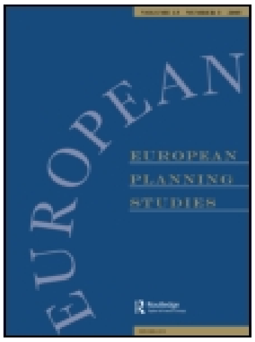

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Regional Convergence in Central and Eastern European Countries: A Multidimensional Approach

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Abstract *The paper examines the dynamics of regional income at the NUTS3 level of the new EU Member States from Central and Eastern Europe in the years 1998–2005. The authors apply a wide range of methods and tools including classical beta and sigma convergence analysis supplemented by transition matrices, kernel density estimations and spatial autocorrelation statistics. Results of such a multi-dimensional empirical study reveal some previously unrecognized patterns of regional growth in Central and Eastern European Countries (CEECs). Well-acknowledged metropolization and marginalization processes that cause regional divergence at the national scale are accompanied by the following processes. Firstly, at the macroregional scale, regional convergence has been observed as a result of differences in growth rates between individual countries. Secondly, at the national scale, petrification of existing regional structures has been prevailing in majority of the countries. Furthermore, weak convergence of clubs has been observed separately among the richest metropolitan regions and between the group of the poorest regions. In general, the polycentric spatial structure of the macroregion has reduced the impact of rapid growth of rich capital city-regions on convergence processes. Simultaneously, diffusion of development processes had a rather limited range and polarization in larger metropolitan regions have been a characteristic feature of CEECs.*

Introduction

The accession of 10 Central and Eastern European Countries (CEECs) to the European Union encourages the conducting of the analysis on changes in regional development patterns in the preceding period. One should have in mind that at the turn of the century, economic transformation of CEECs has been completed to a large extent (Gorzelak, 2008). Both globalization and metropolization have been main driving forces across the macroregion as well as in Western European Countries (Bachtler

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et al., 2000). This leads to a general question of whether one can observe convergence or divergence of regional development in this part of Europe. Such an analysis should also be an indispensable starting point for further evaluation studies on the impact of Structural Funds on regional development process in CEECs.

Research concerning convergence processes between countries and regions of the European Union shows that economic integration promoted significant decrease in *per capita* income dispersion. However, convergence dynamics changed over time. For a long time, the speed of convergence between regions of the future European Union was relatively high. Absolute beta and sigma convergence was observed at the level of countries and regions of the European Union. The process was also observed among regions within individual countries. In the middle of the 1970s, the convergence process significantly slowed down and did not encompass poorer regions (mainly peripheral regions of Southern Europe). In effect, the slow convergence between EU countries in the 1980s was observed along with increasing disparities in growth levels between poorer and richer regions. The differences did not diminish, although since the end of the 1980s again slow convergence is observed, but it does not refer to all regions. In most European countries, internal disparities of regional incomes do not decrease; in many cases they even increase (ESPON, 2005). The process of convergence between countries of the European Union is accompanied by divergence at the regional level, despite increasing transfers to lagging regions. Convergence is observed among regions with higher share of services or high-tech industries. Fast growth of GDP in these regions results in increasing disparities within countries with heterogenic structure of production. On the other hand, agricultural regions are the poorest and stay the poorest (Cappelen *et al*., 1999; Giannetti, 2002). Convergence between the European Union countries is caused by the increasing share of Gross Value Added produced with the use of advanced technologies. Therefore, a chance for the poorest regions lies in increasing their potential to absorb new technologies and changing production structure.

In the Fourth report on economic and social cohesion (EC, 2007), a number of arguments were presented, which need to be discussed in more detail and directly referred to individual countries of Central and Eastern Europe, including Poland. Among the arguments one should mention:

- convergence is occurring at the national level,
- polarization is observed at the regional level, mainly due to dynamic growth of capital regions—to the largest extent in new member states,
- disparities between regions in terms of level of development result, to a large extent, from differences in economic structures and an employment rate,
- economic structure of less-developed regions is dominated by activities with low value added.

In addition, previous studies concerning development of CEE macroregion countries (Gorzelak, 1996; ESPON, 2006; Ezcurra & Pascual, 2007; Gorzelak *et al*., 2001; Gorzelak & Smętkowski, 2010) lead to the following conclusions:

- the fastest growth was observed for capital regions and other large agglomerations, which was caused by establishing new enterprises, development of services sector

and concentration of foreign investment along with smaller differences in the level of development between the rest of the regions in individual countries,
- position of old industrial regions—leaders in previous model of development—was weak, because they suffered during the restructurization process, which included privatization and employment rationalization,
- closeness to the border with European Union countries had positive impact on growth processes, while location on eastern, currently the external border of the EU, negatively influenced growth; this was to a large extent linked with the distance to sources of capital and innovation (measured by transport accessibility, closeness of western border or large agglomeration).
- diversification of economic structure (including quality of labour force and modernity of fixed assets) is found to be one of the most important growth factors; however, industry mix contributes relatively little to the regional differences in labour productivity.
- on the other hand, the lack of adequate transport infrastructure, low qualified labour force, environment problems and low competitiveness (resulting from weak absorption of innovations, limited access to technology and lack of pro-development attitudes in society) were identified as most important barriers to growth.

