Analysis of GDP per Capita Convergence Speed in the Member States of the European Union

Viorica Chirila
Ciprian Chirila
"Alexandru Ioan Cuza" University of Iaşi,
Faculty of Economics and Business Administration, Romania
vchirila@uaic.ro
chcip@uaic.ro

Abstract

The economic convergence of the European Union countries is a result that we expect to be achieved by relying on Solow's neoclassical growth model. This article presents the analysis results of convergence speed in terms of GDP per inhabitant of the European Union individual states. The analyses are carried out on the convergence, in order to highlight the impact of pandemic caused by the COVID 19 compared to the global economic and financial crisis of 2008. The existence of convergence of GDP per capita is confirm by the results obtain in the countries from the sample studied, members of European Union, in the studied period. The speed of convergence, after the 2008 crisis, is significantly reduced, but the emergence of Covid 19 pandemic does not significantly influence the speed of convergence although the results are incipient.

Key words: convergence, GDP per capita**,** speed of convergence, COVID 19 pandemic, economic and financial crise
J.E.L. classification: E13, O47, C22

1. Introduction

Economic convergence was first presented by Solow's (1956) neoclassical growth model. The concept of convergence in the economy (sometimes known as the catch-up effect) assumes that in the poorest economies, income per capita will tend to grow much faster compared to richer economies. So, all nations' economies should converge in the final phase in terms of per capita income, or some other aggregate economic indicator. Convergence also means that developing countries have the capability to grow faster compared to developed countries. This is a possibility when the countries with small values of GDP will have institutions, technologies and possibilities of production like in developed countries.

With regard to convergence in EU countries, it comes in two forms: nominal convergence and real convergence.

Nominal convergence is a multilateral process and consists in a gradual harmonization of the national institutions and policies of the countries that have joined the European Union with those that are part of the European Union, both in the monetary and financial spheres. There are also criteria for nominal convergence in terms of inflation, long-term interest rates, political deficit, government debt and exchange rate stability.

Real convergence aims at equalizing the standard of living and is defined (in a broader sense by the European Commission) as "economic and social cohesion". There is no well-established convergence criterion, but the structure of the external balance of payments, per capita income, the level of government spending, unemployment, etc. are taken into account.

Also, in the literature of economic growth, the term "convergence" comes in two forms. The first type of convergence, "sigma - convergence", it is a possibility of presenting that is a reduction in the dispersion of income levels in countries' economies. On the other hand, the second type, also called

"beta convergence", occurs when the economies with small values of macroeconomic indicators of results grow at a much faster rate than economies with big values of macroeconomic indicators of results. The fact that a country has small values of macroeconomic indicators of results it is not a certainty that it will obtain catch-up growth. Abramovitz M. (Abramovitz M., 1986) emphasized the need for "social capability" to benefit from catch-up growth. Social capability involves the ability to create new technologies, attract capital and participate in global markets. Abramovitz (1986) also points out that these conditions must characterize an economy before catch-up growth can emerge and thus explain why there are still differences in today's world.

2. Literature review

An analysis of the convergence of GDP per capita in the Member States of the European Union for a long period of 1960-2001 is carried out by Kaitila et al. (2003). Since 1991, the new member states of the European Union have been included in the analysis. The results obtained confirm three convergence periods: the period 1960-1973 marked by sustained convergence under EU 15; the period 1973 to 1986 during which convergence stagnates and the third period from 1986 to 2001 and 1991 to 2001, respectively, for the new 7 entrants to the European Union, with less convergence.

With the help of statistical analysis of the panel data Raileanu, Szeles and Marinescu (2010) study the convergence of GDP in 10 countries in Central and Eastern Europe, in the period 1998-2009. The inclusion of Romania in the study determines an increase in the economic convergence in the studied sample. The results confirm that labour productivity and participation in international trade are the main drivers of convergence.

