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Regional disparities in the European Union and the enlargement process: an exploratory spatial data analysis, 1995–2000

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Abstract The aim of this paper is to study the space–time dynamics of European regional per capita gross domestic product (GDP) in the perspective of the enlargement of the European Union using exploratory spatial data analysis. We find strong evidence of global and local spatial autocorrelation as well as spatial heterogeneity in the distribution of regional per capita GDP in a sample of 258 European regions including regions from acceding and candidate European countries over the period 1995–2000. However, contrary to previous results obtained in the literature highlighting a North–South polarization scheme, the enlargement process leads to a new North–West–East polarization scheme. The economic dynamism of EU15 regions and acceding or candidate regions is also investigated by exploring the spatial pattern of regional growth. Implications for regional development and cohesion policies are finally suggested.

JEL Classification O18 · O47 · O52 · R11 · R12

1 Introduction

The European enlargement process to Central and Eastern European countries as well as to Malta and Cyprus in 2004 (EU25) and then to Bulgaria and Romania in 2007 (EU27) poses a previously unprecedented challenge to both regional and social cohesion policies in the European Union (EU). The EU will actually have to

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face a substantial widening of economic disparities as well as a modification of the relative spatial distribution of wealth.

This geo-economic challenge can be illustrated with the following figures. First, as highlighted in the European Commission (2004) and the European Commission (2003), the enlargement will induce an increase of about 30% of the total European area and an increase of more than 25% of the population, whereas at the same time, GDP will increase by only 5% in purchasing power standards (PPS). Second, a new group of States will emerge in the enlarged Union: those with income of less than 40% of the EU average. The center of gravity of cohesion policy will also shift to Eastern Europe. Finally, regional inequalities will substantially increase as the ratio between the richest and the poorest region was about one is to five for EU15 in 2000, while it will be of one is to nine in EU25 and one is to 13 in EU27.

Moreover, the enlargement process will seriously complicate the implementation of the future European regional policy in 2004 and then in 2007. It will be necessary not only to contribute to the development of the regions most in need in the new Member States but also to continue providing assistance for the enduring difficulties in the presently lagging behind regions in EU15. Several propositions have been made to the European Commission to give an answer to these new problems. However, it may seem surprising that the spatial dimension of the distribution of regional disparities in the enlarged EU has been neglected. Trade between regions or countries, technology and knowledge diffusion, and more generally local externalities and spillovers involve spatially dependent regions or countries. Conley and Ligon (2002) develop an empirical approach that explicitly allows for interdependence among countries, and they underline the importance of cross-country spillovers in explaining growth using an international data set. In addition, Ertur and Koch (2005) develop a theoretical framework which includes technological interdependence in a spatially augmented Solow model.

Spatial dependence or autocorrelation can be defined as the coincidence of value similarity with locational similarity (Anselin 2001). Therefore, there is positive spatial autocorrelation when high or low values of a random variable tend to cluster in space, and there is negative spatial autocorrelation when geographical areas tend to be surrounded by neighbors with very dissimilar values. Another spatial effect that is of interest in this framework is spatial heterogeneity, which means that economic variables are not stable across space and that polarization or stratification patterns may be relevant under the form of spatial regimes: a cluster of poor regions contrasting with a cluster of rich regions.

Spatial interactions between regions can be evaluated using exploratory spatial data analysis (ESDA), which is a set of techniques aimed at describing and visualizing spatial distributions, at identifying atypical localizations or spatial outliers, at detecting patterns of spatial association, clusters or hot spots, and at suggesting spatial regimes or other forms of spatial heterogeneity (Haining 1990; Bailey and Gatrell 1995; Anselin 1998a,b). These methods provide measures of global and local spatial autocorrelation. Rey and Montouri (1999) apply these spatial tools to US State data on per capita income throughout the period 1929–1994, and Ying Long (2000) analyzes growth rates of production in the Chinese provinces since the late seventies using ESDA. They all find strong evidence in favor of spatial autocorrelation. Armstrong (1995), López-Bazo et al. (1999, 2004) and Le Gallo and Ertur (2003) also apply these spatial tools to European regional data on per capita GDP and growth rates and reach analogous conclusions. However, their concern is not the European enlargement process, hence, the samples used are limited at best to the 12 first acceding countries and the different time periods studied end at best in 1996. Hence, they do not take into account new Central and Eastern European member States and candidate countries.

In this paper, using an extended EU27 sample of 258 European regions including regions from acceding and candidate European countries over the period 1995–2000, we find strong evidence in favor of both global and local spatial autocorrelation for per regional capita GDP in the enlarged EU. Furthermore, we also show that accession of Central and Eastern European countries disturbs the previous North–South polarization pattern of the EU. The geographical dynamics of EU15 was indeed dominated by an increasing clustering of population and wealth in a central area delimited by North Yorkshire (UK), Franche-Comté (France), and Hamburg (Germany), known as the core. In the enlargement context, this previous North/South polarization pattern is replaced by a new North–West/East pattern in EU27.

Therefore, in our opinion, the geographic localization and spatial environment of each region have indeed to be taken into account when analyzing economic disparities at a regional scale and also for the implementation of efficient regional policies.

In the next Section, the economic and social cohesion policies implemented by the European Commission are presented, and some new orientations made in the context of the enlargement process are discussed. In Section 3, data and the spatial weight matrix used in the ESDA are briefly presented. The results for global and local spatial autocorrelation for the distribution of the levels of regional log per capita GDP are presented and compared in Section 4 for the 1995–2000 period using two samples: 203 regions for EU15 and 258 regions for EU27. Results for average growth rates for the same samples are then presented in Section 5. Some implications for regional development and cohesion policies are finally suggested in the conclusion.

2 The European regional and cohesion policies

2.1 Structural Funds

The aim of the EU is to promote economic and social progress and to gradually eliminate regional differences in standards of living. In this respect, Objective 1 of the Structural Funds is the main priority of the EU's cohesion policy. In accordance with the treaty, the Union works to "promote harmonious development" and aims particularly to "narrow the gap between the development levels of the various regions". This is why more than two thirds of the appropriations of the Structural Funds (more than EUR 135 billion) are allocated to helping areas lagging behind in their development ("Objective 1") where the GDP is below 75% of the Community average in PPS.

Puga (2002) underlines the fact that if a similar criterion was applied to the United States, only two States (Mississippi and Virginia) would have been eligible, that is to say that only 2% of the total population would have been concerned. In contrast, following the European Commission (2003), 48 regions from current

Member States, accounting for 18% of EU15 population (68 million), had income below 75% of the EU15 average per capita (in PPS) in 2000. This indicates the weakness of the regional cohesion in the EU compared to the United States. The inequality between regions increases with the enlargement process as a total of 67 regions in EU25 will fall below the 75% threshold, representing 26% of total population (116 million). The accession of Bulgarian and Romanian regions after 2007 is likely to widen still more this inequality. In the face of this new configuration, the question is to decide if the EU must maintain or not the same regional policy goals.

However, the results of the cohesion policy are very uneven and very difficult to evaluate precisely. Methodological problems are raised when trying to get evidence of the efficiency of Structural Funds in regard with regional development (Fayolle and Lecuyer 2000). Assume that the allocation of structural funds are strongly related to the initial lag in development of each region, measured by initial per capita GDP, and that convergence reflects an actual and strong catch-up of lagging behind regions: how could we discriminate between what is due to structural funds and what is due to more general factors? Thus, catching up will seem to be correlated to the allocation of structural funds but these would neither necessarily explain the catching up process nor that we could exclude that catching up regions would anyway catch up even without receiving any structural funds.

However, it is possible to conclude that regional cohesion policies implemented since 1989 by the European Commission have failed. There is actually strong empirical evidence in favor of persistence of regional inequalities and in favor of North–South polarization in the EU (Armstrong 1995; López-Bazo et al. 1999; Boldrin and Canova 2001; Le Gallo and Ertur 2003). Moreover, from the theoretical perspective, Martin (2000) shows that the economic argument that underlies the European regional policy is rather unclear. The European political decision-makers, at the national and regional levels, have put too much faith in regional policies: reducing regional inequalities and increasing economic efficiency at the national and European level seem to be two contradictory goals. In addition, the local decision-makers are looking for a short-term, positive impact via demand and a long-term, positive impact via supply. The first effect too strongly influences the debate on regional policies, whereas the long-term infrastructure investment choices, which aim to impact the European economical geography, should be more seriously taken into account.

This suggests the urgent necessity of redefining the regional policy goals and tools in the context of the enlarged EU.

2.2 The statistical effect of the enlargement process

The strong regional inequalities in the EU do not seem to be significantly reduced by the European cohesion policy. Furthermore, the situation gets even more complicated because of the enlargement process as the social and economic cohesion challenge becomes more obvious and moves to the Eastern Europe.

Following the European Commission (2003), the European cohesion policy faces a “statistical effect”, i.e., the 13% fall in average per capita GDP in the Community as a result of the accession of ten new Member States and 18% fall for the enlargement to 27 countries, affecting the eligibility under Objective 1 of the

Structural Funds. In 2000, 48 regions from current Member States, accounting for 18% of EU15 population, had income below 75% of the EU15 average per capita (in PPS)—the current eligibility threshold for Objective 1 support. In an enlarged Union of 25, a total of 67 regions will fall below the 75% threshold, representing 26% of total population. From current Member States, only 30 regions will have income below the 75% threshold when compared to the average income for the EU25 (which is 13% lower), accounting for 12% of the current EU15 population. In an enlarged EU27 (where average income is 18% lower than for the EU15), only 18 regions from the current Member States would qualify, representing 6% of EU15 population.

