EUROPEAN INTEGRATION, SPATIAL DEPENDENCIES AND INCOME CONVERGENCE: EVIDENCE OF NEW[1] EU MEMBER STATES[2]

Paweł Folfas

Warsaw School of Economics

ABSTRACT

Convergence is one of the fundamental issue of European integration. This paper is aimed at answering question whether absolute income (GDP *per capita*) beta-convergence exists in the case of regions in new EU Member States before (period 2000-2008) and during (years 2008-2011) crisis. Separate analysis of convergence for crisis period appears to be the main value added of paper. Sample consists of 211 regions (NUTS 3-level) of Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia and Slovakia.

The research is based on econometric models, namely on spatial lagged model (SLM) and spatial error model (SEM) which seem to be a better specification for convergence equation than ordinary least squares (OLS) model. SLM and SEM models detect the absolute income beta-convergence on the level of about 1% during years 2000-2008. Additionally, models do not confirm the existence of absolute income beta-convergence during crisis (years 2008-2011). Moreover, the number of clusters increased during crisis (before crisis there was significant fall in the number of clusters). This is also proof that processes of convergence slowed down or even were stopped with the beginning of global crisis.

SLM models (which offer more reliable findings) find spatial correlation (measured by rho-parameter) at a level of 0.75 during 2000-2008 and 0.35 during 2008-2011. Thus, absolute income beta-convergence in the case of NUTS 3 regions in 10 new EU Member States exists only in pre-crisis period and this period is characterized by much stronger spatial dependencies than period 2008-2011. Also Moran' s global statistics confirm that spatial autocorrelation between NUTS 3 regions has been weakening.

Keywords: European integration, income convergence, spatial econometrics, NUTS 3 regions, new EU Member States

JEL codes: F15 (economic integration)

[1] Additionally appendix 2 includes analysis of convergence for NUTS 3 regions in Germany.

[2] This project is funded by National Science Centre of Poland on the basis of the decision Nr DEC-2013/11/B/HS4/02126.

INTRODUCTION

Convergence is one of the fundamental issue of European integration. This paper is aimed at answering question whether absolute income (GDP *per capita*) beta-convergence exists in the case of regions in new EU Member States before (period 2000-2008) and during (years 2008-2011) crisis. Separate analysis of convergence for crisis period appears to be the main value added of paper. Sample consists of 211 regions (NUTS 3-level) of Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia and Slovakia.

The research is based on econometric models, namely on spatial lagged model (SLM) and spatial error model (SEM) which seem to be a better specification for convergence equation than ordinary least squares (OLS) model. The text includes three major sections: (1) literature review, (2) methodological considerations concerning convergence equation and estimation techniques and finally (3) empirical study on absolute income beta-convergence among NUTS 3 regions of selected 10 new EU Member States and analysis of spatial autocorrelation between these regions.

1. LITERATURE REVIEW

Convergence is one of the fundamental topic of economic integration. Consequently, there is a lot of studies, both theoretical and empirical, concerning the processes of convergence. This literature review includes examples of researches focusing on income (GDP *per capita*) convergence among relatively poorer regions of the European Union – namely regions in Greece, Portugal and Spain, and obviously regions in new EU Member States. Therefore, it is possible to compare (up to a point) results stemming from these researchers and from my empirical study.

Firstly, Soukiazis and Antunes [2004] scrutinize convergence process among the thirty NUTS 3 Portuguese regions studying the evolution of *per capita* income and productivity during the period 1991-2000. Their evidence shows that convergence among the 30 regions in Portugal is rather conditional than absolute. Labour shares in the main economic sectors are important in explaining convergence in *per capita* income and productivity. Output growth, reflecting demand conditions and labour composition by sectors are shown to be relevant conditioning factors in explaining the convergence process in productivity. Moreover their evidence shows a more significant shift of labour from the primary to the

tertiary sector and when this element is introduced into the convergence equations, convergence is shown to be higher. Also Braga [2010] examines income sigma- and beta-convergence among the NUTS 3 Portuguese regions during the period 1970-2001. He proves that in the Portuguese case, the clustering phenomenon leads to growth and convergence within the regions and between the regions. He claims clusters generate mechanisms of equal growth and living conditions. Additionally, Cardoso and Pentecost [2011] detect that human capital has positive impact on regional growth and convergence in Portugal during period 1991-2008. They confirm the convergence among NUTS 3 Portuguese regions and prove that both secondary and higher levels of education have a significant positive effect on regional growth rates which may be regarded as supportive of Portuguese education policy, which over the last three decades has attempted to raise the regional human capital by locating higher education institutions across the country.