Zarembova et al. (2012) is studying convergence of GDP per capita in the Central and Eastern European Countries (Hungary, Latvia, Lithuania, Poland, Estonia, Czech Republic, Slovakia and Slovenia) in the period 1995-2011. The results obtained confirm both the presence of sigma convergence and convergence of time series until 2007; after this year the divergence occurs.

Matkowski et al. (2016) extends the study of convergence of GDP per capita, conducted by Zarembova et al. (2012), to 11 countries in Central and Eastern Europe (takes into account Bulgaria, Croatia, Romania). The convergence of this group of countries is related to the old core EU 15, countries. The study concludes that the speed of convergence is higher, before the global economic and financial crisis (2000-2007), compared to the period after the crisis (2007-2015).

More recently Głodowska and Pera (2019) using regression analysis, panel data econometric analysis and cluster analysis, studies the convergence of 10 Central and Eastern European countries compared to the group of EU-15 countries in 1995 - 2016. The results obtained indicate sigma and beta convergence.

3. Research mehodology

Beta convergence allows to determine the convergence rate with which differences between individual countries are eliminated compared to a reference country (benchmark), as measured by a macroeconomic variable, as is the case with GDP per capita.

In estimating the beta convergence, we use two methods that have been widely applied in econometric analyses. A first method that is based on the theoretical framework of economic growth and that has been applied in the analyses carried out by the Young et al. (2008), Butnaru et al. (2017).

$$\frac{1}{T}\ln\left(\frac{y_{i,\,t_{0+T}}}{y_{i,\,t_0}}\right) = \beta_0 + \beta_1 \ln\left(y_{i,\,t_0}\right) + \varepsilon_i$$

where:

$y_{i,\,t_0}$ - represents the per capita GDP of country i at the time t_0 (reference time);

T - represents the number of periods for which the beta convergence is estimated

ε_i – error variable in the regression model

If the parameter β_1 estimate is negative and statistically significant, then the result obtained will confirm the existence of the phenomenon of beta convergence. But, if the estimated value of this regression coefficient is positive, it will indicate the existence of a phenomenon of divergence.

The estimation of the convergence speed, which we will note with β, can be obtained based on the relationship (Barro and Sala i Martin, 2003):

$$\beta = -\frac{1}{T} ln(1 - \beta_1 T)$$

The method presented above makes it possible to determine the beta convergence, for a group of countries, within a set time frame. But we can use an alternative method that offers the possibility of determining convergence for each country considered in the analysis. The method was proposed by Adam et al. (2002).

For the estimation of the β convergence, for GDP per capita, the following regression equation is estimated:

$$D_{i,t} = \alpha_i + \beta D_{i,t-1} + \sum_{l=1}^{L} \gamma_l \, \Delta D_{i,t-l} + \varepsilon_{i,t} \qquad (1)$$

$D_{i,t}$- represents the difference between the GDP per capita of a country and the GDP per capita of a reference country (in this study we will choose Germany) determined at time t. It is calculated according to the relationships:

$D_t = d_t - d_t^B$

d_t- represents the change (%) in GDP per capita in the individual economy under consideration

d_t^B- represents the change (%) in GDP per capita in the reference economy (benchmark) against which convergence is studied

Δ - is the difference operator,

α_i - is the country-specific value under review, and

$\varepsilon_{i,t}$ - represents the residual variable.

The size of the lag L is determined on the basis of the Schwarz information criterion. The smallest value of this information criterion will indicate the best lag. The estimated value of the parameter β is a direct measure of the rate of convergence of GDP per capita from the economy under analysis to the reference economy considered.

A negative β coefficient indicates the occurrence of the convergence phenomenon. The coefficient β can take values between -2 and 0. The closer the β the coefficient is to -1, the faster the convergence rate. If β=0 or β= -2, it cannot be said that there is convergence. Also, if, β takes values from -1 to 0, this fact indicates a monotonous convergence.