2.3 The future of regional and cohesion policies

The debate on the future of European regional and cohesion policies goes beyond the design of new financial mechanisms and impacts the foundations of the European project. This is the reason why the European Commission initiated a large debate, which is still intense.

The conclusions and recommendations of the European Commission (2002a,b) state that cohesion policy in relation to lagging regions could take one of the following four forms:

– The application of the present threshold of 75% irrespective of the number of countries joining the Union. This option on its own would eliminate a large number of regions in EU15. Their future eligibility for EU support would depend on the priorities and criteria for support outside the least-developed regions.
– The same approach. But where all regions above this threshold currently eligible under Objective 1 should receive temporary support (phasing out), the higher the level, the closer their GDP to the eligibility threshold. Two levels of temporary support could be envisaged: one for regions which, because of the extent of their convergence at the end of the 2000–2006 period, would no longer be regarded as having lagging development in an EU15; the other, set at a higher level, for those which would have been below the 75% threshold without enlargement.
– The setting of a GDP per head threshold higher than 75% of the average, at a level which would reduce or even eliminate the automatic effect of excluding those regions in the EU15 simply because of the reduction in the average EU GDP per head after enlargement. It should also, however, be set at a level which excludes those regions which would no longer qualify at the end of the current programming period in an EU15 without enlargement.
– The fixing of two thresholds of eligibility, one for the regions in EU15 and one for the candidate countries, and leading de facto to two categories of lagging region. This could have a similar result to the previous solution in financial terms in a situation where the aid intensity per head from Union funds is related to regional prosperity.

The enlargement process is thus seriously complicating the implementation of regional policies. The EU is facing an unprecedented increase in the disparities, and there is a broad consensus on the long-term nature of the efforts that will be needed to reduce them as well as around the need to continue to concentrate resources on the less-developed regions, and especially on those in the new Member States. On how to define the less-developed regions, the contributions to the debate have not seriously put into question the continued use of the present eligibility criteria based on the NUTS2[1] geographical level and per capita GDP – which has the merit of being simple and transparent – even if some contributions have called for other criteria to be added.

It must be stressed that all this debate is based on the implicit hypothesis of absence of spillover effects and spatial externalities between regions, or in other terms, absence of spatial correlation. Our opinion is that this implicit hypothesis should at least be tested. Therefore, our contribution to this debate is to advocate the use of spatial criteria along with economic criteria and to study the spatial distribution of regional disparities in the enlarged EU using ESDA. Our aim in this paper is then to show that the spatial distribution of wealth is indeed spatially autocorrelated. The geographic localization and the spatial environment of each region relative to its neighbors must be taken into account in the design and implementation of regional and cohesion policies in the enlarged EU.

3 Data and spatial weight matrix

We use regional per capita GDP measured in PPS over the period 1995–2000 extracted from the Eurostat-Regio database (see Appendix A for more details).[2] To highlight the impact of the enlargement process of the EU to Eastern and Central European countries on the spatial distribution of income, we compare the ESDA results obtained on a sample of 203 NUTS2 European regions belonging to EU15 with those obtained on a sample of 258 European regions belonging to EU27 as predicted by the enlargement process.

To model spatial interactions, we need to specify the spatial connectivity between each region in our sample. The spatial weight matrix is the fundamental tool used to represent the spatial connectivity between regions. More precisely, each region is connected to a set of neighboring regions by means of a *purely spatial pattern* introduced *exogenously* in this spatial weight matrix **W**. This matrix is a square matrix with as many rows and columns as there are regions in the sample (the number of regions is denoted by N). The elements w_{ij} on the diagonal are set to zero whereas the elements w_{ij} indicate the way the region i is spatially connected to the region j. These elements are *non-stochastic*, non-negative, and finite. To normalize the outside influence upon each region, the weight matrix is standardized such that the elements of a row sum up to one. The spatial weight matrix **W** we use in this study is based on the k-nearest neighbors computed from the great circle distance between region centroids as in Le Gallo and Ertur (2003).

1 French acronym for Nomenclature for Territorial Statistical Units used by Eurostat.

2 All computations have been realized by means of SpaceStat 1.90 (Anselin 1999) and GeoDa 1.93 (Anselin 2003). Maps and figures have been realized using Arcview 3.2 (ESRI).

The general form of the k-nearest neighbors weight matrix $\mathbf{W}(k)$ is defined as follows:

$$\begin{cases} w_{ij}^*(k) = 0 \text{ if } i = j \\ w_{ij}^*(k) = 1 \text{ if } d_{ij} \leq d_i(k) \quad \text{and } w_{ij}(k) = w_{ij}^*(k) \Big/ \sum_j w_{ij}^*(k) \\ w_{ij}^*(k) = 0 \text{ if } d_{ij} > d_i(k) \end{cases} \tag{1}$$

where $d_i(k)$ is a critical cut-off distance defined for each region i. More precisely, $d_i(k)$ is the k^{th} order smallest distance between regions i and j such that each region i has exactly k neighbors. We use in this paper the ten nearest neighbors spatial weight matrix and we check for robustness.

4 Statistical results for regional per capita GDP

4.1 Global spatial autocorrelation

The measurement of global spatial autocorrelation is usually based on Moran's I statistic (Cliff and Ord 1981; Upton and Fingleton 1985). For each year of the period 1995–2000, this statistic is written in the following matrix form:

$$I_t = \frac{n}{S_0} \cdot \frac{z_t' W z_t}{z_t' z_t} \quad t = 1, \ldots, 6 \tag{2}$$

where $\mathbf{z_t}$ is the vector of the n observations for year t in deviation from the mean. $\mathbf{W}$ is the spatial weight matrix. S_0 is a scaling factor equal to the sum of all the elements of $\mathbf{W}$. For row-standardized spatial weights, $S_0 = n$ and expression Eq. 2 consequently simplifies.

Moran's I statistic gives a formal indication of the degree of linear association between the vector $\mathbf{z_t}$ of observed values and the vector Wz_t of spatially weighted averages of neighboring values, called the spatially lagged vector. Values of I larger (resp. smaller) than the expected value $E(I) = -1/(n-1)$ indicate positive (resp. negative) spatial autocorrelation. Statistical inference is based on the permutation approach with 10,000 permutations (Anselin 1995).

Table 1a,b displays the values of the Moran's I statistic, using ten nearest neighbors spatial weight matrix, for log per capita regional GDP for the initial period 1995 and the final period 2000 and for the EU15 sample of 203 regions and the extended EU27 sample of 258 regions.

It appears that per capita regional GDPs are positively spatially autocorrelated because the statistics are significant with p=0.0001 for each year and each sample.

Table 1a Moran's I statistics for log per capita GDP (PPS) in 1995 and 2000 for EU15

Year	Moran's I	Mean	Standard deviation	Standardized values	p-values
2000	0.3909286	−0.005	0.028345	13.968	0.0001
1995	0.4487649	−0.005	0.028381	15.988	0.0001

Table 1b Moran's I statistic for log per capita GDP (PPS) in 1995 and 2000 for EU27

Year	Moran's I	Mean	Standard deviation	Standardized values	p-values
2000	0.7008471	−0.004	0.025473	27.670	0.0001
1995	0.7092094	−0.004	0.025436	28.039	0.0001

This result suggests that the distribution of per capita regional GDP is by nature clustered over the whole period. In other words, the regions with relatively high per capita GDP (resp. low) are localized close to other regions with relatively high per capita GDP (resp. low). Considering the evolution of Moran's I statistic over time shows that the standardized values of the statistic remain approximately the same throughout the period whatever the sample considered. It thus indicates a globally significant tendency toward geographical clustering of similar regions in terms of log per capita GDP. These results are robust with regard to the choice of the spatial weight matrix.[3]

Moran's I statistic is a global statistic and does not allow to assess the local structure of spatial autocorrelation. However, it may be asked whether there are local spatial clusters of high or low values, which regions contribute more to the global spatial autocorrelation, and to what extent the global evaluation of spatial autocorrelation masks atypical localizations or "pockets of local nonstationarity". In this respect, local spatial autocorrelation is analyzed with three tools: the $G_i(d)$ statistics Getis and Ord (1992) and Ord and Getis (1995), the Moran scatterplot (Anselin 1996), and local indicators of spatial association "LISA" (Anselin 1995).

4.2 Getis–Ord statistics and local clustering

Since Moran's I yields a single result for the entire data set, it cannot discriminate between a spatial clustering of high values and a spatial clustering of low values in the case of a global positive spatial autocorrelation. Getis and Ord (1992) and Ord and Getis (1995) suggest the use of the $G_i(d)$ statistic to detect local "pockets" of dependence that may not show up when using global statistics. This statistic for each region i and year t can then be written as following (Getis and Ord 1992):

$$G_{i,t}(d) = \sum_{j \neq i} w_{ij}(d) x_{j,t} \Big/ \sum_{j \neq i} x_{j,t} \tag{3}$$

where $w_{ij}(d)$ are the elements of a symmetric binary spatial weight matrix equal to 1 for all links within distance d of a given region i and equal to 0 for all other links including the link of region i to itself. The variable x has a natural origin and is positive. Once standardized, a positive value of $G_i(d)$ indicates a spatial cluster of *high* values, whereas a negative value indicates clustering of *low* values around region i. This statistic has been extended to variables that do not have a natural

[3] Complete results for k=15, 20, 25 nearest neighbors are available from the authors upon request.