Secondly, Tsionas et. al [2014] investigate regional convergence in Greece during the period 1995-2005. According to their study there is an absence of convergence across NUTS 2 Greek regions while there is an evidence of convergence at prefectural level (NUTS 3).
Thirdly, Viegas and Antunes [2013] empirically analyze convergence among NUTS 3 regions of the Iberian Peninsula between 1995 and 2008. The results reveal divergent national trends and indicate no evidence of catching-up effects among the poorest regions, confirming the existence of economic clusters.

After review of studies on regions in Greece, Portugal and Spain, I focus on papers concerning new EU Member States. Paas et al. [2007] conduct analysis for 1214 NUTS 3 regions of EU-25 countries during the period 1995-2002. Authors detect absolute convergence in the EU-25 regions but the speed of regional income convergence was higher for the EU-15 than for the 10 new Member States which joined EU in 2004. They also discover although there was an overall regional income convergence in the EU-25 countries, there was on average no convergence within the countries. Moreover, Artelaris et al. [2010] examine convergence of NUTS 3 regions in all apart from Cyprus and Malta new Member States which joined the EU in 2004 and 2007. They identify the existence of regional convergence clubs in many EU new Member States. In their opinion the identification of regional convergence clubs, irrespective of the pattern that emerges in each, highlights the heterogeneous spatial impact of the EU economic integration process. Their evidence

questions the ability of markets to generate self-correcting mechanisms for regional imbalances.

Additionally, Nevima and Melecky [2011] examine the process of real convergence in the Visegrad countries at regional NUTS 2 level. Their study confirms the existence of beta-convergence among 35 NUTS 2 regions of the Visegrad Four countries in the period 1995-2008. Herz and Vogel [2003] focus on regional growth and convergence in a sample of 31 Central and Eastern European regions (31 NUTS 2 regions from Poland, Hungary and the Czech Republic) over the period 1990-2002. They find that the regional disparity has decreased in the first half of the 1990s. Thereafter it has remained stable. Almost all of the reduced disparity seems to be attributable to income convergence between countries. At the country level, on the other hand, they find no evidence for sigma-convergence. Their econometric analysis finds evidence for conditional beta convergence.

Two next papers concentrate on case of Romania. Namely, Benedek and Veress [2013] investigate the economic convergence between regions in Romania and between the NUTS 2 and NUTS 3 Romanian regions and EU in the period 2000-2010. Their main results confirm that while there is an evident convergence between the country as whole and EU, the inter-regional disparities in Romania has widened. Moreover, Mikulić et al. [2013] provide an analysis of regional convergence in the EU-27 and Croatia during the period 2001-2008 at the NUTS 2 and NUTS 3 level. According to their model, absolute beta-convergence can be found on the national level for EU countries. Convergence also can be found for new Member States regions, but convergence speed on the regional level is lower in comparison to the national level and the estimated beta-convergence parameter is less significant. No evidence on regional convergence (on the country level) can be found in Croatia, and disparities have been highly persistent throughout the period of 2000-2008. More precisely, aside from Latvia and Portugal, Croatia recorded the smallest change in regional dispersion between 2000-2008 when compared to new Member States.

Literature review ends with two example of Polish studies concerning regional convergence. Firstly, Rosiek and Włodarczyk [2012] conduct study on labour market's convergence, thus they focus on unemployment rate instead on GDP *per capita* (as the unemployment rate is important factor affecting wealthy of citizens, I include their research in literature review). The empirical researches conducted by these authors demonstrate that the speed of sigma-convergence is low. In 1999-2007 they found sigma-convergence in

unemployment rates between EU NUTS 2 regions, but in 2008-2009 data indicated divergence in regional unemployment rates in EU–27. In conducted analysis only the beta-convergence of regional unemployment rates is significant and negative. This shows a convergence process where NUTS 2regions in EU-27 with higher unemployment rates catch-up on the other ones with lower unemployment rates. Analysis of beta-convergence indicate that within the period 1999–2009 the dispersion of labour productivity, labour force participation rates, employment rates between NUTS 2 regions in EU-27 was reduced. However, this relationship was not statistically significant. Secondly, Supińska [2013] detects unconditional and conditional income beta-convergence among 211 NUTS 3 regions of Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, and Slovakia during the period 1999-2008. According her study the process of regional growth is also determined by the level and changes in human capital, as well as by location of the region, i.e. the regions which are located in dynamically developing areas may benefit from their location and grow faster. Article prepared by Misiak and Jabłoński [2013] presents the results of statistical calculations of sigma- and beta-convergence among the EU regions in 1995-2008 period. Their calculation was conducted on the basis of GDP *per capita* data for 189 NUTS 2 regions of the EU area and generally confirm both types of convergence.