4. Empirical results

The use of the convergence method based on the theory of economic growth involves estimating the next regression equation:

$$\frac{1}{T} \ln \left(\frac{GDP/capita_{i,\, t_{0+T}}}{GDP/capita_{i,\, t_0}} \right) = \beta_0 + \beta_1 \ln \left(GDP/capita_{i,\, t_0} \right) + \varepsilon_i$$

In order to identify whether the speed of convergence is influenced by the global economic and financial crisis of 2008 and the pandemic caused by the emergence of COVID 19, several regression models have been estimated:

- One model estimates beta convergence throughout the analyzed period considered 1995-2020, which we will call model 1;

$$\frac{1}{T} \ln \left(\frac{GDP/capita_{i,2020}}{GDP/capita_{i,1995}} \right) = \beta_0 + \beta_1 \ln \left(GDP/capita_{i,1995} \right) + \varepsilon_i \qquad (1)$$

- Another model estimates the beta convergence until the onset of the COVID 19 pandemic that we will call model 2

$$\frac{1}{T} \ln \left(\frac{GDP/capita_{i,2019}}{GDP/capita_{i,1995}} \right) = \beta_0 + \beta_1 \ln \left(GDP/capita_{i,1995} \right) + \varepsilon_i \qquad (2)$$

- The third and fourth models estimate the convergence before and after the global economic and financial crisis of 2008, which we will call model 3 and model 4.

$$\frac{1}{T} \ln \left(\frac{GDP/capita_{i,2008}}{GDP/capita_{i,1995}} \right) = \beta_0 + \beta_1 \ln \left(GDP/capita_{i,1995} \right) + \varepsilon_i \qquad (3)$$

$$\frac{1}{T}\ln\left(\frac{GDP/capita_{i,2019}}{GDP/capita_{i,2009}}\right) = \beta_0 + \beta_1 \ln\left(GDP/capita_{i,2009}\right) + \varepsilon_i \quad (4)$$

The results obtained are presented in the table below:

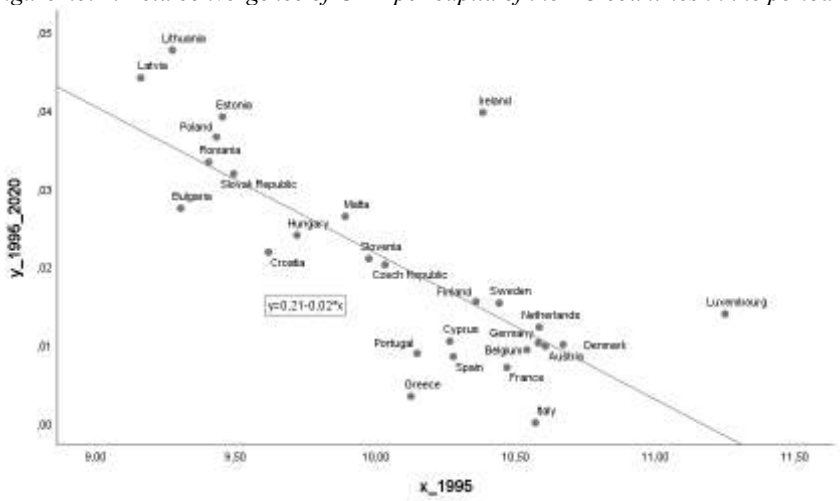
Table no. 1 Estimating of convergence and convergence rate of GDP per capita for the European Union member states

Perioada de estimare a convergenței	β_0	β_1	β
1995-2020	0.208620 (0.0000)	-0.018693 (0.0000)	-0,0152
1995-2019	0.207290 (0.0000)	-0.018361 (0.0000)	-0,0151
1995-2008	0.263021 (0.0000)	-0.022953(0.0000)	-0,0199
2009-2020	0.180481 (0.0173)	-0.016119 (0.0250)	-0,0147
2009-2019	0.203188 (0.0045)	-0.017733 (0.0086)	-0,0162

