The Beta-convergence Analysis and Regional Disparities in EU-28

Analýza beta-konvergence a regionální rozdíly v EU-28

MIHAELA SIMIONESCU

Abstract

The main objective of this research is to analyse the beta-convergence in European Union (EU-28), showing the regional income disparities. There was a faster increase of GDP per capita in poor economies in the period from 2001 to 2012. The absolute convergence was assessed using the approach based on spatial lag dependence. The rate of convergence has a low value of 0.46% for EU-28 during 2001-2012. The catching-up process is mostly in EU-28 a national phenomenon. The results of the estimations suggest not significant convergence within EU-28 members.

Keywords

convergence, regional disparities, Moran's I, spatial lag model, spatial error model

Abstrakt

Hlavním cílem tohoto výzkumu je analyzovat beta-konvergenci v Evropské unii (EU-28) a poukázat na regionální rozdíly v příjmech. V období 2001-2012 byl rychlejší růst HDP na obyvatele v chudých ekonomikách. Absolutní konvergence byla hodnocena pomocí přístupu založeného na prostorové zpožděné závislosti. V létech 2001-2012 má míra konvergence pro EU-28 nízkou hodnotu 0,46 %. Proces dohánění je v zemích EU-28 většinou národním fenoménem. Výsledky odhadů naznačují, že neexistuje významná konvergence v rámci zemí EU-28.

Klíčová slova

konvergence, regionální rozdíly, Moranovo I, prostorový intervalový model, prostorový chybový model

Introduction

Many authors were interested of income disparities in the context of convergence analysis (Barro and Sala-i-Martin (1995), Cuadraro-Roura (2001), Tondl (2001), Baumont et al. (2003), Meliciani and Peracchi (2006), Paas and Schlitte (2006), Anagnostou et al. (2008)). There are some studies for EU, the research importance being major. For example, Hallet (2002) criticized the current that showed that there is a slow regional convergence in Europe in the last decades. The main determinates of income convergence are considered to

be the stylized facts of disparities. Future challenges regarding the policies in Europe are presented. Bosker (2009) analysed for Europe the evolution of regional income disparities. The disparities in Western Europe regions tend to decrease in time, while a large number of regions from Eastern Europe catch up slowly with the Western Europe neighbours. In the East part of Europe the specific factors of the countries are more important than the regional conditions. Maza, Hierro, and Villaverde (2012) examined the spatial influence on the regional income evolution in Europe during 1980-2005. According to mobility index, the regional disparities have decreased. The approach based on a new mobility index has put into evidence that poor regions that are surrounded by rich ones are more likely to become rich than the other poor regions.

The main aim of this study is to evaluate the regional income disparities in the context of convergence process in EU-28 in the period from 1995 to 2013. There is a low level of regional aggregation, the research using NUTS3 level regions in EU-28. The beta-convergence is analysed in this context, the spatial effects being controlled by the use of spatial econometric methods.

The paper is structured in 4 sections. In the second section there is a description of data and methodology related to the convergence analysis and also the recent results regarding the regional income disparities in EU. The third section consists in a presentation of beta-convergence analysis considering the problem of spatial dependence in EU regions and countries. In the end some conclusions are drawn.

1   Data and Methodology

The approach for estimating the regional income convergence is based on the observations of Sala-i-Martin (1992) that made a distinction between conditional and absolute convergence.

Under the assumption of structurally identical economies, the absolute convergence is checked using a regression for economic growth and initial level for certain regions/countries. Unconditional β-convergence assumes that all economies are structurally identical (same steady state). The absolute beta-convergence existence supposes that less developed countries have a faster catch-up tendency than the developed ones while the conditional beta-convergence supposes that each economy tends to go to its steady state. The absolute beta-convergence is present if there is a significant and negative relationship between economic growth for income per capita and the initial level of the same indicator. Quah (1996) showed that the conditional convergence can be tested using the club convergence concept (the steady state varies across groups of relatively homogenous economies). Cuadraro Roura (2001) emphasized that the differences between countries regarding legislation, countries policy, tax system have an important impact regarding the convergence and regional growth.

Regional economic developments might underlie spatial dependence or interaction. If economic events in neighboring regions are not independent, but influence each other, there is spatial dependence. In addition, regional data might have shortcomings such as a bad quality due to measurement problems or inadequately defined regional units,

what is reflected in spatial autocorrelation. Standard regressions do not account for spatial dependence or autocorrelation thus leading to inefficient inference or even biased estimates in case of significant spatial processes. In addition to the use of classical econometric methods presented so far, we therefore refer to models of spatial econometrics in this section, which explicitly take account of spatial interaction. The structure of spatial interconnectedness is usually imposed by so-called spatial weights matrices (W). Wy, e.g., thus displays the spatially weighted average of y in nearby regions. A number of different spatial econometric models – as well as combinations of those – can be formulated: spatial correlation of the error term in e.g. a spatial autoregressive error model, of the endogenous variable itself in a spatial lag model as well as of explanatory variables in a spatial cross-regressive model.