To sum up, generally studies confirm regional convergence in the European Union, however convergence does not always occurs unconditionally, among all regions and during all periods. Consequently, processes of European integration do not guarantee the existence of convergence as it also depends on country- and period-specific factors.

2. METHODOLOGY AND DATA

As this paper investigates absolute income beta-convergence among NUTS 3 regions, I use the following equation proposed by Baumol [1986]:

$$\frac{1}{n}\, ln\frac{y_{i,1}}{y_{i,0}} = \alpha + \beta ln\, y_{i,0} + \varepsilon_i$$

where $y_{i,0}$ and $y_{i,1}$ correspond to the GDP *per capita* of region *i* at the initial and final year respectively and *n* is the number of years in analysed period. Whenever a negative and statistically significant relation is found between the initial GDP *per capita* level and the corresponding growth rate, we can assume the presence of absolute income beta-

convergence (variable $y_{i,0}$ is statistically significant and the parameter β is negative, thus annual speed of convergence equals $-\frac{\ln(1+n\beta)}{n}$).

Convergence equations can be estimated by ordinary or not-linear last squares (OLS or NLS) methods, however they do not include the possible spatial dependencies between regions. Consequently, I use spatial estimation techniques, namely spatial lagged model (SLM) and spatial error model (SEM). I implement following estimation procedure. Firstly, I check existence of spatial dependencies by statistical test (e.g. Moran test, Lagrange multiplier test). Secondly if tests show spatial dependencies, I introduce a special spatial component to the equation – matrix ***W***, that reflects spatial relations between analyzed regions. More precisely, it shows how pairs of regions relate to each other. In this paper I apply the common border matrix (it is a binary matrix with values equaling 1 when the regions are neighbours and 0 otherwise – so regions from different countries are neighbours). Thirdly, I estimate SLM and SEM and compare their quality using information criteria and results of previous statistical tests [Kopczewska 2006, s. 123-142].

Spatial lagged model includes external spillovers resulted from economic growth of other regions (namely neighbouring regions). In SLM spatial dependence is introduced to the equation through a spatially lagged dependent variable. Matrix ***W*** in this type of model is included together with the spatial lag of the dependent variable:

$$y_i = \beta_i \boldsymbol{X_i} + \rho \boldsymbol{W} y_j + u_i \qquad u \sim IIDN(0,1)$$

where y_i and y_j correspond to dependent variable in region *i* and in neighbouring regions *j* respectively and ***X*** is the set of independent variable. Rho-parameter (ρ) is the spatial coefficient, which is used to assess the existence and strength of spatial relations. If it is significant, a dependent variable is explained not only by the domestic determinants, but also by factors coming from external (neighbouring) regions. However, spillovers may result from many other factors, which are not captured by the SLM model. To incorporate the effect of unknown sources of spillovers, spatial error model can be used. In this model spillovers become a part of the error term component, and spatial dependency is revealed in the error terms, i.e. the error terms are correlated and show spatial covariance. In spatial error models, matrix ***W*** is introduced to the error term equation:

$$y_i = \beta_i \boldsymbol{X_i} + u_i \text{ where } \quad u_i = \lambda \boldsymbol{W} u_i + \varepsilon_i \qquad \varepsilon_i \sim IIDN(0,1)$$

where $\boldsymbol{W}u_i$ is the spatial lagged error term, ε_i is the random error term of the model, and λ is a coefficient that is introduced to the model to satisfy the assumption about random error terms. It shows to what extent shocks in neighbouring regions are transferred to the analysed region [Kopoczewska 2006, s. 132-133].

In this paper the research is a cross-section analysis, covering 211 NUTS 3 regions of 10 out of 13 new EU Member States: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, and Slovakia (Cyprus and Malta are excluded from the sample because they did not belong to former communist block and Croatia is also excluded as it joined the EU much later than other countries). Initial year of analysis is 2000 because during period 2000-2004(2007) 10 new EU Member States were intensively supported by EU pre-accession funds aimed also at improving the convergence. Year 2008 was chosen as a symbolic beginning of the global economic crisis (in 2008 there was a peak in GDP and GDP *per capita* before their sharp falls in 2009). Data concerning GDP *per capita* of 211 NUTS 3 regions are extracted from Eurostat statistical database.

3. ESTIMATION RESULTS AND SPATIAL AUTOCORRELATION ANALYSIS

Estimated models are aimed at answering question whether absolute income beta-convergence exists in the case of regions in new EU Member States before (period 2000-2008) and during (years 2008-2011) crisis. I start with models for years 2000-2008. The OLS estimation detects absolute income beta-convergence on the level of 3% (see table 2). However, goodness of fit of the model (R^2 and Adj R^2) is low (about 34%). Such low values of R^2 point out that some important factors might have not been included in the regression. Consequently, the model is tested for existence of spatial dependencies (see table 1). Moran and LM tests suggest replacement of OLS model by spatial models – SLM appears to be better than SEM (higher value of statistic in LM test for SLM test than for SEM test; robust LM tests also suggest choice of SLM).

