UDC: 330.55(498:4-672EU) ; 330.45:517.521 JEL: O47, O2 ID: 207709964
PRELIMINARY REPORT

The Intensity of Convergence Process in the European Union

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ABSTRACT *– The objective of this research is to analyze the differences between Romania and the European Union regarding the convergence process. In this paper we were interested in determining the forecasting horizon for which Romania, in certain conditions, might have a value of GDP per capita that is closer to the average of EU (25 countries) and we obtained that 18 years are necessary for Romania to achieve the convergence compared to EU average of GDP per capita. The co-integration approach suggested that in the last 15 years there is a divergence of the Romania economic growth and the EU-25 average. This research might be developed by taking into account other measures of economic convergence.*

KEY WORDS: *beta convergence, GDP per capita, regression, co-integrated series*

Introduction

The convergence analysis is made from the point of view of closeness of homogeneity state and the existence of conditions that might facilitate the realization of these objectives. For measuring the intensity of convergence process the beta indicator based on regression analysis is seldom used in studies. The approach based on co-integrated series also provides important information regarding the realization degree of convergence process. From the economic development perspective of the countries in a community there are situations when the co-integration analysis has a high utility. These situations are: linear and persistent economic growth, when there are different rates of economic growth, the knowledge of a statistical equilibrium regarding the economic evolutions between countries.

This paper consists in several parts. After a brief introduction, a short literature review is made, underlying the latest results regarding the beta convergence assessment. The results indicated that the tendencies in the last 15 years do not close the economic growth convergence from Romania to the average EU economic growth. Almost 18 years are necessary for Romania to have a value of GDP per capita that is closed on the EU-28 average. A short part dedicated to main conclusions was presented in the end.

Literature review

Barro and Sala-i-Martin (1996) presented sigma and beta indicators as suitable indicators for measuring the convergence degree and the speed for the convergence realization. Beta

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parameter indicates the speed for convergence process when the sign is negative. Frenken Kochn at al. (2005) and Quah (1996) consider the beta an unsuitable indicator for the economic growth real convergence. There are few beta approaches: club convergence, absolute beta convergence, and conditional beta convergence. The sigma and beta tools are related and reciprocal checked. Davide Furceri (2005) gave a mathematical relationship between the beta and sigma-convergence. Quentin Wodon and Shlomo Yitzhaki (2006) showed that in the univariate setting the sigma-convergence implies the beta-convergence. Therefore an important caution is necessary for the interpretation of the beta-convergence as notion. Terry Robinson (2007) analyzed the convergence of European gas prices since 1978 by applying several tests: a simple test for beta convergence, a cointegration test and the approach of Nahar and Inder's.

Hassan Mohammadi and Rati Ram (2012) used a simple model of beta-convergence for consumption of energy per-capita. Unconditional beta-convergence patterns are in accordance with sigma-convergence versions. Thomas M Steger (2012) observed that linear growth model for subsistence consumption can reproduce the beta-divergence. Giuseppe Bruno, Riccardo De Bonis, Andrea Silvestrini (2012) analyzed the sigma and beta-convergence for some financial instruments like shares, insurance products, debt securities and deposits. They observed the beta-convergence of shares and insurance products.

Monfort, Cuestas, and Ordóñez (2013) utilized a cluster analysis, putting in evidence the existence of two convergence clubs in EU-14, the Eastern European countries being divided in two groups. Pedro Verga Matos and Horacio Haustino (2012) tested the beta-convergence and sigma-convergence in the corporate governance models, observing a significant evidence of convergence within countries. Vu (2013) observed that practitioners make an important mistake by using the final calculation from the logarithmic measure of gap to make the interpretation of the convergence speed of gap in level expression. Laurent Weill (2013) analyzed the improvement in EU bank competition by applying sigma and beta-convergence for panel data. The authors observed a convergence in bank competition for EU members.