As a result, some authors found (Petrakos, 2001) that the scale of regional problems related to high and growing disparities in selected CEE countries may take alarming, by the EU standards, dimensions. Furthermore, the analysis of the regional productivity level (Ezcurra & Pascual, 2007) leads to conclusions that these are linked mainly to region-specific factors.

The above-mentioned studies concerning the regional development process in CEE countries were in principle conducted at the NUTS2 regional level (Ezcurra *et al.*, 2007), which was mainly caused by the non-availability of reliable and comparable data for subregions (NUTS3). However, differences in levels of development between NUTS2 regions in a particular country are often much lower than intraregional disparities. Currently, the data for subregions are available, at least in the basic range, which encourages the verification of conclusions from the above-mentioned studies at a lower regional level. The advantages of such an approach include the possibility of excluding capital regions from the analysis, which might have a significant impact on research results, having in mind that these regions in total amount to about 15% of the population and 25% of the GDP for the CEE macroregion. The analysis will be performed for the years 1998–2005/2006, which is a relatively long period and in which growth paths for individual countries were quite similar (Gorzelak & Smętkowski, 2010).

The basic indicator used in our regional convergence analyses is GDP (or rather GRP as gross regional product) *per capita* and its real change. GDP denominated in euro *per capita* well describes the level of development of individual regions and allows the determination of their relative position on an economic map of CEE countries. It should be mentioned, however, that the value of regional GDP in this approach is strongly determined by the level of wealth of the appropriate country. Four groups of countries with regional GDP range of relatively similar intervals can be distinguished: Slovenia; Vysehrad countries (Czech Republic, Poland, Slovakia, Hungary), Baltic states (Lithuania, Latvia and Estonia) and separately Bulgaria and Romania (Gorzelak & Smętkowski, 2010). Therefore, comparative analyses of CEE countries with respect to the level and dynamics of growth using absolute values are rather non-informative. One should consider using relative measures, either with the purchasing power parity approach or relative to country averages. The latter was used in our research. Such an approach allows the obtaining of results independent of the specific country context and is more and more frequently used in research of the dynamics of socio-economic development (Portnov & Schwarz, 2008).

To sum up, in our research we took into account two important aspects that have not been sufficiently reflected in previous studies—on the one hand spatial aspect linked with the exclusion of capital subregions and, on the other hand, contextual aspect linked with analysing relative indicators (with respect to country averages). As a result, our convergence analysis includes four dimensions, i.e. all 179 NUTS3 regions (combined NUTS3 comprising the city and its direct surroundings)—Model (1), 169 NUTS3 regions (without capital subregions)—Model (2) for both real GDP in EUR or in relation to CEE10 average—Model (A) and GDP relative to national average—Model (B) (Table 1).

There are two main concepts of convergence found in the literature: sigma convergence and beta convergence (Sala-i-Martin, 1990; Barro and Sala-i-Martin, 1992). Sigma convergence takes place if dispersion of *per capita* income (or other analysed phenomena) among regions or countries decreases in time. The concept of beta convergence deals with the relationship between average growth rate of GDP *per capita* and its initial level. There are two variants of beta convergence—absolute and conditional. Absolute beta convergence assumes that countries or regions will become similar in terms of GDP *per capita* independent of initial conditions. It implies that poor countries (regions) will tend to grow faster than rich and the lower the initial level of real GDP *per capita*, the faster they grow. As a result, poorer regions catch up with the rich and the development gap is narrowing. Conditional convergence assumes that countries or regions will become similar only when they are similar in terms of structural characteristics, e.g. education level, production structure, transport infrastructure, etc.

In the analysis for CEE countries, we used both classical beta and sigma convergence approaches and the alternative methodology of analysis of the whole distribution and its dynamics in time (see Table 2 for the summary). The latter allow the estimation of probabilities of becoming relatively poorer, relatively richer or income persistence for regions at different levels of initial income.[1] The study also includes spatial autocorrelation methods that enable the assessment of spatial structure organization and its change.

Existence of convergence separately for different groups of regions is known as the convergence of clubs. This kind of convergence cannot be tested within the classical framework of sigma or beta convergence. Therefore, an alternative methodology has been proposed—analysis of the entire distribution. For the European Union regions, it usually indicates bimodal ("twin-peaked") distribution of GDP *per capita*—the clearly

Table 1. The dimensions of regional convergence analysis in CEECs

	Model (1): $N = 179$ (units combined, NUTS3 comprising the city and its direct surroundings)	Model (2): $N = 169$ (units without capital subregions)
Model A GDP (EUR or %)	Model A1	Model A2
Model B GDP (country = 100)	Model B1	Model B2

Source: Own elaboration.