Table 2a Getis–Ord G_i statistics for log per capita GDP (PPS) in 1995 and 2000 for EU15

Years	Percentage of significant statistics at 5% significance level	Percentage of positively significant statistics at 5% significance level	Percentage of negatively significant statistics at 5% significance level	Percentage of significant statistics at Sidàk's pseudo-significance level	Percentage of positively significant statistics at Sidàk's pseudo-significance level	Percentage of negatively significant statistics at Sidàk's pseudo-significance level
2000	34.98%	20.20%	14.78%	16.75%	5.42%	11.33%
1995	37.93%	22.17%	15.76%	15.76%	4.93%	10.84%

origin and to nonbinary standardized weight matrices (Ord and Getis 1995) and has the following expression:

$$G_{i,t}(d) = \frac{\sum_{j \neq i} w_{ij}(d)x_{j,t} - W_i\mu_t}{\sigma_t\{[(n-1)S_{1i} - W_i^2]/(n-2)\}^{1/2}}, \quad j \neq i \tag{4}$$

where $W_i = \sum_j w_{ij}$ and $S_{1i} = \sum_j w_{ij}^2$ for $j \neq i$. μ_t and σ_t are the usual sample mean and standard deviation for the sample of size $n-1$ excluding region i for year t. The sign of this statistic is interpreted in the same way as the preceding one.

These statistics are based on spatial accumulations and can thus help to deepen the analysis for detecting spatial clusters around each region i without being affected by the value taken by the variable in that region i.[4] Moreover, they may help reveal problems with the spatial scale of the observational units by incrementing d.

Statistical inference is based on the normal asymptotic approximation as suggested by Ord and Getis (1995) even though they concede there might be a problem in the presence of global spatial autocorrelation (pp. 298–299 in Ord and Getis 1995). Inference is further complicated by the fact that these local statistics will be correlated when the neighborhood sets of two regions contain common elements (Ord and Getis 1995; Anselin 1995). This is actually a problem of multiple statistical comparison.[5] When the *overall* significance associated with the multiple comparisons (correlated tests) is set to α, and there are m comparisons, then the individual significance α_i should be set to α/m (Bonferroni) or $1-(1-\alpha)^{1/m}$ (Sidák). The second procedure requires the variables to be multivariate normal, which is asymptotically the case for $G_i(k)$. With m=n, these procedures can be overly conservative in evaluating the significance of the $G_i(k)$ statistics (Anselin 1995; Ord and Getis 1995). However, using k-nearest neighbors spatial weight matrices, we note that the number of comparisons cannot exceed k because two given regions

[4] Note that statistics which include the value taken by the variable in region i have also been suggested by Getis and Ord (1992) and Ord and Getis (1995).

[5] More about this problem can be found in Savin (1984).

Table 2b Getis–Ord G_i statistics for log per capita GDP (PPS) in 1995 and 2000 for EU27

Years	Percentage of significant statistics at 5% significance level	Percentage of positively significant statistics at 5% significance level	Percentage of negatively significant statistics at 5% significance level	Percentage of significant statistics at Sidàk's pseudo-significance level	Percentage of positively significant statistics at Sidàk's pseudo-significance level	Percentage of negatively significant statistics at Sidàk's pseudo-significance level
2000	47.67%	29.84%	17.83%	18.99%	3.88%	15.12%
1995	49.61%	31.40%	18.22%	20.93%	5.81%	15.12%

cannot have more than k common neighbors. In this respect, we suggest using $m=k$ and we present the results obtained with both the usual 5% significance level, which may be too liberal, and the 5% Sidák pseudo-significance level, which is indeed less conservative than using $m=n$.

The results for the extended Ord and Getis (1995) statistic for ten nearest neighbors are summarized in Table 2a,b and displayed in Fig. 1a,b.[6] The problem of multiple statistical comparisons is taken into account using Sidák's pseudo-significance level with $m=10$.

First, we note that for the sample restricted to EU15, more than one third (34.98%) of the Getis–Ord statistics are significant at the 5% level in 2000 (20.20% are positive and 14.78% negative). With the enlargement, almost half of them (47.67%) become significant (29.84% are positive and 17.83% are negative). Many European regions are therefore surrounded by rich regions and benefit from a favorable economic environment. Second, it is also possible to note a relative stability of the ratio 2:3 vs 1:3 in favor of significantly positive statistics for the two samples, which shows the persistence of the relative distribution of regional per capita GDP. However, considering the Sidàk pseudo-significance level, this ratio becomes favorable to significantly negative statistics. Clustering of poor regions seems therefore more significant than clustering of rich regions.

The EU before the enlargement (EU15) is characterized by a North/South polarization pattern (if we exclude the cluster of eastern poor German regions) as it has been found in numerous previous studies (Armstrong 1995; López-Bazo et al. 1999; Le Gallo and Ertur 2003). Furthermore, this polarization pattern is persistent through the period (Fig. 1a,b). In contrast, considering the extended EU27 sample taking into account the enlargement process (Fig. 2a,b), this North–South polarization pattern is replaced by a new North–West/East polarization pattern with a cluster of rich regions in the North–West and a cluster of poor regions in the East.

The cluster of rich regions in 1995 as well as in 2000 and for both samples consists mainly of western German regions, north of Italy, Austria, south of United Kingdom, and some French, Belgian, and Dutch regions. The number of such regions increases with the enlargement of the EU to eastern countries as the relative wealth of northwestern regions increases mechanically as poorer regions are added

[6] The complete results are presented in Appendix B for the restricted sample of 203 regions and in Appendix D for the sample of 258 regions extended to candidate countries.

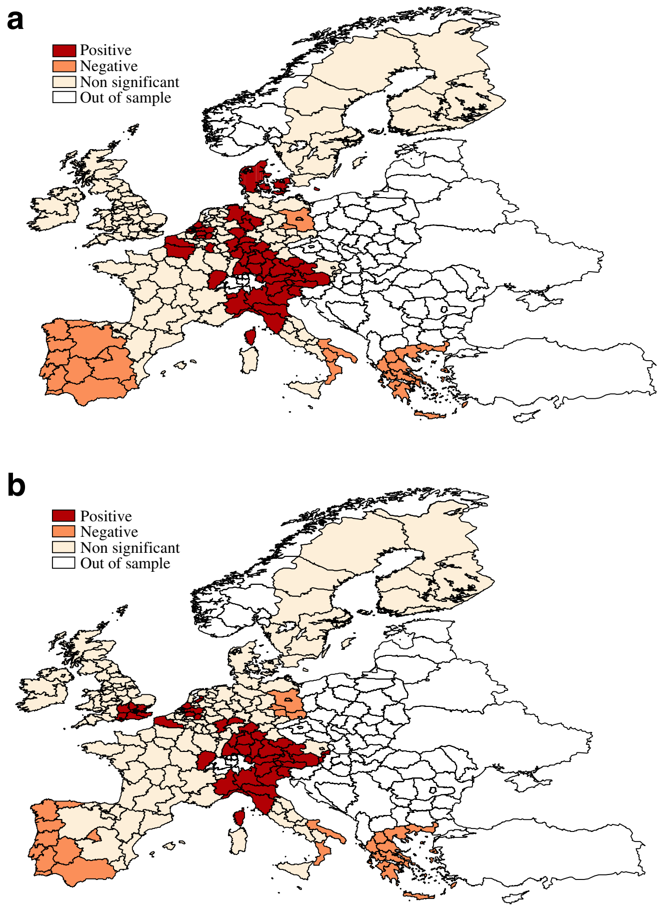

Fig. 1 **a** Getis–Ord significance map for per capita GDP in logarithms (PPS) for 1995 and EU15 (5% significance level) **b** Getis–Ord significance map for per capita GDP in logarithms (PPS) for 2000 and EU15 (5% significance level)

in the sample (Fig. 2a,b). The clusters or poor regions for EU15 consists of four areas: first, the lagging behind Greek regions with significantly negative statistics even with the Sidàk pseudo-significance level both in 1995 and 2000; second, southern Italy (Puglia, Calabria, and Basilicata in 1995); third, central and southern Spanish regions and all the Portuguese regions; and finally, eastern German regions.

The global picture is quite different when we take into account the enlargement process with the extended EU27 sample. There is now only one big cluster of poor regions which mainly contains regions from the eastern countries: all the Polish, Romanian, and Bulgarian regions, Cyprus, Lithuania, and Latvia as well as eastern regions from Hungary, Slovakia, and the Czech Republic. Finally, we can note that only Greece has regions which remain significantly negative amongst the EU15 regions; the other EU15 regions in Spain, Portugal, and Italy that were significantly negative at the 5% level are no more significant in the extended EU27 sample.