Table 1. Results of tests for spatial dependencies

Period	2000-2008	2008-2011	2000-2011
Moran I test	0.577736268***	0.219875147***	0.487082859***
LM test for SLM	164.3559***	22.6774***	128.7748***

LM test for SEM	151.835***	21.992***	107.924***
Robust LM test for SLM	15.002***	1.546	20.8793***
Robust LM test for SEM	2.481	0.8607	0.0285

*** denotes statistical significance at level 0.001

Source: Own study based on estimation in R CRAN

According to the SLM there is an absolute income beta-convergence at the level of 0.9% among NUTS 3 regions of 10 new EU Member States during period 2000-2008 (see table 3). Moreover, SEM confirms the absolute convergence at the level of 1.3% (see table 4). However, information criteria (lower value of AIC and higher value of LogLik) confirm that SLM is better specification than SEM. The value of rho-parameter illustrating spatial dependencies is almost 0.75 and is statistically significant (see table 3). Growth in one region is explained in about 56% by the growth of surrounding areas.

Table 2. Results of OLS models of absolute convergence

Period	**2000-2008**	**2008-2011**	**2000-2011**
Intercept	0.304799***	0.032933	0.228228***
$ln\ y_0$	-0.026166***	-0.003958	-0.019672***
R^2	0.3393	0.008602	0.3422
Adjusted R^2	0.3361	0.003859	0.3391
F-statistic	107.3***	1.814	108.7***
AIC	-989.71	-1003.2	-1112.8

*** denotes statistical significance at level 0.001

Source: Own study based on estimation in R CRAN

The OLS estimation of model for period 2008-2011 do not detect absolute income beta-convergence (see table 2). Goodness of fit of the model (R^2 and Adj R^2) is extremely low (less than 1%). Such low values of R^2 point out that some important factors for sure have not been included in the regression. Consequently, the model is tested for existence of spatial dependencies (see table 1). Moran and LM tests suggest replacement of OLS model by spatial models – this time SLM seems to be slightly better than SEM (slightly higher value of statistic in LM test for SLM test than for SEM test; robust LM do not suggest anything).

Table 3. Results of SLM of absolute convergence

Period	2000-2008	2008-2011	2000-2011
Intercept	0.0934338***	0.0172670	0.0712349***
ln y_0	-0.0086731***	-0.0021222	-0.0064719***
P	0.74581***	0.34914***	0.72158***
Wald-statistic	267.48***	16.83***	216.8***
AIC	-1138.3	-1018.7	-1232.8
LogLik	573.1456	513.3493	620.4146

*** denotes statistical significance at level 0.001

Source: Own study based on estimation in R CRAN

According to the SLM and SEM there is not absolute income beta-convergence among NUTS 3 regions of 10 new EU Member States during period 2008-2011 (see tables 3 and 4). Information criteria (slightly lower value of AIC and slightly higher value of LogLik) confirm that SLM is slightly better specification than SEM. The value of rho-parameter illustrating spatial dependencies is almost 0.35 (more than two times lower than in model for years 2000-2008) and is statistically significant (see table 3).

Table 4. Results of SEM of absolute convergence

Period	2000-2008	2008-2011	2000-2011
Intercept	0.191282***	0.0156406	0.1280882***
ln y_0	-0.012057***	-0.0020324	-0.0073013***
Λ	0.79423***	0.34997***	0.77611***
Wald-statistic	347.21***	16.897***	296.31***
AIC	-1130.4	-1018.4	-1222.6
LogLik	569.187	513.2241	615.2827

*** denotes statistical significance at level 0.001

Source: Own study based on estimation in R CRAN

SLM and SEM models detect the absolute income beta-convergence on the level of about 1% during years 2000-2008. Additionally, models do not confirm the existence of absolute income beta-convergence during crisis (years 2008-2011). Models for whole period (2000-2011) inform about the absolute income beta-convergence on the level of 0.7% (SLM – see table 3) and 0.8% (SEM- see table 4). The strength of interregional dependencies measured by rho-parameter is about 0.72 (see table 3).

Figure 1. Spatial autocorrelation

Positive Negative

Source: Own deliberation.

According to the SLM results spatial autocorrelation between NUTS 3 regions has been weakening. This phenomena is worth to scrutinize. The basic measure of spatial autocorrelation (see illustration of spatial autocorrelation on figure 1) is Moran's global statistics (Moran I).