Table 2. Measures of differentiation of economic growth level

Dimension	Tendency	Methods
Differences in growth level	σ and β convergence/divergence	Coefficient of variation, Barrotype regression
Modality	Unimodality Multimodality (a) polarization (b) stratification	Kernel density estimation (univariate)
Mobility	Inertia (stabilization)	Transition matrices, kernel density estimation (conditional density)
	Mobility (mixing)	Mobility indicator (classes, ranks)
Distribution	Consolidation Fragmentation	Spatial autocorrelation

Source: Own summary based on Yamamoto (2008).

distinguished upper peak refers to the richest regions. Relatively poorer regions do not have much chance to become relatively richer, which makes the dispersion of *per capita* GDP quite persistent. For regions with GDP *per capita* above a certain level, the variability of incomes does not increase in time, which on one hand leads to convergence among the richest and on the other hand preserves interregional disparities of income (Ezcurra & Rapún, 2006). What is more, usually richest regions experience much faster growth than the rest, which results in increasing polarization (Magrini, 2004; Grazia & Pittau, 2005; Grazia Pittau & Zelli, 2006).

Beta and Sigma Convergence

In the CEE macroregion, one can observe weak negative relationship between average growth rate and initial level of GDP *per capita* at the regional level (Table 3; negative

Table 3. Results of regression analysis for beta convergence in 1998–2005—all countries

		Model (1): $N = 179$ (combined NUTS3 comprising the city and its direct surroundings)			Model (2): $N = 169$ (without capital subregions)		
Dimensions		N	Parameter	Significance (p-value)	N	Parameter	Significance (p-value)
Model (A)	GDP level and its real change (EUR, %)	179	−0.0040	0.071*	169	−0.0067	0.002**
Model (B)	GDP level and its real change relativized to national average (each country = 100)	179	0.0002	0.000**	169	0.0000	0.898

Source: Own elaboration based on EUROSTAT data.
*Statistical significance at 10% level.
**Statistical significance at 5% level.

parameter values indicate convergence, while positive mean divergence). Convergence was particularly observed after exclusion of capital regions from consideration.[2] The above-mentioned relationship was linked with slight decrease of the coefficient of variation measuring the dispersion of GDP *per capita* (Table 3). This result suggests weak tendencies for beta and sigma convergence among all regions from analysed countries, especially for regions away from the capital. Additional consideration of differences in exchange rates and appreciation of local currencies strengthened the beta convergence effect, while analysis of relative data (in relation to country averages) showed lack of convergence within countries or even weak divergence. On the contrary, there is lack of correlation between GDP change and its level for regions excluding capital subregions. This may suggest an impact of other factors, independent from initial level of development, that affect growth paths of CEEC regions excluding capital.

These conclusions are corroborated by convergence analysis for individual countries. Convergence processes were heterogeneous—in most countries internal disparities increased in the analysed period (sigma divergence) or were relatively stable (lack of convergence), which can be concluded from the coefficients of variation depicted in Table 4 (the higher the value of the indicator, the higher the disparities). The highest increase of disparities was observed in Romania and Bulgaria and the lowest in Estonia and Slovenia. In general, the analysis without capital subregions (Model 2) allows the observation of the process of convergence of development levels, especially for countries in which capital regions have significant shares in national economies. However, countries with a more polycentric settlement structure, i.e. with other large cities except the capital, faced the polarization process, which was the case of Romania, Poland and Lithuania.

In principle, initially poorer regions were not growing faster than richer regions (Table 5)—absolute beta convergence was not observed in several countries (Lithuania, Poland, Romania,[3] Slovenia, Slovakia). There was a positive relationship between average growth rate and initial GDP *per capita* level observed, i.e. beta divergence—in Poland also after excluding the capital region. On the other hand, slow convergence processes occurred in Bulgarian regions without the capital.

Therefore, convergence tendencies for regions from all 10 countries were a result of varying levels of economic transformation and not processes happening in individual countries. The divergence processes within particular countries have been observed as a result of fast growth of capital regions, while for the rest of the regions this conclusion is not supported. This may indicate the importance of a national context as reflected in differences of spatial organization structure or in a wide range of potential growth factors.

Quah (1996) proposed alternative methodology based on transition matrices and kernel density estimation. Both methods allow the analysis of the whole distribution of income and its dynamics in time.

Transition Matrices

In transition matrix methodology, the initial distribution of relative GDP *per capita* is divided into several intervals called income classes. Then, transition matrix is estimated—it describes how the distribution of income changes over time. The estimated elements of transition matrix reflect probabilities of moving between defined income classes, i.e. the probability of becoming relatively richer or poorer or staying in the same group (for example of application see e.g. Ponzio and Di Gennaro (2004)).

Table 4. Coefficients of variation weighted by population in 1998 and 2005—each country separately (Model A)

	Model 1: $N = 179$ (combined NUTS3 comprising the city and its direct surroundings)					Model 2: $N = 169$ (without capital subregions)				
Country	1998	2005	Change	Rank 1998	Rank 2005	1998	2005	Change	Rank 1998	Rank 2005
CEE10	54.5	54.4	−0.1	–	–	46.0	40.6	−5.4	–	–
Bulgaria	26.4	40.4	14.0	7	6	19.4	18.3	−1.1	4	5
Czech Republic	22.8	28.2	5.4	8	9	5.8	6.0	0.2	10	9
Estonia	38.4	42.4	4.0	2	4	6.4	4.8	−1.6	9	10
Hungary	34.1	42.1	8.0	4	5	23.5	22.2	−1.3	2	2
Lithuania	19.1	28.8	9.7	10	8	13.3	17.7	4.4	7	6
Latvia	36.0	42.5	6.5	3	3	26.7	19.6	−7.1	1	4
Poland	31.4	37.4	6.0	5	7	17.5	21.5	4.0	5	3
Romania	28.3	43.4	15.1	6	2	21.1	26.4	5.3	3	1
Slovenia	22.1	26.6	4.5	9	10	9.4	10.6	1.2	8	8
Slovakia	42.9	52.8	9.9	1	1	14.4	17.0	2.6	6	7

Source: Own elaboration based on EUROSTAT data.