Source: Results obtained by the authors

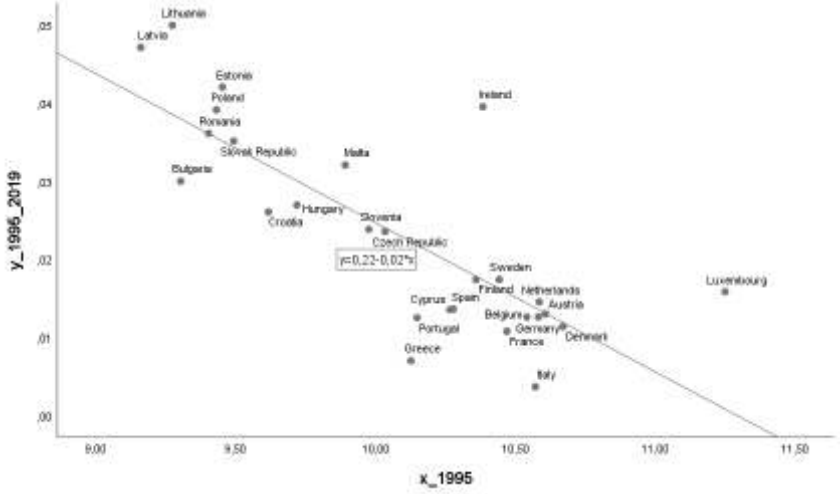
Note: β_0 - represents the constant of the convergence model; β_1 - means the convergence coefficient; β - represents the convergence rate of GDP per capita.

Figure no. 1. Beta convergence of GDP per capita of the EU countries in the period 1995-2020



Source: Results obtained by the authors

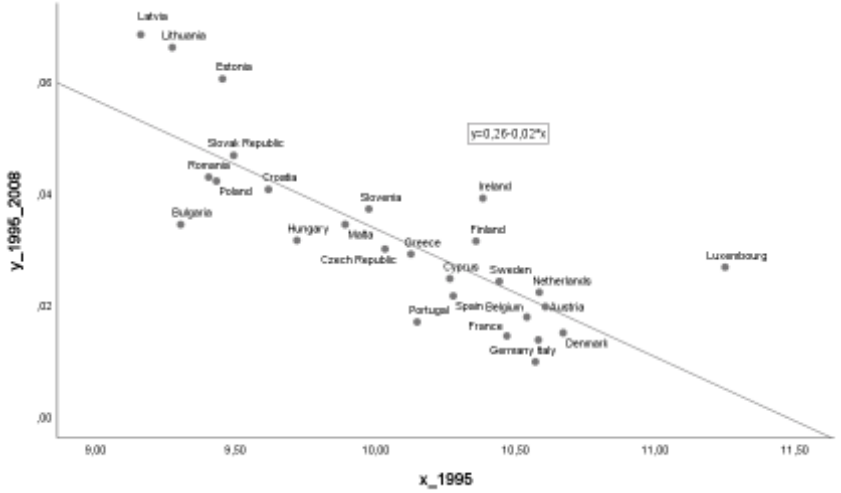
Figure no. 2. Beta convergence of GDP per capita of the EU countries in the period 1995-2019