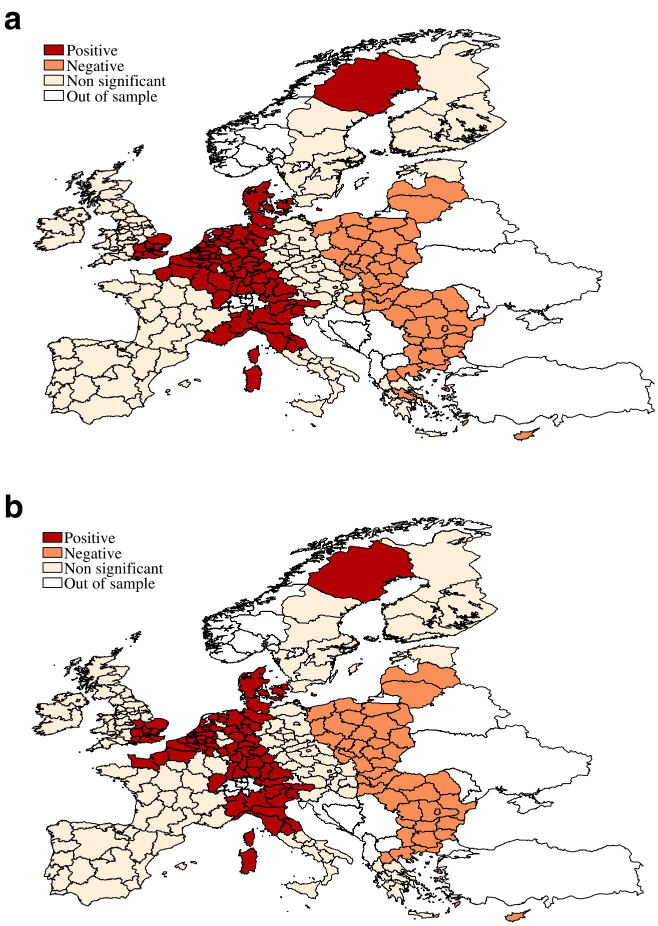

Fig. 2 **a** Significant Getis–Ord statistics for per capita GDP in logarithms (PPS) for 1995 and EU27 (5% significance level) **b** Getis–Ord significance map for per capita GDP in logarithms (PPS) for 2000 and EU27 (5% significance level)

Using the Getis–Ord statistics, we therefore find evidence in favor of a new polarization pattern of European regions which appears with the enlargement process of the EU to eastern new acceding and candidate countries. The existing North/South polarization pattern is replaced by a North–West/East polarization pattern.

Another way to detect local spatial clusters but also to analyze local instability in the form of atypical localizations, spatial outliers, and spatial regimes is to use Moran scatterplots in conjunction with LISA as suggested by Anselin (1995). In the presence of global positive autocorrelation, Moran's I statistic may indeed mask regions that deviate from this global pattern.

Table 3a Spatial association for European regions in the Moran scatterplots for 1995 and 2000 and the sample of 203 regions (EU15)

Year	Quadrant HH	Quadrant LL	Quadrant LH	Quadrant HL
2000	41.87%	33.00%	16.75%	8.37%
1995	43.35%	31.53%	16.26%	8.87%

4.3 Moran's scatterplot

Local spatial instability is studied by means of the Moran scatterplot (Anselin 1996), which plots the spatial lag Wz_t against the original values $\mathbf{z_t}$. The four different quadrants of the scatterplot correspond to the four types of local spatial association between a region and its neighbors: HH, a region with a high[7] value surrounded by regions with high values, LH, a region with a low value surrounded by regions with high values, etc. Quadrants HH and LL (resp. LH and HL) refer to positive (resp. negative) spatial autocorrelation indicating spatial clustering of *similar* (resp. *dissimilar*) values. The Moran scatterplot may thus be used to visualize atypical localizations, i.e., regions in quadrant LH or HL. Moreover, the use of standardized variables makes the Moran scatterplots comparable across time.

The global spatial autocorrelation may also be visualized on this graph because, from Eq. (1), Moran's I is formally equivalent to the slope coefficient of the linear regression of Wz_t on $\mathbf{z_t}$ using a row-standardized weight matrix.

Table 3a,b display the types of spatial association prevailing across European regions for each of our samples.

It can be noted that most European regions are characterized by positive spatial association. More specifically in 2000, almost 75% of EU15 regions exhibited association of similar values (41.87% in quadrant HH and 33% in quadrant LL). This positive spatial association increases significantly with the enlargement process because in 2000, 86.05% of EU27 regions exhibited association of similar values (56.59% in quadrant HH and 29.46% in quadrant LL).

Moran scatterplots also allow detecting atypical regions, i.e., regions that deviate from the global spatial association pattern, belonging to the quadrant LH or HL. In 2000, 25.12% of EU15 regions deviate from the global spatial association pattern (16.75% in quadrant LH and 8.37% in quadrant HL). The share of these regions moves to 13.95% (almost two times lesser) when we consider EU27 (8.14 in quadrant LH and 5.81 in quadrant HL). We finally note that these two schemes are persistent in time as the figures are almost identical at the initial and final periods.

Figures 3a,b and 4a,b display the Moran scatterplots for the logarithm of per capita GDP measured in PPS (initial and final years) of our two samples of, respectively, 203 and 258 regions using the ten nearest neighbors spatial weight matrix.

Considering EU15, we observe in quadrant HH numerous regions from northwestern Europe (from Belgium, western Germany, northern Italy, Netherlands, Austria, southern UK, Denmark, and some French, Finnish, and Swedish regions).

[7] High (resp. low) means above (resp. below) the mean.

Table 3b Spatial association for European regions in the Moran scatterplots for 1995 and 2000 and the sample of 258 regions (EU27)

Year	Quadrant HH	Quadrant LL	Quadrant LH	Quadrant HL
2000	56.59%	29.46%	8.14%	5.81%
1995	55.04%	30.23%	8.14%	6.59%

Considering the enlargement process in EU27, more northwestern European regions belong to quadrant HH, which do not include any regions from new acceding or candidate countries.

In quadrant LL consisting of poor regions surrounded by poor regions, we observe all the Greek regions, four Portuguese regions, southern Spanish and Italian regions, as well as eastern German regions, Northern UK when considering EU15. All these regions were eligible under Objective 1 of the Structural Funds throughout the period 1994–1999. The composition of quadrant LL changes significantly with the enlargement process to 27 European countries. We observe that almost all of the regions from new acceding or candidate countries belong to that quadrant as well as southern regions previously noted. However, two phenomena distinguish the quadrant LL in the case of EU27 compared to the case of EU15. First, we note that regions from EU15 are relatively near from the origin and therefore from the mean, while regions from new acceding and candidate countries are very far from the origin. Second, quadrant LL in the case of EU15 is relatively stable in time while it is possible to note a variation in the case of EU27. Actually, numerous regions from new acceding and candidate countries seem to move away from the origin (therefore from the mean) which could mean that these regions are becoming poorer and poorer. It is the case of mainly Romanian and Bulgarian regions.

In quadrant HL consisting of regions relatively richer than surrounding regions (diamonds in the rough), we can observe capital regions such as Madrid, Lisboa, Berlin, Ile de France, as well as Luxembourg and northern Spanish regions when considering EU15. In the sample of 258 regions for EU27, we observe also numerous capital regions in quadrant HL (Madrid, Lisboa, Berlin, Vienna, Stockholm, Uusimaa which includes Helsinki, Prague, Bratislava, Közép-Magyarorsyág which includes Budapest) but we also observe regions from EU15 near the border with new acceding countries as southern Swedish and Finnish regions.

In quadrant LH consisting of regions relatively poorer than surrounding regions (doughnuts), we observe not only regions from EU15 traditionally having structural problems such as Walloon regions in Belgium and Burgenland in Austria but also many French regions (11 among 22 regions), Finnish, Swedish, and Dutch regions. Considering EU27 in the enlargement perspective, we observe in this quadrant not only Spanish regions, eastern German regions, and two Belgian regions (Hainaut and Namur) but also some regions from new acceding countries such as Slovenia or two Czech regions. We note that in the extended EU27 sample, all the French and Dutch regions belong to quadrant HH.

It is also possible to note that for the EU15 sample, in 1995 and 2000, highly urbanized areas in western Europe such as Hamburg, Brussels, London, Ile de France, and Luxembourg are spatial outliers with respect to the x-axis. For the EU27 sample, only Brussels and London remain as spatial outliers both in 1995