Mariusz Próchniak and Bartosz Witkowski (2013) checked the time stability of the beta convergence for GDP using two samples: EU15 and EU27. The authors also verified the stability and strength of specific factors of growth. M. Simona Andreano, Lucio Laureti and Paolo Postiglione (2013) assessed the economic growth of North Africa and Middle East countries using the conditional beta-convergence.

The measurement of convergence intensity in EU-28

The intensity of this process depends on many factors like the analysis period or the economic and social conjuncture of the particular period. The regression analysis measures the marginal reaction of the effect (GDP per capita) for change in cause (in condition expressed as low relative development level in initial stage). The analysis is completed by a check using t test.

A non-linear model is proposed, but it could be linearized:

$$\frac{1}{T}\log\left(\frac{y_{iT}}{y_{i0}}\right) = \alpha + \beta \log y_{i0} + e_{it}, \text{ i=1,2,…,n countries}$$

y_{i0}- The base period development level (for example. GDP)

y_{iT}- Development level after T time units

β –Parameter representing the regression slope

e_{it}- The error

In order to measure the polarization the following variant is used:

$$\frac{1}{T}\left[\log\frac{y_{iT}}{y_{i0}} - \log\frac{y_{At}}{y_{A0}}\right] = \alpha + \beta \log y_{i0} - \log y_{A0} + e_0$$

y_{At} – The central level around which the i regions polarize, i=1, 2,…, n

In order to test the significance of the slope t computed is determined:

$$t_{computed} = \frac{\beta}{\sqrt{\frac{\sigma_e^2}{\sum_{i=1}^{n}(y_{i0} - \bar{y}_0)^2}}}$$

If computed t is greater than the critical value (t taken from the table for a level of significance alfa ($^{\alpha}$) and n-2 degrees of freedom), the significance is confirmed. The slope shows the increase in average rate when the development level decreases with one unit. So, we expect a negative sign for the parameter.

The beta coefficient expresses a rational relationship confirmed by the economic theory, actually by the neoclassic theory of the economic growth that concerns about the inverse relationship between the convergence intensity and the distance compared to stable equilibrium state. The input is represented by the development level in different past periods and it is analyzed using the regression analysis. The result may confirm or not the economic theory. The coefficient expresses a state on a certain time interval and for all the analyzed regions. The way to express the relationship has an average character, but it is the result of estimation process. Therefore, the check of coefficient significance is necessary.

The slope expresses a potential (a repeatedly situation) of the low developed countries to register a superior rhythm compared to developed countries.

There are many causes for this situation of inequality; among them one could enumerate the low level of beginning and the entrainment effect. The potential expressed by the level and the sign of beta has a character of average that is different from a country to another. However, a propensity for convergence may be evidenced. The result estimated for the slope is compatible with the convergence only is the sign is "minus" and there is a significant level at least in t test terms.

There is a risk for beta coefficient to represent a biased estimation, fact known as Galton fake. Another limit would be that there might be almost equal conditions for the countries in

the sample regarding savings rate, depreciation rate and population growth. These conditions and the technology conduct mostly to a polarization process. The non-linear model could be extended by adding up new variables. The condition of low level does not compulsory implies a high level of increase. But only for a low reference base that could be initially easy to surpass. However, in time the overcome becomes more difficult. If we suppose that there are strong efforts to surpass the leaders. The investments should be taken into account. In this case the model is:

$$\frac{1}{T}\log\left(\frac{y_{iT}}{y_{i0}}\right) = \alpha + \beta \log y_{i0} + \gamma Invest_i + e_i$$

In order to apply the model, some details should be established. The base year is 1995. The proportion refers to base year and to the final year 2012 and to level of GDP per capita in that year for the 28 countries, but also for the base year in those countries. $\frac{1}{28}\log\frac{y_{iT}}{y_{i0}} = 0{,}2428 - 0{,}296 \cdot \log(y_{i0})$

After the application of t test regarding the significance of the slope the t computed is -3.2, fact that refers that the parameter differs from zero. The parameters are significant according to F test. The negative sign confirms the expectations and also the economic theory. The low value of the coefficient of determination of the economic growth ($R^2 = 0{,}264$) indicates the existence of other causes.