Source: Results obtained by the authors

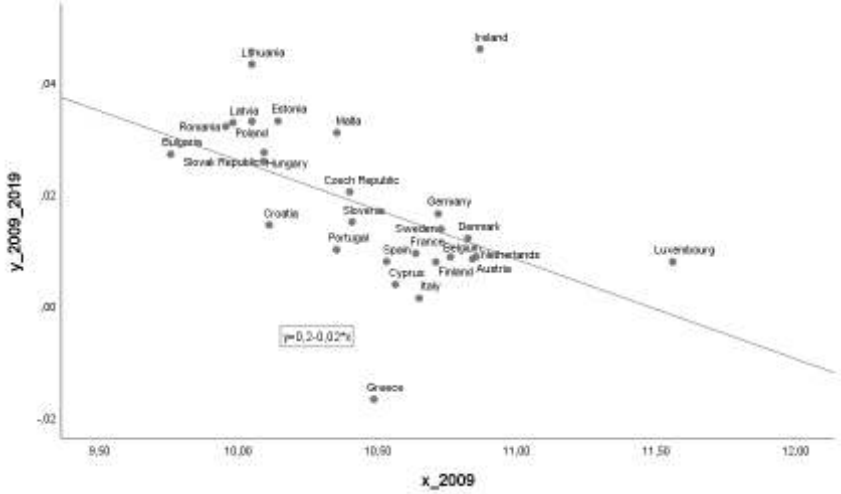
Highlighting beta convergence through the graphical representations in Figures 1-5 shows us very small differences in convergence in all periods studied. We note, however, that in the period 1995-2008, that is, before the global economic and financial crisis, highlighted in Figure 3, Ireland does not have an extreme value, a situation which is present in all the other periods studied.

Figure no. 3. Beta convergence of GDP per capita of the EU countries in the period 1995-2008



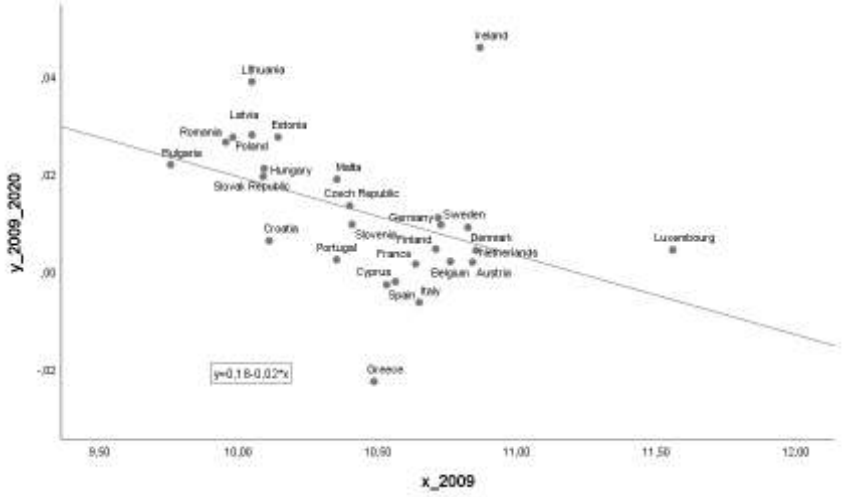
Source Results obtained by the authors

Figure no. 4. Beta convergence of GDP per capita of the European Union countries in the period 2009-2019



Source: Results obtained by the authors

Figure no. 5. Beta of GDP per capita convergence of EU countries in the period 2009-2020



Source: Results obtained by the authors

Table no. 1 shows the results obtained for beta convergence of the Member States of the European Union in different periods of time considered. The first period between 1995-2020 considers the entire time frame for which we have data for GDP per capita for all considered countries, members of the European Union, from the Eurostat database. Regression coefficient β_1 estimated is negative and statistically significant, which confirms the presence of beta convergence.

The second period analyzed, 1995-2019 excludes the year 2020, when the health crisis caused by the appearance of COVID 19 began. The results obtained also confirm the existence of convergence at a speed of convergence almost identical to the previous period studied (the difference is at the fourth decimal place 0.0152 and 0.0151). In order to study the beta convergence and, implicitly, the speed of convergence of the European Union countries before and after the global economic and financial crisis, we considered two distinct periods 1995-2008 and 2009-2020. The pre-crisis convergence speed (0.0199) is higher than convergence speed after the crisis (0.0147) showing the significant effect of the global financial crisis on the beta convergence and the speed of convergence. The global economic and financial crisis has therefore led to a significant decrease in GDP convergence in the European Union.

Also, taking into account the period after the global crisis until the Covid 19 crisis, which implies the exclusion of 2020 from the beta convergence study, it is clearly observed, this time, that the convergence speed has decreased (0.0147 compared to 0.0162), the emerging of the health crisis has led to a reduction in the speed of convergence.