Table 5. Regression results for absolute beta convergence analysis in period 1998–2005 (Model A)

	Model 1: $N = 179$ (combined NUTS3 comprising the city and its direct surroundings)			Model 2: $N = 169$ (without capital subregions)		
Country	*N*	Parameter	Significance (*p*-value)	*N*	Parameter	Significance (*p*-value)
CEE10	179	−0.0040	0.071*	169	−0.0067	0.002**
Bulgaria	27	−0.0154	0.431	26	−0.0484	0.014**
Czech Republic	13	0.0249	0.101	12	−0.0192	0.591
Estonia	5	0.0153	0.434	4	−0.0879	0.359
Hungary	19	−0.0034	0.838	18	−0.0219	0.249
Lithuania	10	0.0507	0.017**	9	0.0350	0.137
Latvia	5	0.0082	0.739	4	−0.0385	0.215
Poland	39	0.0240	0.014**	38	0.0269	0.030**
Romania	41	0.0274	0.053*	40	0.0158	0.289
Slovenia	12	0.0302	0.055*	11	0.0230	0.357
Slovakia	8	0.0238	0.054*	7	0.0135	0.620

Source: Own elaboration based on EUROSTAT data.
*Statistical significance at 10% level.
**Statistical significance at 5% level.

To make the initial division into income classes least arbitrary, we used the natural break algorithm and assumed five intervals. This allows the avoidance of a situation of finding high mobility as a result of little changes in income around arbitrarily chosen border values.[4]

In addition, the transition matrix allows the estimation of the long-run evolution of income distribution, called ergodic distribution. In case of convergence analysis, this can be interpreted as a synthetic one-number summary of ongoing processes of convergence or divergence in the analysed period. Convergence will be indicated if in the ergodic distribution the probability mass concentrates in one group of income (average income group). On the other hand, if probability peaks appear in the opposite income classes, there is an indication of GDP *per capita* polarization and convergence of clubs. Given the reduced study period, the ergodic distribution should be interpreted with caution.

High probabilities on the diagonal of transition matrix (Table 6, Model A1) indicate persistence of income distribution and stability of division into groups—the highest for the poorest regions (80–90% of them stay poor) and among the richest.

With respect to the whole macroregion (Model A1), one can observe some indications of diminishing differences and becoming similar among all regions with respect to income level (high probabilities for income groups close to the average level in ergodic vector). However, this is rather a process of becoming more homogeneous for the group of widely understood average regions, linked with generally becoming relatively poorer ("equalizing downwards").

It results from the existence of relatively small but stable group of richest regions, which face fastest growth. On the other end of the distribution, there is an even more stable group

Table 6. Dynamics of the distribution of relative GDP *per capita* in 1998–2005 (% means probabilities of moving between groups)

(a) Model (A1) CEEC = 100 ($N = 179$)					
Initial	Final group				
	Group 1 (≤48%)	Group 2 (48%; 63%]	Group 3 (63%; 84%]	Group 4 (84%; 182%]	Group 5 (>182%)
Group 1 (54)	83%	15%	2%	0%	0%
Group 2 (16)	19%	44%	38%	0%	0%
Group 3 (22)	0%	14%	64%	23%	0%
Group 4 (71)	0%	3%	20%	76%	1%
Group 5 (16)	0%	0%	0%	31%	69%
Ergodic	16%	14%	34%	34%	2%
(b) Model (B1) country = 100 ($N = 179$)					
	Group 1 (≤71%)	Group 2 (71%; 84%]	Group 3 (84%; 101%]	Group 4 (101%; 114%]	Group 5 (>114%)
Group 1 (21)	90%	10%	0%	0%	0%
Group 2 (61)	41%	49%	8%	0%	2%
Group 3 (55)	9%	38%	51%	2%	0%
Group 4 (17)	0%	12%	29%	47%	12%
Group 5 (25)	0%	0%	16%	16%	68%
Ergodic	78%	17%	3%	0%	1%
(c) Model (A2) CEEC = 100 ($N = 169$)					
	Group 1 (≤45%)	Group 2 (45%; 63%]	Group 3 (63%; 84%]	Group 4 (84%; 211%]	Group 5 (>211%)
Group 1 (50)	78%	22%	0%	0%	0%
Group 2 (19)	11%	58%	32%	0%	0%
Group 3 (21)	0%	14%	67%	19%	0%
Group 4 (68)	0%	3%	21%	76%	0%
Group 5 (11)	0%	0%	0%	82%	18%
Ergodic	10%	20%	39%	31%	0%
(d) Model (B2) country = 100 ($N = 169$)					
	Group 1 (≤71%)	Group 2 (71%; 82%]	Group 3 (82%; 101%]	Group 4 (101%; 114%]	Group 5 (>114%)
Group 1 (21)	90%	10%	0%	0%	0%
Group 2 (53)	45%	43%	11%	0%	0%
Group 3 (63)	10%	29%	59%	2%	2%
Group 4 (17)	0%	12%	29%	47%	12%
Group 5 (15)	0%	0%	27%	27%	47%
Ergodic	79%	16%	5%	0%	0%