Thus, firstly I calculate the value of Moran I statistics for variable GDP *per capita* (in standardized values) in 2000, 2008 and 2011 (see plots in Appendix). In all periods Moran I is statistically significant and its value equals: 0.6748523 in 2000, 0.4837925 in 2008 and 0.4539137 in 2011. So there has been still positive autocorrelation between NUTS 3 regions from 10 new EU Member States, but the autocorrelation has been weakening. Secondly, it is worth to notice hot spots – regions in which GDP *per capita* is higher than in neighbouring areas in the bigger extent than spatial regime suggests – see special points below regression line on plots in Appendix. In 2000 there were 7 hot spots (SI021-Osrednjeslovenska, CZ010-Hlavni mesto Praga, PL127-Miasto Warszawa, PL415-Miasto Poznań, SK010-Bratislavsky kraj, PL213-Miasto Kraków and HU101-Budapest), 9 (SI021-Osrednjeslovenska, CZ010-Hlavni mesto Praga, PL127-Miasto Warszawa, PL415-Miasto Poznań, SK010-Bratislavsky kraj, RO321-Bucuresti, EE001-Pohja Esti, LV006-Riga and HU101-Budapest) in 2008 and again 7 (SI021-Osrednjeslovenska, CZ010-Hlavni mesto Praga, PL127-Miasto Warszawa, PL415-Miasto Poznań, SK010-Bratislavsky kraj, EE001-Pohja Esti and HU101-Budapest) in 2011. Thirdly, according to Moran's local statistics there is a quite big number of clusters[3] (regions surrounded by regions with similar value of GDP *per capita*) in the sample of 211 NUTS regions from 10 new EU Member States. In 2000 there were about 60 clusters (in Bulgaria, the Czech Republic, Poland, Romania and Slovenia), ca. 40 in 2008 (in Bulgaria, the Czech

[3] More precisely – regions than together with surrounding areas create clusters.

Republic, Romania, Slovakia and Slovenia) and around 60 in 2011 (in Bulgaria, the Czech Republic, Poland, Romania, Slovakia and Slovenia).

To sum up, the number of clusters in 2008 was lower than in 2000, but in 2011 again achieved level from year 2000. This is indirectly proof that processes of convergence among NUTS 3 regions from 10 new Member States slowed down or even were stopped with the beginning of global crisis.

CONCLUSIONS

SLM and SEM models detect the absolute income beta-convergence on the level of about 1% during years 2000-2008. Additionally, models do not confirm the existence of absolute income beta-convergence during crisis (years 2008-2011). Additionally, the number of clusters increased during crisis (before crisis there was significant fall in number of clusters). This is also proof that processes of convergence slowed down or even were stopped with the beginning of global crisis. SLM models (which offer more reliable findings) find spatial correlation (measured by rho-parameter) at a level of 0.75 during 2000-2008 and 0.35 during 2008-2011. Thus, the absolute income beta-convergence in the case of NUTS 3 regions in 10 new EU Member States exists only in pre-crisis period and this period is characterized by much stronger spatial dependencies than period 2008-2011. Also Moran' s global statistics confirm that spatial autocorrelation between NUTS 3 regions has been weakening.

My results correspond with study of Nevima and Melecky [2011] who examine the process of real convergence in the Visegrad countries at regional NUTS 2 level. Their study confirms the existence of absolute beta-convergence among 35 NUTS 2 regions of the Visegrad Four countries in the period 1995-2008, so the period before crisis. Also Mikulić et al. [2013] confirm absolute beta-convergence before crisis (namely during the period 2001-2008) at a level of 4.5 % for whole European Union and at a level for 2.3% for new EU Member States (NUTS 2 level and OLS estimation). Finally, Supińska [2013] detects absolute beta-convergence for the 211 NUTS 3 regions (the same sample as in my study) in period 1999-2008 at a level about 1% (SLM and SEM). To sum up, before crisis absolute income beta-convergence among regions of new EU Member States exists but during crisis probably

does not. However, further studies are needed as soon as data for next years (2012, 2013 and so on) are available.

