convergence models is included, it is possible to state that all the analysed countries were converging towards a common steady state and creating a „convergence club" in any period taken into account. Within the „convergence clubs" one can distinct two groups of countries: (1) converging downward, i.e. diverging from the leader (Luxemburg) and converging internally, (2) converging upward, i.e. converging to the „leader" and internally. The results of studies conducted for the different periods of European integration, lead to the conclusion that the number of countries included in the second group has been gradually declining while the integration connections have been deepening. It is also additional evidence of the declining importance of the catching-up process based on capital accumulation (beta convergence) in eliminating income disparities in the European Union.

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