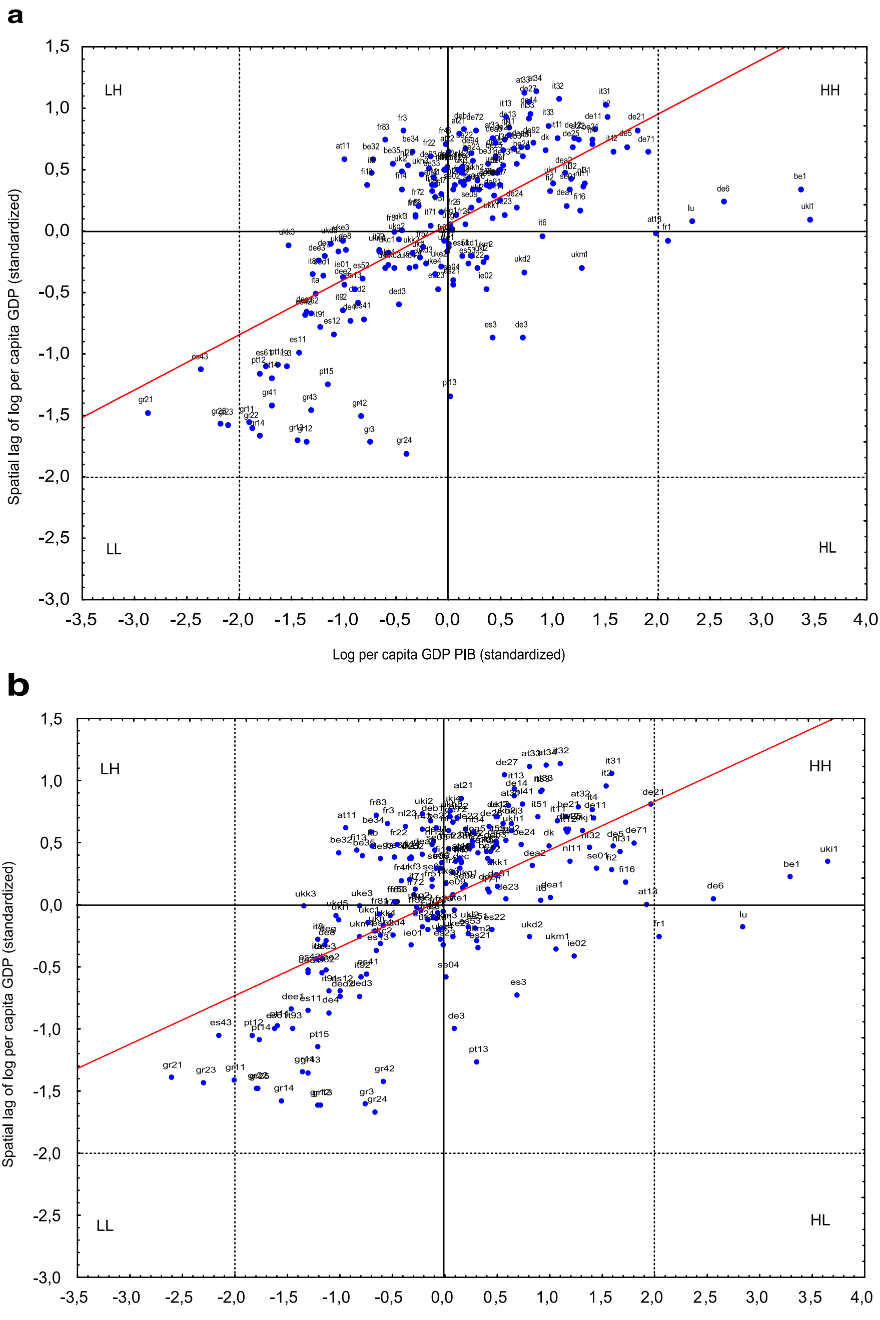

Fig. 3 **a** Moran scatterplot for log per capita GDP measured in PPS in 1995 for the sample of 203 regions EU15 **b** Moran scatterplot for log per capita GDP measured in PPS in 2000 for the sample of 203 regions EU15

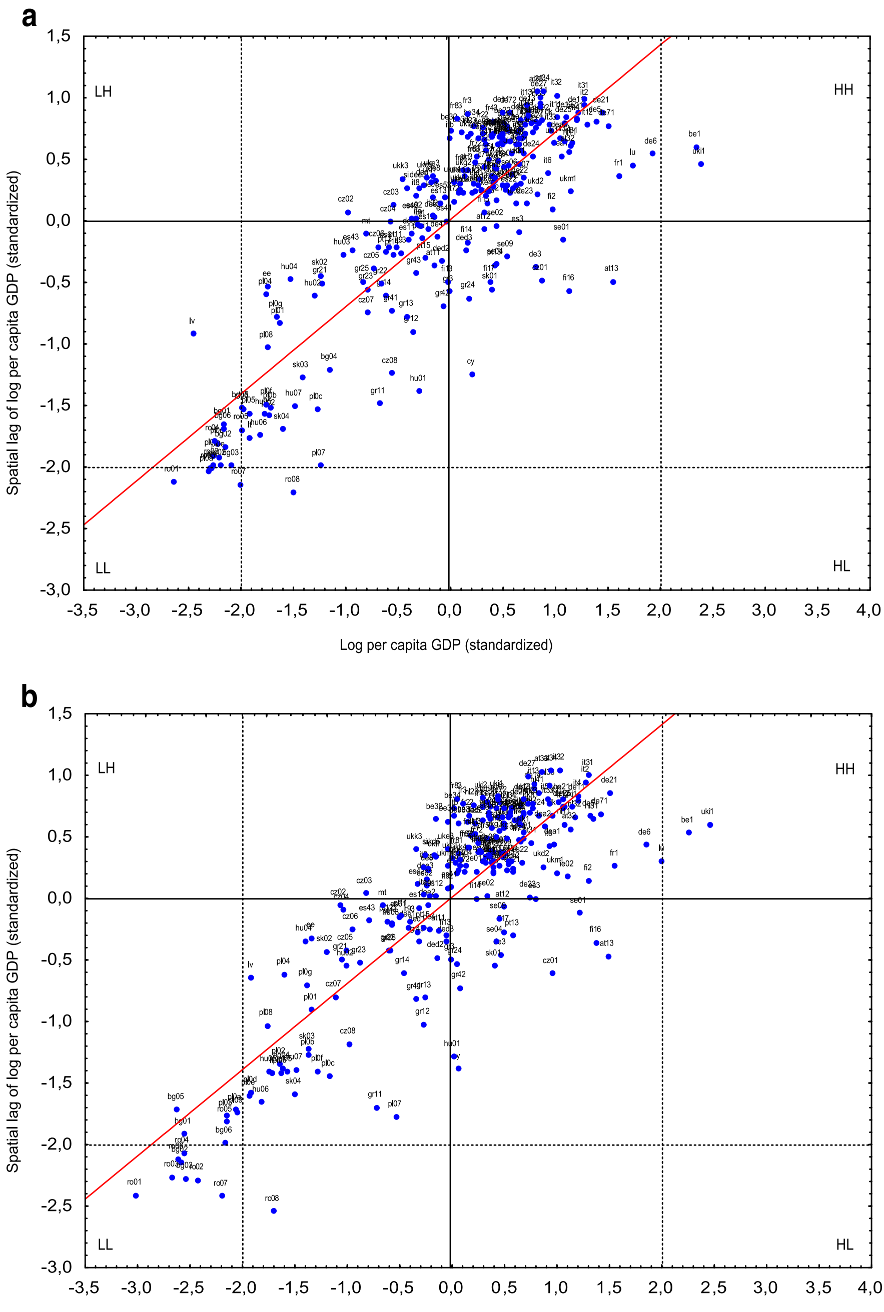

Fig. 4 **a** Moran scatterplot for log per capita GDP measured in PPS in 1995 for the sample of 258 regions EU27 **b** Moran scatterplot for log per capita GDP measured in PPS in 2000 for the sample of 258 regions EU27

and 2000. There is no spatial outlier with respect to the y-axis for the EU15 sample whatever the time period considered. In contrast, for the EU27 sample, some Romanian regions appear as spatial outliers in 1995. Furthermore, in 2000, there are many more Romanian regions and even a few Bulgarian regions appearing as such.

Therefore, the analysis of Moran scatterplots confirms the polarization result obtained previously with the Getis–Ord statistics. It seems that the North/South polarization pattern observed for EU15 is replaced by a North–West/East polarization pattern when considering the enlargement process without questioning the presence of lagging behind regions in southern Europe.

Concerning spatial heterogeneity among European regions, we then can hardly conclude in favor of a stratification scheme for the enlarged EU with many distinct regimes because positive spatial associations are prevailing in the extended sample of 258 regions for EU27 (almost 86% of the regions belong to quadrants HH or LL). In contrast, this seems to be less obvious for the restricted sample of 203 regions for EU15 because almost 25% of the regions belong to quadrants HL or LH.

However, despite the information given by the Moran scatterplots, we do not have any indication about the statistical significance of spatial associations. We must therefore compute the LISA proposed by Anselin (1995).

4.4 Significance of local clusters: LISA

Anselin (1995) defines LISA as any statistics satisfying two criteria: First, the LISA for each observation gives an indication of significant spatial clustering of similar values around that observation; and second, the sum of the LISA for all observations is proportional to a global indicator of spatial association.

The local version of Moran's I statistic for each region i and year t is written as:

$$I_{i,t} = \frac{(x_{i,t} - \mu_t)}{m_0} \sum_j w_{ij}(x_{j,t} - \mu_t) \text{ with } m_0 = \sum_i (x_{i,t} - \mu_t)^2/n \quad (5)$$

where x_{it} is the observation in region i and year t, μ_t is the mean of the observations across regions in year t, and where the summation over j is such that only neighboring values of j are included. A positive value for $I_{i,t}$ indicates spatial clustering of *similar* values (high or low) whereas a negative value indicates spatial clustering of *dissimilar* values between a region and its neighbors. Note that this statistic is based on spatial covariances rather than spatial accumulation and measures a different concept of local spatial association from Getis and Ord (1992) and Ord and Getis (1995) statistics. It is therefore interesting to consider them in conjunction with $G_i(d)$ statistics.[8]

In presence of global spatial autocorrelation, inference must be based on the conditional permutation approach. This approach is conditional in the sense that

[8] Following Anselin (1995, p.101), the $G_i(d)$ statistic cannot be considered as a LISA "because its individual components are not related to a global statistic of spatial association".

the value x_i at location i is held fixed, while the remaining values are randomly permuted over all locations.[9] Ten thousand permutations were used here to compute the empirical distribution function which provides the basis for statistical inference. The p-values obtained for the local Moran's statistics are then pseudo-significance levels (Anselin 1995, p. 96 and pp. 99–100). In addition, as normality is unlikely to be the case with LISA, we use the Bonferroni 5% pseudo-significance level with m=10 instead of the Sidák 5% pseudo-significance level to deal with the multiple comparison problems.