Source: Own elaboration based on EUROSTAT data.

of the poorest regions, which also do not take part in the convergence process. Therefore, although the distribution of GDP *per capita* becomes more homogeneous for most regions, the persistence of richest and poorest groups of regions leads to the conclusion that for CEE countries the only pattern of convergence on the regional level is convergence of clubs.

As far as within-country analysis is concerned (Model B1), fast growth mainly of the richest capital regions but also other relatively rich metropolitan areas causes within-country disparities to increase much faster than dispersion between countries. It results in strong polarization of regions in terms of GDP *per capita* (extremely asymmetric distribution in an ergodic vector and concentration of the probability in the poorest regions group).

The exclusion of capital subregions (Models A2 and B2) does not significantly affect the final results. This indicates that there are also other rich regions except capital regions that have been developing relatively fast in the CEECs. As a result, regional divergence and polarization is observed in given countries, because the highest probability of ergodic vector is concentrated in the poorest group. The continuation of this tendency would cause only 20% of regions to have GDP *per capita* higher than 80% of average and only a few were above average.

Kernel Density Estimation

Kernel density estimator (KDE) can be perceived as a continuous generalization of the transition matrix with infinite number of rows and columns. Kernel density estimation deals with estimating an unknown density function for a random variable based on finite number of observations of that variable. KDE is a continuous analogue to histogram. The value of density function at some point is calculated as relative frequency of observations in the neighbourhood of that point. The neighbourhood is called estimation bandwidth (window) and relative frequency is estimated based on some known density function, called kernel function.

The choice of kernel function does not have much impact on the results of estimation. The crucial element is a bandwidth selection—there are special procedures and formulas to calculate optimal bandwidth for different kernel functions—one can find it, for example, in Silverman (1986). We use these procedures to calculate optimal bandwidth for Gaussian kernel function.

Analysis of mobility of regions with respect to relative GDP *per capita* using kernel density estimation corroborated results from transition matrices. One can observe very strong stability of relative income within countries (Figure 1), indicated by concentration of the density figure along the diagonal in all analysed dimensions.

In relation to GDP *per capita* for the group of 10 CEE countries (Model A1), one can observe clear indications of convergence for separate groups of regions. Tendencies of income convergence can be observed mainly among the richest regions (above 200% of the average GDP *per capita*) and separately for the poorest (extreme ends of the distribution are placed parallel to the horizontal axis of initial income). This indicates that the only observed pattern of convergence is the convergence of clubs.

The next model (B1) indicates that the richest and other relatively rich regions are clearly distinguished (separate peaks of the distribution around 150% and 250% of relative GDP *per capita*) and form distinct clubs, although convergence tendencies within these groups are rather weak. They rather constitute separate "welfare islands", which, in addition, by growing faster than average cause widening of disparities within countries. Tendencies of within-country convergence can be observed only for the poorest group of regions (a horizontal shape of high-density region under 60% of 2005 income). Within-country distribution analysis (Model B1) indicates much stronger persistence and lower mobility of regions than in the case of relation to income level for all analysed countries (Model A1).

The exclusion of capital subregions leads to a slight convergence between the rest of the regions in Model B2. This seems to be a club convergence, because only extreme ends of