The regional beta-convergence is assessed in two variants. The first alternative uses the common OLS approach for cross-sections, where the independent variable is the initial level of income while the dependent one is the growth in income per capita). In the second variant dummy variables are introduced to take into consideration the country-specific effects. The both types of convergence were assessed (absolute and conditional convergence). According to Barro (1995) we start from the following model:

$$\ln(\frac{y_{io+T}}{y_{io}}) = \alpha_0 + \alpha_1 \ln(y_{io}) + \sum_{j=1}^{N} \alpha_{2j} c_{ji} + \varepsilon_i \quad (1)$$

y_{io} - the initial value of GDP per capita in the i-th region
T- number of years in the mentioned period
α_0, α_1, α_{2j}- parameters

$$c_{ji} = \begin{matrix} 1, if\ region\ i\ is\ in\ country\ j \\ 0, \qquad else \end{matrix}$$

c_{ji} - a dummy variable
ε_i - the error (normal distribution, independently distributed)

If α_1 has a negative value, the less developed economies have the tendency to grow faster than the rich countries. If T is the length of the time period, the annual convergence rate is computed as:

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

Half-life (the necessary period for half of the initial GDP per capita inequalities to disappear) is another indicator for evaluating the convergence speed:

$$\tau = \frac{\ln(2)}{\beta} \quad (3)$$

Most of the convergence analyses considered that growth rates are independent across regions, but this assumption is not realistic. The economic growth of a region has may chances to be influenced by the economic situation of the neighbouring regions. Abreu et al. (2005) showed that many errors are made by ignoring spatial interdependencies between regions. The authors proposed two models that solve this problem: Spatial Lag Model (SLM) and Spatial Error Model (SEM). The spatial dependence supposes the use of

a spatial weight matrix denoted by W. This matrix shows the intensity of spatial dependence and the spatial structure. Ertur and Le Gallo (2003) showed that the spatial weigh has a random design. The binary contiguity supposes that elements of matrix w_{ij}=1 if the two regions (i and j) are within a certain distance or if these regions have a common border. If W is the distance based weight matrix, the distance is computed as the squared inverse of the best circle distance between the regions' geographic regions. It is made the assumption that the spatial interaction is null and a critical distance cut-off is used. Le Gallo et al. (2003)showed that the functional form of the squared inverse distances is seen as gravity function. The rows of the distance matrix are standardized.

$$W: w_{ij} = 0, if \ i = j$$

$$W: w_{ij} = \frac{1}{d_{ij}^2}, if \ d_{ij} \leq D \quad (4)$$

$$W: w_{ij} = 0, if \ d_{ij} > D$$

d- the distance between centres of the two regions (i and j)
w_{ij} - spatial weight
D- the critical distance cut-off
Anselin (2001) defined the spatial autocorrelation like spatial clustering of the close values of the parameters. There is a positive autocorrelation if the values of the parameters are spatially clustered.

For a certain set of characteristics and a certain attribute that is associated to it, the Moran's I statistic sets if the pattern is random, dispersed or clustered.

The Moran's I statistic measures the global spatial autocorrelation that is characterized by correlation in sign among nearby spaces. Spatial correlation is multi-directional and multi-dimensional. The formula for this statistic is:

$$I = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_i (X_i - \bar{X})^2} \quad (5)$$

X- analysed variable
X - the average of X
N- number of units
w_{ij} - element in the matrix of spatial weights

The null hypothesis states the lack of spatial autocorrelation. The expected value of the statistic is computed as: $(I) = \frac{1}{1-N}$.

Moran's I takes values between -1 and +1, the extreme values indicating the perfect dispersion (-1) and perfect correlation (+1). The null value shows random spatial pattern. The Moran

I's statistic values are transformed to Z-scores. At a significance level of 5%, the values outside the interval [-1.96; 1.96] imply spatial autocorrelation.

The spatial autocorrelation presents two forms: nuisance form (restricted to error) and the substantive one.

If the nuisance dependence is ignored, the estimates are inefficient. Therefore, Anselin (1988) proposed two types of model specifications estimated using maximum likelihood method (ML method). The spatial error model (SEM) is suitable for nuisance form.

$$\ln(\frac{y_{i0+T}}{y_{i0}}) = \alpha_0 + \alpha_1 \ln(y_{i0}) + \sum_{j=1}^{N} \alpha_{2j} c_{ji} + \varepsilon_i \tag{6}$$

λ is the spatial autocorrelation coefficient.
$[W . \varepsilon]i$ - the i-th element of weighted errors vector
c_{ji} is 1 if the i-th region is inside the country j
$ui, \varepsilon i$ - errors term (independently and normally distributed)

On average the growth in GDP per capita is explained by the convergence assumption.