We are interested to determine the forecasting horizon for which Romania, in certain conditions, might have a value of GDP per capita that is closer to the average of EU (25 countries). Therefore, the average indices are computed using the indices from 2003-2012 based on annual rates of GDP in constant prices. The average index of growth for EU 25 is 1.022, while the average index for Romania is 1.078.

The initial levels are based on the values registered for 2010 and the growth rate from 2011 and 2012. The following levels in PPS thousands Euro were computed: 25.5 for EU and 10.2 for Romania. The future moment denoted by T is computed as:

$$T = \frac{\log 25.5 - \log 10.2}{-\log 1.022 + \log 1.078} = \frac{0.3979}{0.0231} = 17.176 \cong 18\, years$$

The result is quite far in time (almost 18 years).

Co-integrated series and the convergence

A non-stationary time series with a certain trend that becomes stationary (no trend) by computing the differences of order d between successive terms is co-integrated of order *d*. Two time series are co-integrated of order *d,b* if the integration order of each data series is identical and there is a linear combination with an inferior degree of integration that is *b*.

We start from two time series representing the GDP per capita in country A (Z_t), respectively in country B (X_t). If the time series have a linear trend, the differences of order one are integrated of order 1 and there is a linear combination between the two series that is

integrated of order 0, then the initial time series are co-integrated of order 1,1: $Z_t, X_t \sim CI(1,1)$.

In order to have a convergence process the average differences for an interval *t* should be inferior to the initial difference between the development levels:

$$E\left(\frac{Z_t - X_t}{e_t}\right) < (Z_0 - X_0)$$

In other words, the two time series with different trends there is the following relationship:

$$Z_t, X_t \sim CI(d, b)$$

$$\lim_{T \to \infty} E\left(\frac{Z_t - X_t}{e_t}\right) = 0$$

The values of GDP per capita in PPS thousands EURO for Romania and EU-25 are presented in the following table.

Table 1. GDP per capita in PPS thousands EURO

Year	EU-25 (X)	Romania(Y)
1999	18.8	4.8
2000	19.5	4.9
2001	19.9	5.2
2002	20.2	5.4
2003	20.4	5.7
2004	20.9	6.2
2005	21.3	6.4
2006	21.9	6.9
2007	22.5	7.4
2008	23.6	8.3
2009	24.9	9.4
2010	25.7	11.4
2011	26.2	11.9
2012	26.3	12.1

Source: Eurostat

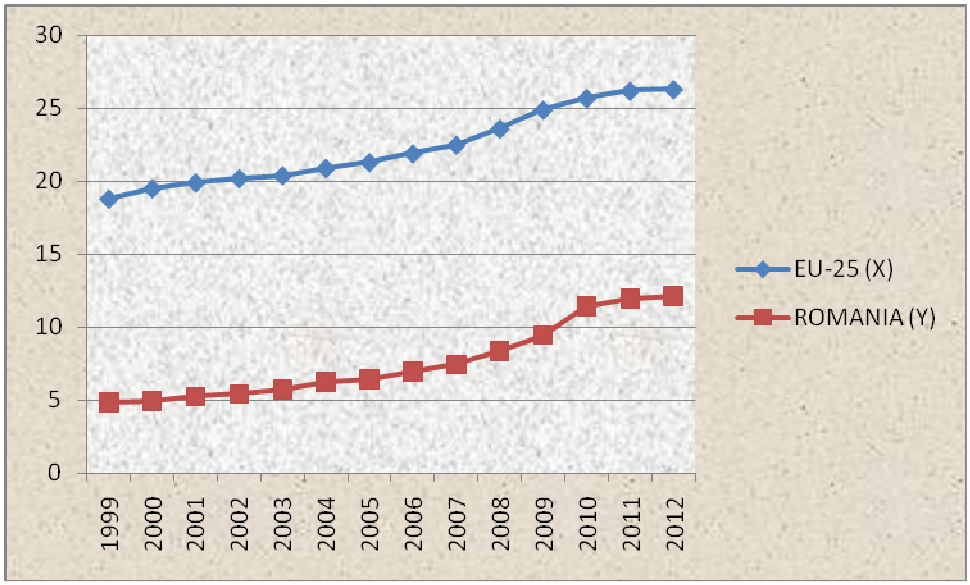
The first order differences between the consecutive terms of the time series are computed in the following table:

Table 2. The differences between the GDP per capita values

EU-25 (X(t)-X(t-1))	Romania (Y(t)-Y(t-1))
0.7	0.1
0.4	0.3
0.3	0.2
0.2	0.3
0.5	0.5
0.4	0.2
0.6	0.5
0.6	0.5
1.1	0.9
1.3	1.1
0.8	2
0.5	0.5
0.1	0.2
0.7	0.1

Source: own computations

Figure 1. The evolution of GDP per capita in EU-25 and Romania during 1999-2012



In EU and Romania the GDP per capita presents a linear growth tendency. The computed averages for each data set regarding the GDP increased, fact that shows the trend presence. The first order differences have an oscillating evolution around a constant. Therefore, we can conclude that the initial time series are co-integrated of order 1. After estimating the parameters we have the following regression model: Y=-14.66531+0.9974*X and the linear combination is: Z=Y- (-14.66531+0.9974*X)

The time series are co-integrated of order one, because both data series are integrated of order one and the linear combination has a lower order of integration. The consequences are: the estimations of parameters are over-consistent and the evolutions in time characterize the

processes in a static equilibrium. A high value of the parameter expressed in a standard form is a condition of closeness in time of the evolution that started from a higher level.

The tendencies are described below:

- for the evolution of the GDP per capita in PPS for Romania: X=22.2928+0.3051*t and the standard level is 0.3051*(8.366/0.541)= 4.718
- for the evolution of the GDP per capita in PPS for EU-25: Y=7.5714+0.2997*t and the standard level is 0.2997*(8.366/0.836)= 2.999

The slopes represented by the coefficient of time variables (0.3051 for Romania and 0.2997 for EU-25) and the standardized values regarding the slope (4.718 for Romania and 2.999 for EU-25) showed that the tendencies in the last 15 years do not close the economic growth convergence from Romania to the average EU economic growth.

Conclusions

In this paper we were interested in determining the forecasting horizon for which Romania, in certain conditions, might have a value of GDP per capita that is closer to the average of EU (25 countries) and we obtained that 18 years are necessary for Romania to achieve the convergence compared to EU average of GDP per capita. The co-integration approach suggested that in the last 15 years there is a divergence of the Romania economic growth and the EU-25 average. This research might be developed by taking into account other measures of economic convergence.

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Intenzitet procesa konvergencije prema Evropskoj uniji

REZIME *– Cilj ovog istraživanja je da analizira razlike između Rumunije i Evropske Unije uzimajući u obzir proces konvergencije. U ovom radu želeli smo da predvidimo vremenski horizont u kom će Rumunija, pod određenim uslovima, dostići vrednost BDP po stanovniku koji je približan proseku EU (25 zemalja) i utvrdili da će joj biti neophodno 18 godina da dostigne prosek BDP-a po stanovniku. Kointegracioni pristup ukazuje na to da u poslednjih 15 godina postoji divergencija ekonomskog rasta Rumunije i proseka zemalja EU-25. Ovo istraživanje moglo bi se unaprediti uzimajući u obzir i ostale mere ekonomske konvergencije.*

KLJUČNE REČI: *beta konvergencija, BDP po stanovniku, regresija, kointegrisane serije*

Article history: Received: 23 January 2014
Accepted: 2 March 2014