REFERENCES

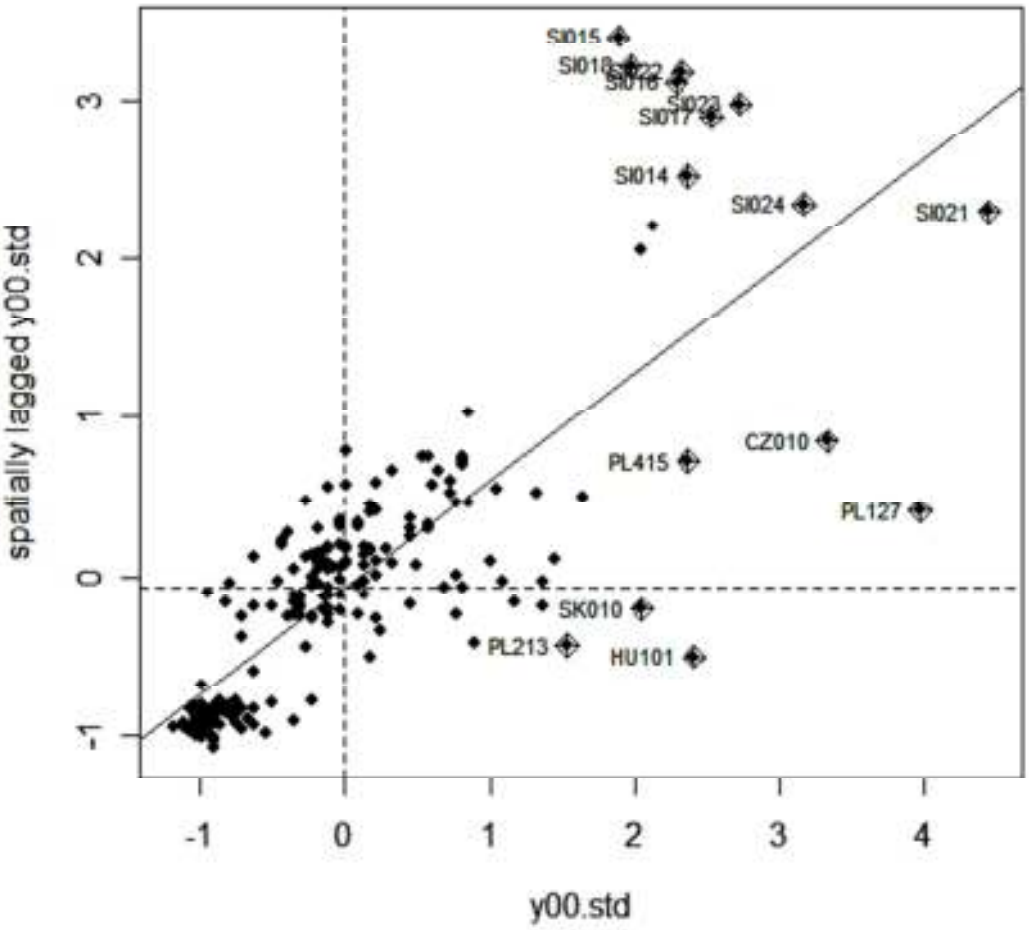
1. P. Artelaris, D. Kallioras, G. Petrakos, Regional Inequalities and Convergence Clubs inthe European Union New Member-States, “Discussion Paper Series of University of Thessaly”, 2010, Vol. 16, Iss. 3, pp. 43-62.
2. W. Baumol: Productivity growth, convergence and welfare: what the long-run data show?, “American Economic Review”, 1986, Vol. 76, No. 5, pp. 1072-1085.
3. J. Benedek, N-C. Veress, Economic disparities and changes in the convergence of the Romanian Nuts 2 and Nuts 3 regions, “Romanian Review of Regional Studies”, 2013, Vol. IX, No.1, pp. 85-90.
4. V. Braga, Regional growth and local convergence: Evidence for Portugal, 2003, European Regional Science Conference Paper, pp. 1-19.
5. C. Cardoso, E. J. Pentecost, Regional Growth and Convergence: The Role of Human Capital in Portuguese Regions, “Working Papers of Loughborough University”, 2011, No. 2011/03, pp. 1-28.
6. B. Herz, L. Vogel, Regional Convergence in Central and Eastern Europe: Evidence from a Decade of Transition, “Diskussionspaper von Universität Bayreuth”, 2003, No. 13-03, pp. 1-30.
7. K. Kopczewska, Ekonometria i statystyka przestrzenna z wykorzystaniem program R CRAN, Wyd. CeDeWu, Warszawa 2006
8. D. Mikulić, Ž. Lovrinčević, A. G. Nagyszombaty, Regional convergence in the European Union, new Member States and Croatia, “South East European Journal of Economics and Business”, 2013, Vol. 8, Iss. 1, pp. 7-19.
9. T. Misiak, Ł. Jabłoński, Realna konwergencja między regionami Unii Europejskiej w latach 1995-2008, „Studia Prawno-Ekonomiczne”, 2013, No. 88, pp. 267-292.
10. J. Nevima, L. Melecky, The β-Convergence Analysis of the Visegrad Four NUTS 2 Regions, “Mathematical Models and Methods in Modern Science”, 2011, pp. 48-53.
11. T. Paas, A. Kuusk, F. Schlitte and A. Võrk, Econometric analysis of income convergence in selected EU countries and their NUTS 3 level regions, “University of

Tartu - Faculty of Economics and Business Administration Working Paper Series", 2007, No. 60, pp. 1-56.