The results of the convergence rate for each European Union country considered in the analysis, towards reference value GDP per capita in Germany, are presented in Table 2. The speed of convergence is estimated, this time, only for two periods: a period between 1995-2008 shows the situation before the global economic and financial crisis and the period between 2009-2020 shows the situation after the global economic and financial crisis. Based on these we can mention that Belgium, Finland and Ireland are the only countries in the studied sample that have maintained their high speed of convergence of GDP per capita after the global economic and financial crisis.

Before the economic crisis Belgium, Austria, Croatia, Finland, Ireland, Italy, Portugal and Slovenia had the closest convergence rate values to -1, which indicates the highest convergence speed. In the same period a monotonous convergence is observed in the case of Bulgaria, Cyprus, Czech Republic, France, Hungary, Poland and Romania.

After the economic and financial crisis, the highest speed of convergence is identified in the case of Belgium, Estonia, Hungary, Luxembourg and Romania.

The results presented confirm that the global economic and financial crisis of 2008 had a significant influence on GDP per capita convergence in the European Union countries.

Table no. 2 Estimating of speed of GDP per capita for each of the EU member states

Country	1995 - 2008	Probability	2009-2020	Probability
Austria	-1.127011	0.0071	-0.974261	0.0206
Belgium	-1.049256	0.0135	-1.086570	0.0151
Bulgaria	-0.644626	0.2421	-0.897304	0.0047
Croatia	-1.224178	0.0368	-0.630517	0.1215
Cyprus	-0.605892	0.0468	-0.590243	0.0659
Czech Republic	-0.349664	0.4099	-0.709936	0.0775
Denmark	-0.538416	0.1240	-1.553403	0.0066
Estonia	-0.805893	0.1077	-0.938420	0.0026
Finland	-1.322665	0.0036	-1.070103	0.0023
France	-0.638076	0.0628	-1.834492	0.0092
Greece	-0.411808	0.2170	-0.861718	0.0255
Hungary	-0.674498	0.1031	-1.134921	0.0154
Ireland	-1.140767	0.0427	-1.078728	0.0090
Italy	-0.383830	0.2245	-0.703740	0.1266
Latvia	-0.223131	0.7038	-0.932410	0.0058
Lithuania	-1.784349	0.0404	-1.999627	0.0013
Luxembourg	-1.767489	0.0161	-1.008518	0.0128
Malta	-1.438807	0.0010	-0.832145	0.0756
Netherlands	-0.716233	0.0668	-0.669376	0.0406
Poland	-0.746333	0.0272	-0.933747	0.0202
Portugal	-1.127246	0.0101	-0.912171	0.0500
Romania	-0.948355	0.0068	-1.089035	0.0001
Slovak Republic	-1.656595	0.0020	-1.265658	0.0011
Slovenia	-1.139799	0.0075	-0.925127	0.0034
Spain	0.207385	0.6865	-0.488272	0.2879

Source: Results obtain by the authors

5. Conclusions

The analysis of the convergence speed of GDP per capita in the European Union countries allows the assessment of an important objective that is to be achieved: economic and social cohesion. The assessment of the convergence speed of GDP per capita of the European Union States was carried out using two methods: a method based on Solow's growth model that allows the overall assessment of the beta convergence (and implicitly of the convergence rate) for the group of countries studied and a method that considered as a reference value the GDP per capita of Germany, which made it possible to assess the convergence of each country considered in the sample.

The results obtained confirm the existence of the GDP beta convergence in the sample of countries considered. Also, the significant impact on the beta of convergence and the speed of convergence, of the global economic and financial crisis and the health crisis are confirmed. A limit to the study is determined by the fact that the available data do not allow us, for the moment, to identify the true impact of the crisis caused by the emerging of Covid 19 that is still present. Therefore, further research based on the analysis of a longer time frame will shed some clarification in this regard.

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