Anselin (1995) gives two interpretations of LISA. They can be used first as indicators of significant local spatial clusters ("hot spots") in the same way as the $G_i(d)$ statistics and second as diagnostics for local instability (atypical localizations or "pockets of nonstationarity"), significant outliers, and spatial regimes. This second interpretation is similar to the use of a Moran scatterplot to identify outliers and leverage points for Moran's I: Because there is a link between the local indicators and the global statistic, LISA outliers will be associated with the regions which exert the most influence on Moran's I. Finally, combining the information in a Moran scatterplot and the significance of LISA yields the so-called "Moran significance map", showing the regions with significant LISA and indicating by a color code the quadrants in the Moran scatterplot to which these regions belong (Anselin and Bao 1997). Table 4a,b display the global results for each of our samples.[10]

First, we note that in 2000, 43.35% of LISA statistics are significant at the 5% pseudo-significance level for the restricted sample of 203 regions for EU15 while the figure moves to 55.43% for the extended sample of 258 regions for EU27. Among these statistics, 36.46% exhibit significant positive spatial association: 20.20% of them belong to quadrant HH and 16.26% belong to quadrant LL. This represents almost two thirds of significant statistics at the 5% pseudo-significance level. In the extended sample of 258 regions for EU27, 55.43% exhibit significant positive spatial association: 35.27 of them belong to quadrant HH and 17.44% belong to quadrant LL. This represents 95.09% of significant statistics at the 5% pseudo-significance level. This result implies that the local positive spatial association pattern is more predominant when we consider the enlarged EU (EU27) than EU15. Therefore, the enlargement process of the EU is strengthening the positive spatial association pattern detected in the present EU.

These results allow assessing the relative importance of regional clusters but they do not give any information about their localization and the localization of atypical regions. We therefore visualize the LISA statistics on Moran significance maps at the 5% pseudo-significance level. Figure 5a,b display the results for 1995 and 2000 using the restricted sample of 203 regions for EU15.

Regions characterized by a spatial association of the HH type are mainly localized in three areas. The biggest cluster includes regions from northern Italy, western Austria, and south-western Germany (this area included Denmark in 1995), the second cluster, smaller in 2000 than in 1995, is the one localized in the north of Belgium and in the south of Netherlands, and finally the third cluster,

[9] Note that only the quantity $\sum_j w_{ij}(x_i - \mu)$ needs to be computed for each permutation because the term $(x_i - \mu)/m_0$ remains constant for a given location i.

[10] Results using the Bonferroni 5% pseudo-significance level are presented in Appendix E. The complete results are presented in Appendix C for the restricted sample of 203 regions and in Appendix D for the sample of 258 regions extended to candidate countries.

Table 4a Significant LISA for log per capita GDP measured in PPS for 1995 and 2000 in the sample of 203 regions for EU15

Years	Percentage of significant statistics at the 5% pseudo-significance level	Percentage of significant HH statistics at the 5% pseudo-significance level	Percentage of significant LL statistics at the 5% pseudo-significance level	Percentage of significant LH statistics at the 5% pseudo-significance level	Percentage of significant HL statistics at the 5% pseudo-significance level
2000	43.35%	20.20%	16.26%	4.93%	1.97%
1995	47.29%	23.15%	15.76%	6.90%	1.48%

appearing only in 2000, includes regions surrounding London in the southeast of United Kingdom. Regions belonging to quadrant LL are localized mainly in four areas, all the Greek regions with significant LISA at the 5% Bonferroni pseudo-significance level in 1995 and 2000, regions from southern Italy (Puglia, Basilicata, Calabria in 2000), eastern German regions (Brandenburg, Chemnitz, Dresden, Leipzig, Dessau, Halle), Portuguese regions (except Lisboa), and finally southern and central Spanish regions (except Madrid). This type of spatial association is more persistent through the period under study than spatial association of the HH type.

There are four significant HL regions: three capital regions localized in the core of the LL clusters (Madrid, Lisboa, and Berlin) and the southern Swedish region of Sydsverige (in 2000). In contrast, there are much more significant LH regions: these are structurally lagging behind regions belonging to the richest European countries as northern French regions (Nord-Pas-de-Calais significant at the 5% Bonferroni pseudo-significance level in 1995, Picardie in 1995, and Franche-Comté in 1995 and 2000) and southern Belgian regions (Limburg, Hainaut, Belgian region of Luxembourg, Namur), as well as Corse, the Austrian region of Burgenland, and outer London in the United Kingdom. We also observe some regions from northern and western Germany (Lüneburg, Weser-Ems, Koblenz, Trier) and from northern Netherlands (Friesland, Drenthe, Flevoland).

Figure 6a,b display the results for 1995 and 2000 using the extended sample of 258 regions for EU27. The enlargement of the EU clearly modifies the structure of significant spatial clusters. Regions belonging to quadrant HH are localized mainly in the northwest of the enlarged EU (EU27) in a cluster which spreads out from

Table 4b Significant LISA for log per capita GDP measured in PPS for 1995 and 2000 in the sample of 258 regions for EU27

Years	Percentage of significant statistics at the 5% pseudo-significance level	Percentage of significant HH statistics at the 5% pseudo-significance level	Percentage of significant LL statistics at the 5% pseudo-significance level	Percentage of significant LH statistics at the 5% pseudo-significance level	Percentage of significant HL statistics at the 5% pseudo-significance level
2000	55.43%	35.27%	17.44%	0.78%	1.94%
1995	57.36%	35.66%	19.38%	0.78%	1.55%

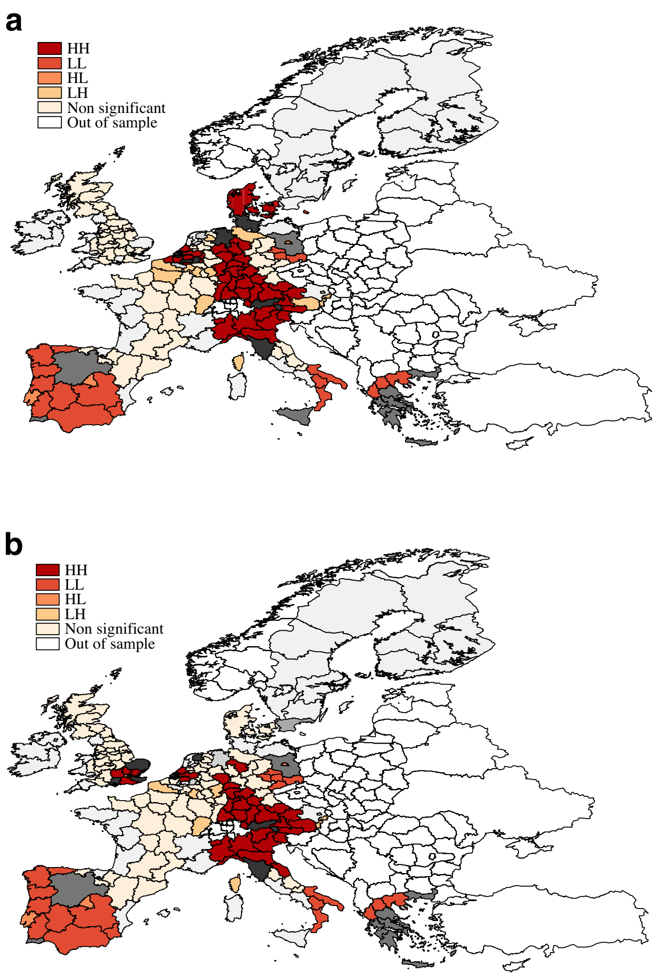

Fig. 5 **a** Moran significance map for log per capita GDP measured in PPS for 1995 in the sample of 203 regions for EU15 (5% pseudo-significance level) **b** Moran significance map for log per capita GDP measured in PPS for 2000 in the sample of 203 regions for EU15 (5% pseudo-significance level)

north of Italy and south of France to Denmark, northern Germany and southern United Kingdom.

We can note that many regions belonging to that cluster are significant at the 5% Bonferroni pseudo-significance level. This HH cluster is much bigger and persistent through the period under study than the corresponding cluster for the restricted sample of 203 regions for EU15. We can also note that many regions that belonged to quadrant LH in the restricted sample belong now to quadrant HH. Finally, we can note that the Swedish region of Övre Norrland is the only significant HH Scandinavian region at the 5% pseudo-significance level. This can be explained by its neighborhood structure, which does not include any regions from new acceding countries in contrast to other Swedish and Finnish regions.