If there is a substantive form of spatial dependence, the spatial lag model (SLM) should be used. In this case, the regional growth in the regions around influences the regional growth in that certain region.

$$\ln(\frac{y_{i0+T}}{y_{i0}}) = \alpha_0 + \rho[W \cdot \ln(\frac{y_{0+T}}{y_0})]_i + \alpha_1 \ln(y_{i0}) + \sum_{j=1}^{N} \alpha_{2j} c_{ji} + \varepsilon_i \tag{7}$$

$\left[W \cdot \ln(\frac{y_{0+T}}{y_0}) \right]_i$ - the i-th element of weighted growth rates vector

ρ - spatial autocorrelation coefficient

2   The Convergence in EU-28

The aggregation level influences the results of regional convergence study. Arbia (2006) showed that if different spatial scales are used will generate distinct results. The use of large spatial units in constructing the models usually hides problems like spatial autocorrelation and heterogeneity.

In this study it was chosen a low aggregation level, because there could be spillover effects that are not detected at higher levels as Brauninger and Niebuhr (2005) explained. NUT-3 level is chosen for EU-28.

The data is represented by the adjusted GDP per capita for purchasing power standards (in PPS), being provided by Eurostat. The data in PPS has the advantage of being adjusted for differences in national price levels.

Figure 1: Regional GDP per capita levels relative to the EU-28 average
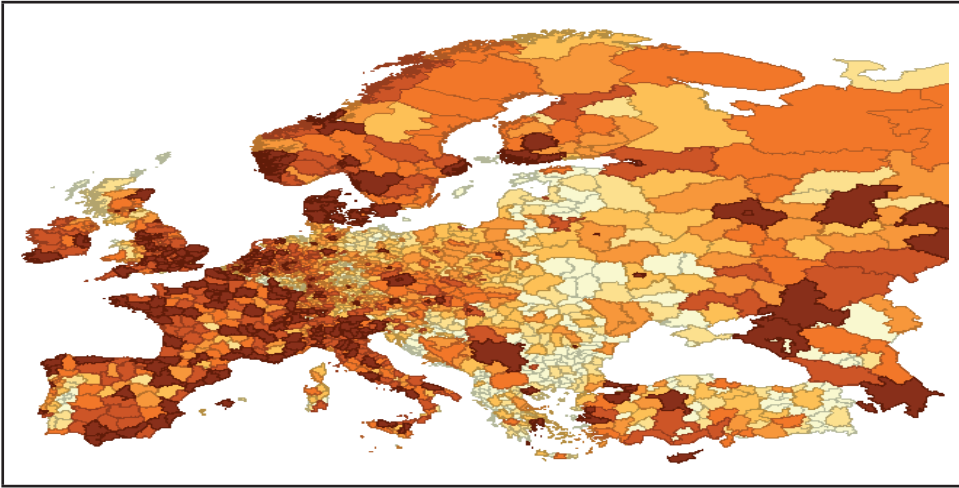
The values for groups:
<=50
(50;75)
(75;100)
(100;125)
(125;150)
(150;175)
>=175

<=50

>=175

Source: author's computations based on Eurostat database

Many regions from Spain, Greece, Finland, Ireland, Croatia, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Portugal, Slovenia, Slovakia, Czech Republic, Romania and Bulgaria had growth rates under the average rate of EU-28. Only few regions from "blue-banana", mostly from Netherlands and England, had rates above the average. In the regression the data for Russia were not used.

Figure 2: Regional GDP per capita disparities and growth in EU-28
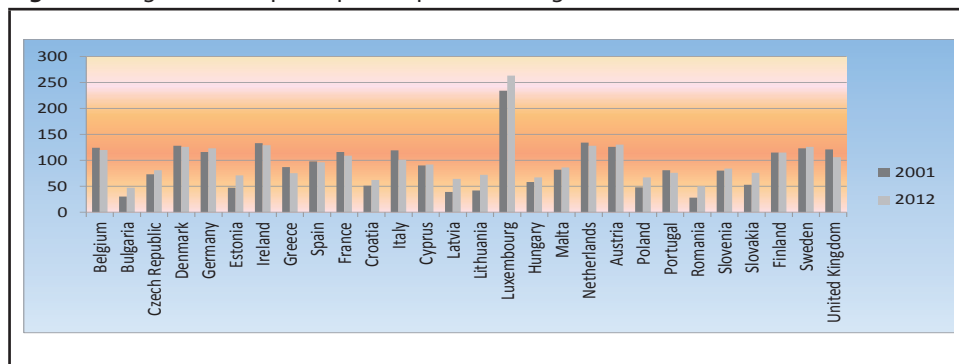
Source: author's computations based on Eurostat database

The second figure indicates that there are significant GDP per capita disparities between EU-28 countries. There was a faster increase of GDP per capita in poor economies. According to the spatial distribution there is a centre-periphery structure.