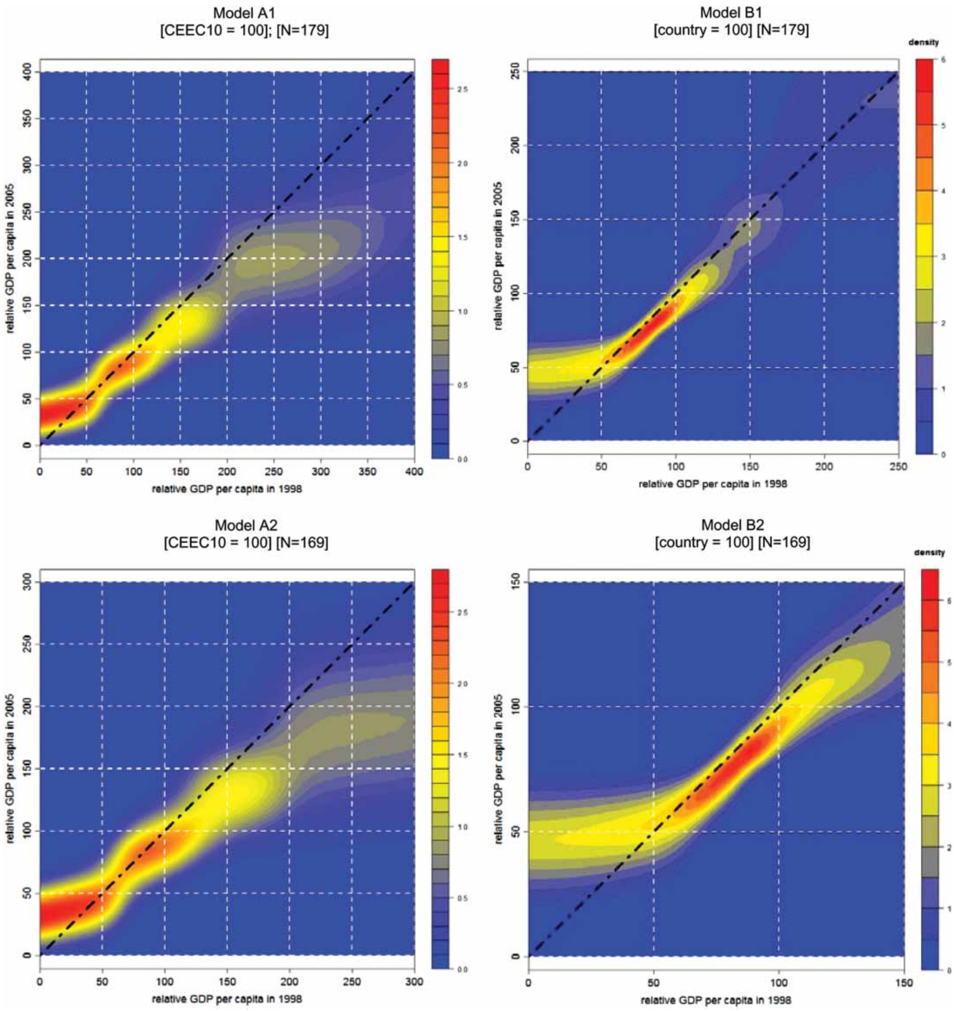

Figure 1. Dynamics of the distribution of GDP *per capita* in 1998–2005 (kernel density estimate, 179 regions).
Source: Own elaboration based on EUROSTAT data.

the distribution are placed parallel to the horizontal axis. Nevertheless, the regions from the range 60–110% of average income are still very stable. On the contrary, the conclusions from Model A2 are the same as from Model A1, i.e. extreme groups of regions—over 200% of average and less than 50% of average, but also midrange regions—tend to converge.

Spatial Autocorrelation

Another method used in the analysis of regional convergence is spatial autocorrelation (ESPON, 2005). In short, this method relates the intensity of the phenomenon of interest in the analysed regional unit to its intensity in surrounding units (Aneselin, 1988). It allows to account for regularities of the analysed indicator in space. The global Moran's *I* statistic is used, that ranges from −1 to 1. Positive values of that statistic indicate the tendency of spatial clustering of units with similar values as the analysed indicator. On the other hand, negative *I* values show that units with different values from the analysed indicator are close to each other in space, which might be interpreted as an indication of higher dispersion and polycentrism of the phenomenon of interest. Moran's *I* close to 0 means random distribution of the analysed phenomenon in space, i.e. its spatial entropy. On the other hand, to point out the most important clusters of regional units one can use local indicators of spatial interaction (LISA). As a result, one can identify the most important areas with positive spatial autocorrelation of type: HH (clusters of units with high values—high values surrounded by high values) and LL (clusters of units with low values—low values surrounded by low values), and also with negative autocorrelation of type HL (so called hot spots—high values surrounded by low values) and LH (so called cold spots—low values surrounded by high values)—describing regional units different from their neighbourhood with respect to the analysed indicator.

The results of the analysis are presented only for all 179 regions (Model 1) as excluding capital regions would distort continuity of economic space. We tested different spatial weight matrixes presenting results for $k = 6$ neighbours which relatively well reflects regional pattern based on NUTS3 regions.[5] Table 6 allows the observation of a decrease in spatial dependence for the whole macroregion with respect to the level of development expressed in GDP *per capita* in euro. This was caused by previously mentioned fast growth of Baltic States, but also Romania and Bulgaria, with simultaneous appreciation of their local currencies. However, one should mention that the level of spatial concentration and separation of high and low developed areas was still quite high. On the other hand, values relative to country average indicate high extent of polycentrism of the CEE macroregion. Development centres of individual countries were separated from each other by less-developed areas, which resulted in the lack of statistical significance of Moran's *I* statistic and indicated random location of growth poles (Table 7).

At the same time, in the CEE macroregion one could observe polarization processes (both in Models A and B), manifested by spatial concentration of growth dynamics. This meant that regions surrounded by faster-growing regions also tended to grow faster (strong influence of regions from the Baltic States) and inversely slow development of neighbouring regions led to the arising of macroregions with low dynamics of growth

Table 7. Values of Moran's *I* statistic—spatial autocorrelation (for *k* neighbours = 6) [$N = 179$]

Indicator	Model A Real values (EUR; %)	Model B Relativized values1 (each country = 100)
GDP *per capita* 1998	0.8281**	*−0.0035*
GDP *per capita* 2005	0.6364**	*0.0171*
GDP growth in years 1998–2005	0.1723**	0.0729*
GDP growth in years 1998–2005 versus GDP *per capita* 1998	*−0.0402*	*0.0369*

Source: Own elaboration based on EUROSTAT data. *Italics*, statistically non-significant.
*Statistical significance at 5% level.
**Statistical significance at 1% level.