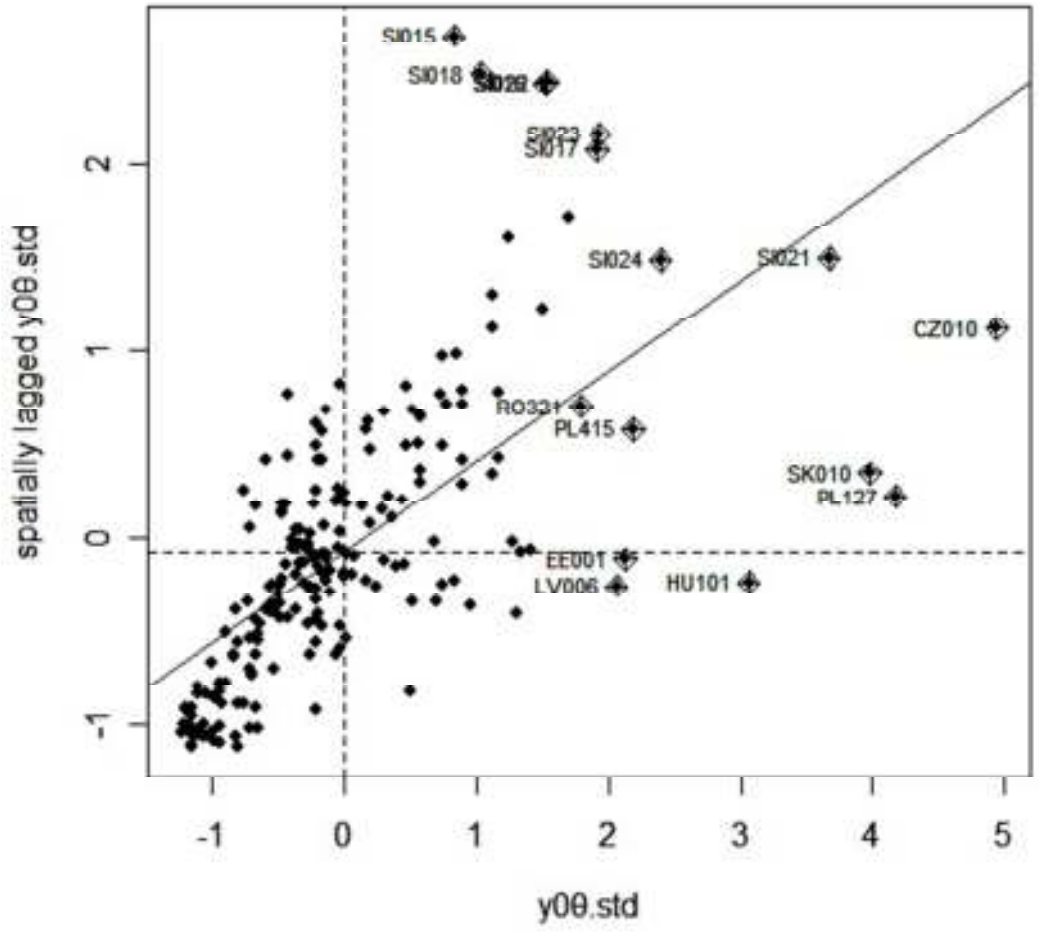
12. J. Rosiek, R. W. Włodarczyk, Comparative analysis of the EU-27 countries labour markets' convergence, "Economics and Management", 2012, Vol. 17, Iss. 1, pp. 216-222.
13. E. Soukiazis and M. Antunes, The evolution of real disparities in Portugal among the NUTS III regions. An empirical analysis based on the convergence approach, "Estudos Regionais", 2004, No. 6, pp. 163-181.
14. J. Supińska, Does human factor matter for economic growth? Determinants of economic growth process in CEE countries in light of spatial theory, "Bank i Kredyt", 2013, Vol. 44, Iss. 5, pp. 505-532.
15. M. Tsionas, S. Sakkas and N.C. Baltas, Regional Convergence in Greece (1995–2005): A Dynamic Panel Perspective, "Economics Research International", 2014, Vol. 2014, pp. 1-6.
16. M. Viegas, M. Antunes, Convergence in the Spanish and Portuguese NUTS 3 Regions: An Exploratory Spatial Approach, "Review of European Economic Policy", 2013, Vol. 48, No. 1, pp. 59-66.