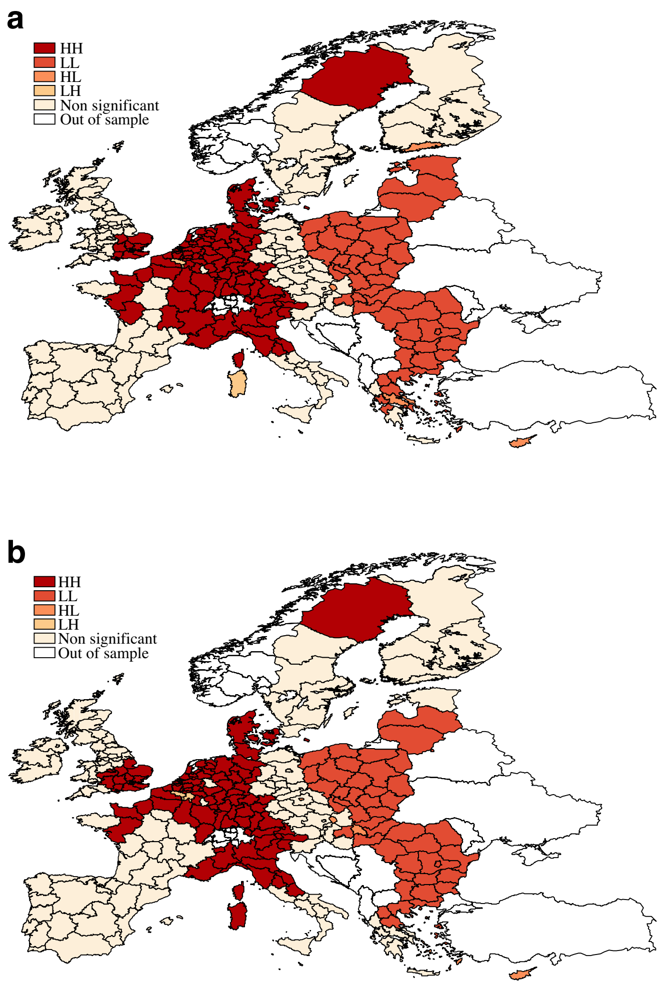

Fig. 6 **a** Moran significance map for log per capita GDP measured in PPS for 1995 in the sample of 258 regions for EU27 (5% pseudo-significance level) **b** Moran significance map for log per capita GDP measured in PPS for 2000 in the sample of 258 regions for EU27 (5% pseudo-significance level)

The spatial association pattern of the LL type is deeply modified with the enlargement process. LL regions mostly are localized at the East of the enlarged EU. This area extends from Baltic States to the North of Greece. It is made up of all Romanian, Bulgarian, and Polish regions, Baltic States, most eastern Hungarian regions, Slovakia, and Czech Republic.[11] Only northern regions of Greece remain significant among EU15 regions; other regions from southern Italy, Spain, and Portugal are no more significant. The "diamonds in the rough" significant at the 5% level are mainly capital regions of acceding countries like Prague, Bratislava, and

[11] We note that almost all of these statistics are significant using the Bonferroni pseudo-significance level.

Table 5 Moran's *I* statistic for average annual growth rates of per capita GDP (PPS) for the 1995–2000 period for EU15 and EU27

	Moran's *I*	Mean	Standard deviation	Standardized values	*p*-values
EU15	0.2933744	−0.005	0.028303	10.542	0.0001
EU27	0.4075095	−0.004	0.025456	16.166	0.0001

Közép-Magyarorsyág (Budapest) as well as a few regions in Greece and Cyprus. Only the Belgian regions of Hainault and Namur remain significantly of the "doughnuts" type.

It is worth stressing the following interesting result: We note the presence of a fringe between the cluster of rich regions in the North–West and the cluster of poor regions in the East of the enlarged EU. This fringe is mainly made up of central European regions characterized by a low level of per capita GDP and benefit from a more favorable environment than more Eastern European regions also characterized by even a lower level of per capita GDP. It mainly consists of eastern Germany regions, western Czech regions, and Slovenia which are characterized by an LH spatial association pattern and which have positive Getis–Ord statistics (see Appendices B and D), that is to say that they benefit from a more favorable environment for their future economic development than more eastern regions. We can also put the stress on highly urbanized areas belonging to this fringe which could also promote regional development policies.

This result is important for the implementation of the regional and cohesion policy in the enlarged EU as these regions will probably benefit more from spillover effects coming from the richer western regions in contrast to eastern regions which will probably less or not benefit from these spillovers.

5 Exploratory spatial data analysis for average annual growth rates

The preceding results show evidence in favor of the persistence of strong spatial disparities for levels of per capita GDP throughout the period 1995–2000, according to a North–South pattern for EU15 and to a North–West/East for EU27. We will now apply ESDA to assess the spatial characteristics of the distribution of the average annual growth rates of per capita GDP.[12] We will first evaluate global spatial autocorrelation. Second, we will determine local clusters of high or low average annual growth rates using the Getis–Ord statistics. Finally, we will analyze the structure and the significance of local spatial associations by means of the Moran scatterplot and LISA.

[12] We use the approximation of average annual growth rates throughout the period 1995–2000, i.e., for a region i of the sample, we have $g_i = [\ln y_{i,2000} - \ln y_{i,1995}]/5$ where $y_{i,2000}$ and $y_{i,1995}$ stand for per capita GDP of region i measured in PPS, respectively, in 2000 and 1995. Indeed, this variable is the dependant variable in empirical growth regressions.

Table 6 Getis–Ord G_i statistics for average annual growth rates of per capita GDP (PPS) for the 1995–2000 period for EU15 and EU27

	Percentage of significant statistics at 5% significance level	Percentage of positively significant statistics at 5% significance level	Percentage of negatively significant statistics at 5% significance level	Percentage of significant statistics at Sidàk's pseudo-significance level	Percentage of positively significant statistics at Sidàk's pseudo-significance level	Percentage of negatively significant statistics at Sidàk's pseudo-significance level
EU15	33.50%	12.81%	20.69%	10.84%	4.93%	5.91%
EU27	23.64%	11.24%	12.40%	10.86%	5.43%	5.43%

5.1 Global spatial autocorrelation

The results presented in Table 5 show a strongly significant positive global spatial autocorrelation (p=0.0001) for both samples.

We note that the standardized values are far below those computed for the levels of log per capita GDP for both samples. Nevertheless, these results indicate that regions presenting relatively high average annual growth rates (resp. low) are localized near other regions with relatively high average annual growth rates (resp. low).

5.2 Getis–Ord statistics and local clustering

The results for the extended Ord and Getis (1995) statistic for the average annual growth rates of per capita GDP measured in PPS using ten nearest neighbors are summarized in Table 6 for both samples and displayed on Fig. 7a,b.[13] The problem of multiple statistical comparisons is taken into account using Sidák's pseudo-significance level with m=10. As before, statistical inference is based on the normal asymptotic approximation.

For the EU15 sample, we note that 33.50% of the Getis–Ord statistics are significant at the 5% level, whereas only 23.64% remain significant for the EU27 sample. In addition, the shares of significantly positive and negative statistics vary between the samples: For the EU27 sample, 11.24% of the Getis–Ord statistics are significantly positive and 12.40% are significantly negative, while for the EU15 sample, 12.81% are significantly positive and 20.69% are significantly negative. However, it is possible to note that there is almost no difference between the two samples when considering the Sidàk pseudo-significance level.

For EU15, local clusters of high average annual growth rates are localized in three areas: first, regions around Madrid in Spain; second, regions around London at the southeast of United Kingdom; and finally, central and eastern regions in Greece. For the enlarged EU, we note two main clusters at each side of Europe. As

[13] The complete results are presented in Appendix B for the restricted sample of 203 regions and in Appendix D for the sample of 258 regions extended to new acceding and candidate countries.

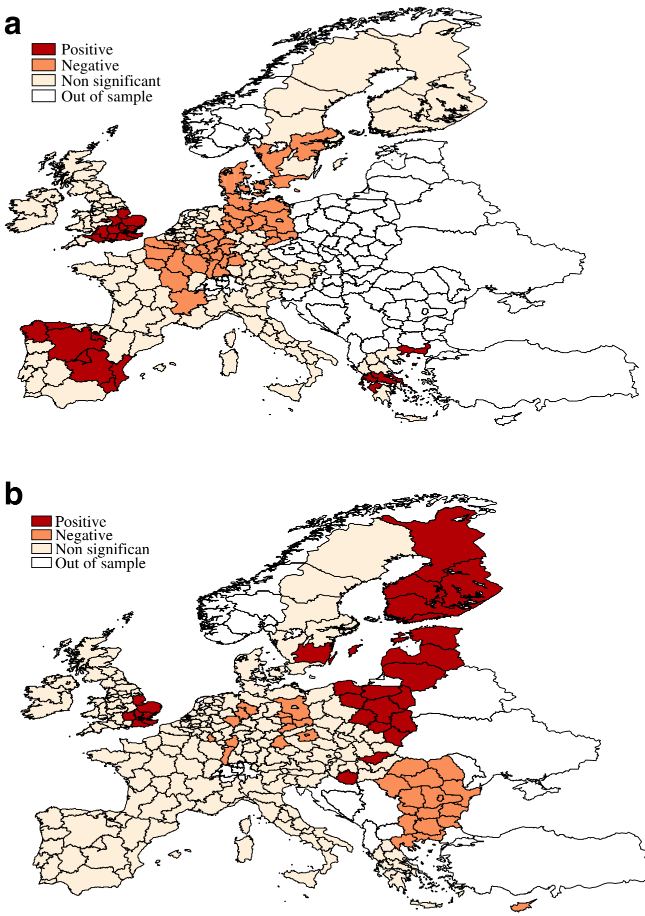

Fig. 7 **a** Getis–Ord significance map for average annual growth rates of per capita GDP (PPS) for EU15 and the 1995–2000 period (5% significance level) **b** Getis–Ord significance map for average annual growth rates of per capita GDP (PPS) for EU27 and the 1995–2000 period (5% significance level)

for the preceding sample, regions around London are characterized by high average annual growth rates. The other cluster is localized near the Baltic Sea in the North–Eastern Europe: Finnish regions excluding Åland Islands (four of them are significant at the Sidàk pseudo-significance level), Småland med öarna in Sweden is also significant at the 5% level. The three Baltic States are significant at the Sidàk pseudo-significance level and nine Polish regions are as well significant (seven of them are significant at the Sidàk pseudo-significance level). Finally, two Hungarian regions (Dél-Dunántúl et Észak-Magyarország) are also significant at the 5% level.