(mainly in Romania and Bulgaria). This may be the evidence for some, but rather low impact of regional surroundings on growth processes. On the other hand, one could point out clearly contrary examples, indicating barriers to diffusion in growth processes. The best examples are seaside areas of Bulgaria and Romania, which grew much faster than the adjoining regions. A similar situation was observed for eastern regions of Hungary and Poland, where existing development centres (larger cities) were surrounded by areas with low growth dynamics.

However, the impact of the level of development of the regional neighbourhood on the growth dynamics of individual regions seemed not to be statistically significant as the whole CEE macroregion is concerned. At the local level (Figure 2), one could observe a lack of this impact in case of Bulgaria and Romania, where some regions grew fast, despite low level of development. On the other hand, part of less-developed regions noted very low growth dynamics, which led to the increased polarization of the socio-economic space of these countries. A similar situation was observed in eastern Poland. The lack of the influence of regional neighbourhood was also visible in Czech Republic,

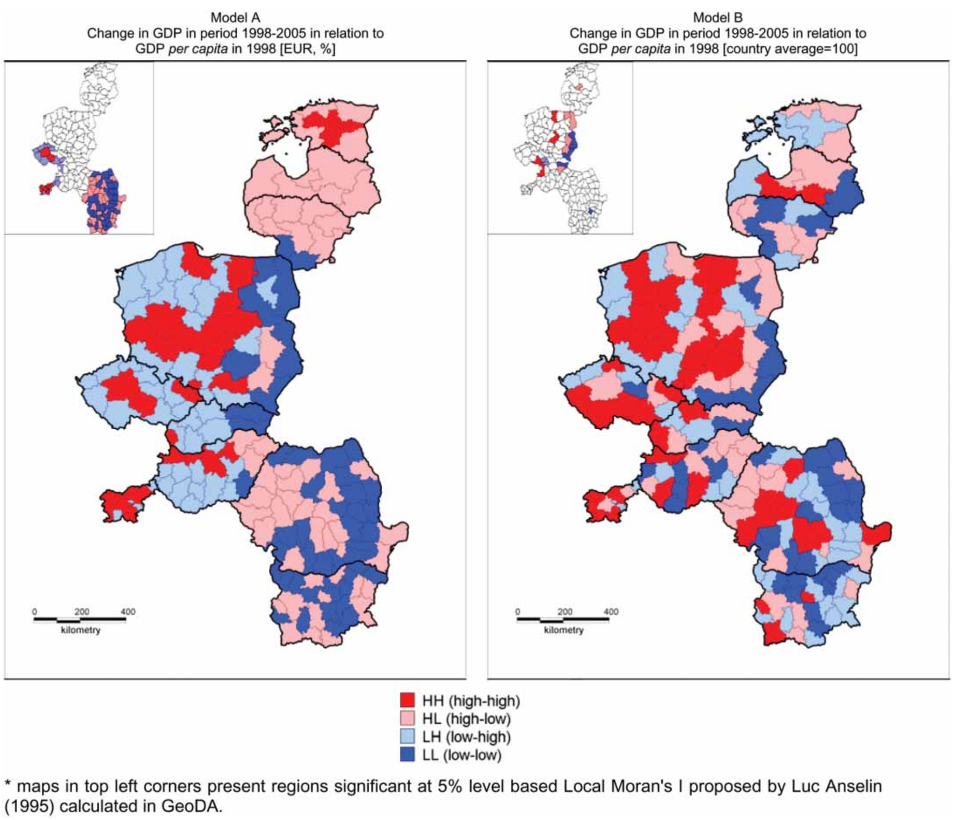

Figure 2. Spatial regimes—growth dynamics versus level of development based on Moran's scatterplot (quadrants) and bivariate local Moran *I* statistics.

Source: Own elaboration based on EUROSTAT data.

Note: Maps in top left corners present regions significant at 5% level based Local Moran's *I* proposed by Anselin (1995) calculated in GeoDA.

Poland, Slovakia, Hungary and Slovenia—as a result of fast growth of metropolitan centres, in particular when compared to relatively low development level of their regional surroundings. It was not that apparent in the case of the Baltic countries, due to very high growth also at the country level, additionally strengthened by the effect of low base. However, also in these countries one could indicate less-developed regions with lower growth dynamics.

Model A enables us to identify significant differences between the well-developed western part and the less-developed eastern part of the CEECs macroregion. There are several main growth poles (HH) besides capital regions, sometimes in the form of a development axis like in Hungary—regions from Budapest to the Austrian border, in the western part of the macroregion. On the other hand, in the eastern part of the macroregion, there is a clear division between rapidly growing regions (HL) (usually large cities, industrial districts and costal regions) and backwarded regions (LL) situated along the external border of the EU and in the Romania–Bulgaria borderland. On the contrary, Model B enables us to indicate national growth poles (HL) that are also situated in less-developed provinces. These centres are quite often surrounded by lagging and stagnating regions—the situation was typical for the south-eastern part of Poland, which may partly be due to various barriers to growth (like economic structure differences or insufficient transport infrastructure).