APPENDIX 1

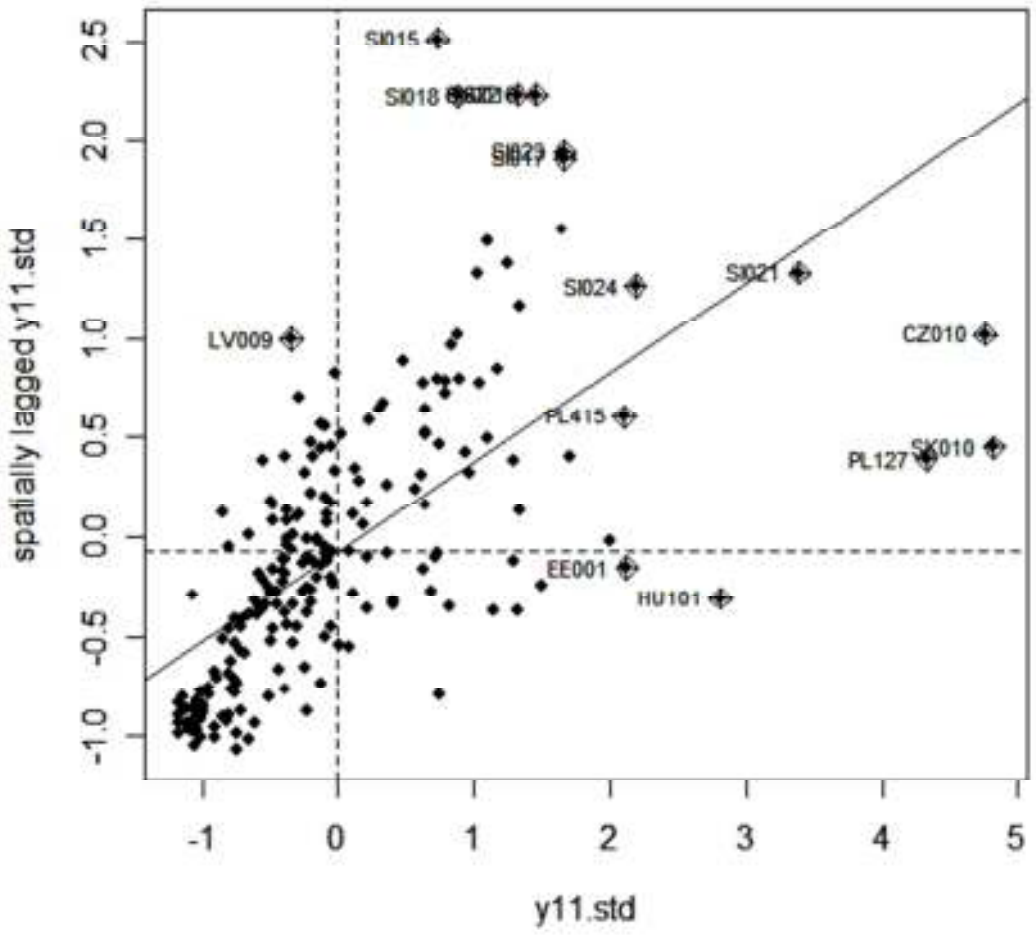
Plots illustrating Moran's global statistics for GDP *per capita* (in standardized values) in 2000, 2008 and 2011 (*y00.std*, *y08.std* and *y11.std*)



Source: Own study based on estimation in R CRAN



Source: Own study based on estimation in R CRAN



Source: Own study based on estimation in R CRAN

APPENDIX 2

In this paper the research is a cross-section analysis, covering 211 NUTS 3 regions of 10 out of 13 new EU Member States: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, and Slovakia belonging to former communist block. However, also East Germany (former German Democratic Republic) used to belong to this block. Consequently, in this appendix there are estimation results for NUTS 3 regions in Germany (spatial lagged models)

Table A. Results of SLM of absolute convergence

Okres	**1992-2012**	**1992-2000**	**2000-2008**	**2008-2012**
Period	0.11944753***	0.1706662***	0.0935392***	1.2823e-02
Intercept	-0.01104038***	-0.0164866***	-0.0075567***	-4.5573e-05
ln y_0	0.51421***	0.62188***	0.16333*	0.28994***
R^2	148.35***	255.4***	5.9382*	19.835***
Adjusted R^2	-2923.5	-2394.8	-2724.2	-2452.2
F-statistic	1465.731	1201.379	1366.122	1230.075

*** denotes statistical significance at level 0.001

* denotes statistical significance at level 0.05

Source: Own study based on estimation in R CRAN