The beta-convergence analysis is more suitable for the various regions in EU-28. Fischer and Stirbock (2004) identified two convergence clubs represented by rich countries in Northern and Central Europe and poor countries of new members of EU plus southern periphery in the Western Europe. Feldkircher (2006) found country-specific effects on GDP increase in EU.

The values of coefficient I are highest with a cut-off distance of hundred kilometres. In this study we used a critical cut-off distance of 500 km. the three types of models are built: classical model using OLS, Spatial Lag Model (SLM) and Spatial Error Model (SEM). The Moran's I coefficients indicated the existence of relevant spatial autocorrelation of the errors. Therefore, this indicator did not provide reliable information regarding the spatial dependence. Therefore, LM tests are used to check the form of the spatial autocorrelation.

The results of the estimations suggest no significant convergence with-in EU-28 members. The catching-up process is mostly in EU-28 a national phenomenon.

Regarding the absolute convergence, the LM tests indicated an option of spatial lag dependence in the EU-28. The estimated rate of convergence was 0.46% in the EU-28. OLS tends to be biased, the substantive form of spatial autocorrelation being obvious for the data. OLS estimation results indicated absolute convergence at an annual rate of 1.85% between 2001 and 2012. The rate of absolute convergence is higher than that based on spatial lag model, the auto-correlation being obvious. The rich neighbouring regions tend faster to convergence than the poor ones.

In the poor countries a faster convergence speed was observed compared to rich countries even during the economic crisis. Some countries experienced relatively high mean rates of real per capita GDP growth, such as Malta, Bulgaria, Luxembourg, and Romania, but most highly developed countries (e.g., Denmark, Netherlands, and Sweden) have been

growing at a slower rate on average. The process of real convergence of the Romanian economy continued in the years of crisis, with the GDP per capita rate by more than 2 percentage points above the rate of the European Union in 2009 – 2013.

Conclusions

The issue of whether European regions show convergence in income levels has been a major concern in the EU during the last decades and thus has geared a considerable amount of research work in the field. From a methodological point of view, a number of related econometric concepts were applied and developed. Nevertheless, critical arguments can be brought forward even against the most recently applied econometric frameworks.

The spatial approach in the convergence context brought us to the conclusion that there is not significant convergence within EU-28 countries. Our results show that ignorance of the spatial correlation leads to potentially misleading results. There was a faster increase of GDP per capita in poor economies.

Under the assumption of structurally identical economies, the absolute convergence is checked using a regression for economic growth and initial level for certain regions/countries. The rate of convergence was 0.46% in the EU-28. The absolute convergence is at an annual rate of 1.85% between 2001 and 2012. The economic context should take into account the effects of recent economic crisis that determined an obvious decrease in convergence. Surprisingly, in the crisis period the poor countries registered a real convergence surpassing the EU-28 average. The process of real convergence of the Romanian economy continued in the years of crisis, with the GDP per capita rate by more than 2 percentage points above the rate of the European Union in 2009 – 2013. Moreover, Croatia was admitted as member of EU in 2013, evident efforts for achieving the regional convergence being observed after 1990. After an initial drop in the late 1990s, the difference between potential output and actual output narrowed systematically in Croatia, and output growth rates have been close to or above the estimated growth in potential output since then.

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Contact address
Mihaela Simionescu, Ph.D.

Institute for Economic Forecasting of the Romanian Academy / Institutul de Prognoza Economica, Academia Romana
(mihaela_mb1@yahoo.com)

Appendix

Figure 3: The results of OLS estimation

Intercept	2.3007 (33.89)*
	-0.298(-7.95)*
R-square adjusted	0.4762
AIC	3331.72
Jarque-Bera	94103.06 (prob.=0.00)
Koenker-Bassett test	109.11 (prob.=0.00)
White test	401.33 (prob.=0.00)
Moran's I	22.42 **

Significant level of 0.05 level; in brackets there are standard errors
*** Significant level of 0.01 level*

Figure 4: SLM estimation results

Intercept	2.453 (37.28)**
	-0.163(-6.25)**
R-square adjusted	0.5451
AIC	3314.64
LM- test	176.994 (0.00)

*** Significant level of 0.01 level*

Figure 5: SEM estimation results

Intercept	2.498 (40.23)**
	-0.363(-5.03)**
Λ	0.6262 (29.65)**
LM test	540.9586 (0.00)

Figure 6: Moran´s I