Conclusions

In Central and Eastern Europe in the period 1998–2005, one could observe relatively weak regional convergence. The regions with lower initial level of GDP *per capita* have been growing slightly faster than better-developed regions. The sigma convergence process has been observed especially in case of exclusion of capital subregions from the analysis. This was primarily a result of different motions of development of regions from particular countries at different stages of economic transformation. On the one hand, one could observe fast economic growth of less-developed countries (Baltic States—fast development linked with economic liberalization; Bulgaria, Romania—catching up on arrears arising from the late introduction of the restructurization processes). On the other hand, richer countries like Slovenia, Czech Republic, Hungary or Poland that are more advanced in the restructurization processes faced slower development, especially in some regions. As a result, for the whole set of regions, convergence processes have been prevailing.

In most countries, one could observe weak tendencies of polarization of development processes, but in smaller countries, the situation was rather stable. Leading regions, besides capital regions, included other large cities (especially in countries with polycentric structure). This indicates that the important role in the regional development processes is played by metropolization, linked with change in the development paradigm and a move from industrial to information economy. On the other hand, in most countries one can indicate problem areas, characterized by very low rate of growth or even economic stagnation. Most often, these are agricultural regions, in particular located at the external, eastern border of the European Union and also along hard-to-cross physical-geographical internal borders (for example, Danubian borderland of Romania and Bulgaria). The regional divergence caused by these processes was especially visible in Poland, Romania and Lithuania and also Slovakia and Slovenia, but the last belong to the group of countries facing very low differences in level of income between regions. However, the exclusion of capital regions leads to the observation of regional convergence in some countries like Bulgaria, Latvia and Estonia.

The transition matrices and density estimation analysis show very strong stability of relative income within countries in relation to both the average of CEECs and country averages. Stability was the highest for separate groups of the richest and the poorest regions. For these groups, convergence has been observed, while in case of all regions, convergence processes do not take place. The differences in the level of GDP *per capita* have been decreasing as a result of regional mobility towards the average in the macroregion. However, two groups mentioned above remained relatively stable, which led to growing polarization within countries.

The spatial autocorrelation analysis indicates that regional development in CEECs follows a polycentric pattern consisting of separate development centres. It is a result of metropolization processes that lead to the development of growth poles in close proximity to the largest cities. These relatively rich regions have been developing rapidly, which led to increase of regional disparities and strengthened polarization effects. On the extreme end, one can observe the poorest regions, especially agricultural ones, that also converge, but in a condition of very low growth rate that increases the economic distance to other regions. The spatial structure within countries also plays an important role in the development process, i.e. dynamically growing regions might positively affect surrounding regions and on the contrary slow growth might reduce development in neighbouring areas. However, some examples of barriers to trickling down effects might also be provided resulting in lack of economic interdependence between metropolitan areas and surrounding regions (Gorzelak and Smętkowski, 2008).

All processes mentioned above lead to separate club convergence among the richest (metropolitan areas) and poorest regions (agricultural regions). The income mobility in the remaining group was relatively higher. However, the reasons behind this process are difficult to find based on the presented analysis and would require further studies devoted to identification of the other development factors that shape economic space in this part of Europe.

This paper describes the dynamics of regional development in the context of relatively fast economic growth. We should remember that this is a relatively short period of time which requires that the empirical results need to be treated with some caution. Furthermore, in the next couple of years the situation will be very strongly influenced by the expected economic slow-down or even a recession, which has already been felt by some of the fast-growing countries in the region, such as Estonia or Latvia, and countries with an excessive budget deficit (Hungary). On the other hand, in the coming years one should observe the first effects of using the European Union structural funds.

Notes

1. The detailed description of the methodology can be found in Quah (1996) or Wójcik (2004).
2. In case of linear regression for spatial data, the assumption of independence of error terms might not be satisfied, which requires a different approach. Here, regression residuals are spatially correlated for both 179 and 169 regions' analyses (significant global Moran's *I* statistic). However, that finding does not change the conclusions—on 5% significance level conclusions concerning convergence (sign and significance of beta parameter) are identical when Spatial Lag Model or Spatial Error Model is used—detailed results available upon request.

3. Romania was the only country with spatially autocorrelated error terms from beta convergence regression. Using Spatial Lag Model or Spatial Error Model did not change the conclusions about sign and significance of convergence parameters for that country.
4. We also estimated transition matrices for group borders based on the quintiles of the initial distribution. The results were very much alike.
5. The results are quite similar and robust regardless of investigated spatial weight matrix. The main difference is the higher value of Moran's *I* statistics by ca. 0.12 pp in case of GDP dynamics (Models A and B) for matrix elaborated on the basis of first-order contiguity that indicates higher significance of positive spatial autocorrelation. Detailed results are available upon request.

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