For EU15, local clusters of low average annual growth rates are mainly localized in an area extending from the south of Sweden to the center of France. More precisely, it is made up of three Swedish regions (one of them significant at the Sidàk level), Denmark, northern, eastern, and western German regions (26 regions, nine of them significant at the Sidàk level), Luxembourg (significant at the Sidàk level), three Belgian regions, and eight French regions (Alsace is significant

Table 7 Spatial associations of European regions in the Moran scatterplots for the average annual growth rates for EU15 and EU27 and the 1995–2000 period

	Quadrant HH	Quadrant LL	Quadrant LH	Quadrant HL
EU15	41.87%	37.93%	10.84%	9.36%
EU27	41.47%	36.82%	11.24%	10.47%

at the Sidàk level). With the enlargement process, this type of clusters is localized in two areas. First are all of the Romanian and Bulgarian regions, which are significant at the Sidàk level (except Vest and Nord-Vest in Romania which are significant at the 5% level). Two northern Greek regions (one of them significant at the Sidàk level) are also part of this area as well as Cyprus. The second cluster of low average annual growth rates is composed of some of the regions which were found before in the EU15 sample as characterized by a neighborhood with low average annual growth rates: central and eastern German regions, Luxembourg, Alsace, and Prague and Strední Cechy in the Czech Republic.

5.3 Moran's scatterplot

Table 7 presents the results for Moran's scatterplots.

We note that 79.8% (resp. 78.29%) of EU15 regions (resp. EU27 regions) present a positive spatial association. Figures 8 and 9 display the results. EU15 regions from Spain, Ireland, United Kingdom, Finland, and Italy belong to the

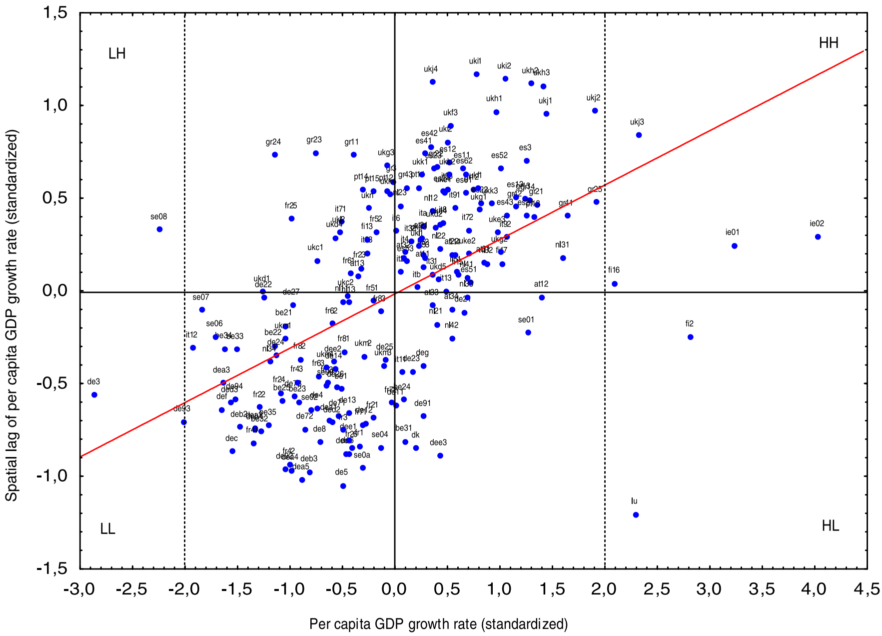

Fig. 8 Moran scatterplot. Average annual growth rates of per capita GDP (PPS) for EU15 and the 1995–2000 period

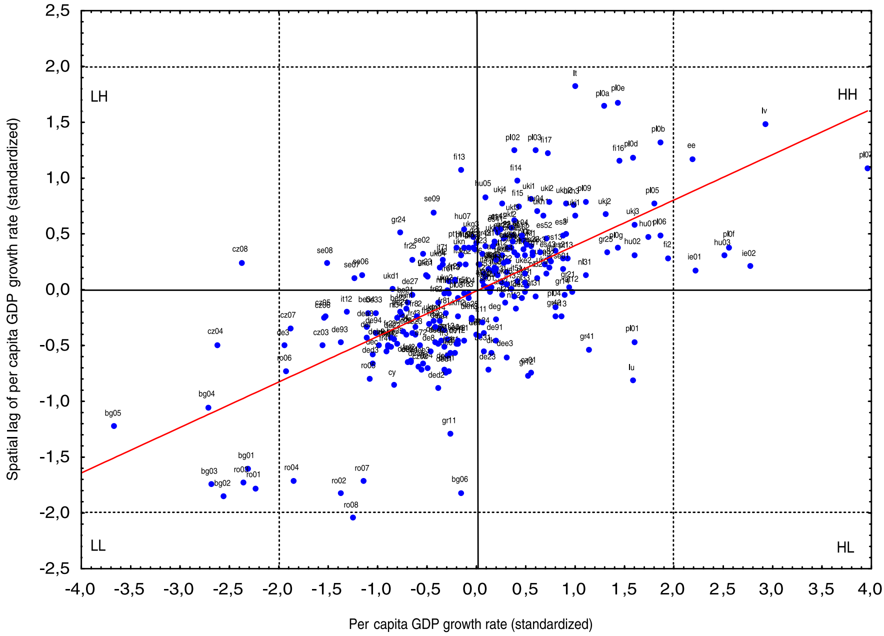

Fig. 9 Moran scatterplot. Average annual growth rates of per capita GDP (PPS) for EU27 and the 1995–2000 period

quadrant HH for both of the samples. Baltic States, Slovenia, and most of the Polish, Hungarian and Slovak regions belong as well to this quadrant. We can note that none of the French, German and Belgian regions belong to this quadrant for both samples. Most of Belgian, French, and German regions belong to quadrant LL as well as Scottish regions for both samples. All of the Bulgarian, Romanian, and most of the Czech regions also belong to quadrant LL.

In quadrant HL which contains more dynamic regions than their neighbors, we can find two Belgian regions, Denmark, Luxembourg, and some German, Italian, Austrian, and Dutch regions for both samples. We note that Prague, Bratislava, and two Polish regions are also characterized by this type of spatial association. Finally, due to the enlargement process and to the modification of their neighborhood structure, some Greek regions are moving from quadrant HH to quadrant HL; Finnish or Swedish regions are moving from quadrant LL to quadrant LH.

Figure 9 confirms the previous findings concerning the time pattern of Moran scatterplots between 1995 and 2000 for the levels of per capita GDP for the EU27 sample (Fig. 4a,b). We noted that some of the regions belonging to quadrant LL in 1995 tend to move away in 2000 from the origin, therefore from the sample mean of the enlarged EU. Romanian and Bulgarian regions were mostly concerned; these two candidate countries will probably not accede to the EU before 2007. In this study, we see that all these regions belong to quadrant LL when their average annual growth rates are considered, hence, this area characterized by relative low levels also exhibits a very low relative dynamism.

More generally, the Moran scatterplot for levels of per capita GDP in 1995 compared to the Moran scatterplot for average annual growth rates can be

Table 8a Significant LISA at the 5% pseudo-significance for the average annual growth rates of per capita GDP (PPS) for EU15 and EU27 and the 1995–2000 period

	Percentage of significant statistics at the 5% pseudo-significance level	Percentage of significant HH statistics at the 5% pseudo-significance level	Percentage of significant LL statistics at the 5% pseudo-significance level	Percentage of significant LH statistics at the 5% pseudo-significance level	Percentage of significant HL statistics at the 5% pseudo-significance level
EU15	46.31%	14.78%	23.65%	4.43%	3.45%
EU27	31.01%	12.79%	13.57%	1.55%	3.10%

interpreted in terms of actual catching up with respect to the European sample mean. Clusters exhibiting low per capita GDP levels at the beginning of the period (LL and LH quadrants in Figs. 3a and 4a) and high average annual growth rates between 1995 and 2000 (HH and HL quadrants in Figs. 8 and 9) can be interpreted as actually catching-up the European sample mean. These clusters are mainly localized in Spain for the EU15 sample and in Poland, Hungary and Baltic States for the enlarged EU27 sample. Clusters which benefit from the same initial conditions (LL and LH quadrants in Figs. 3a and 4a) but which are characterized by low average annual growth rates (LL and LH quadrants in Figs. 8 and 9) are not actually catching up. These clusters are mainly localized in eastern Germany and Belgian Walloon for the EU15 sample and in Romania and Bulgaria for the enlarged EU27 sample.

As in the preceding Section, we still need to compute the LISA to assess the statistical significance of the spatial associations detected.

5.4 Significance of local clusters: LISA statistics

Table 8a,b displays the results of LISA applied to average annual growth rates.[14]

Almost half of the LISA (46.31%) are significant at 5% in the EU15 sample (Fig. 10) and 31.01% of them are significant in the EU27 sample (resp. 14.78% and 12.02% at the 5% Bonferroni pseudo-significance level). First, 38.43% of the significant statistics are presenting a positive spatial association pattern (14.78% belong to quadrant HH and 23.65% to quadrant LL) (Fig. 11). This figure moves to 26.36% in the extended sample of EU27 (12.79% belong to quadrant HH and 13.57% to quadrant LL). Only 7.88% of significant LISA are presenting a negative spatial association pattern (4.43% belong to quadrant LH and 3.45% to the quadrant HL) in the EU15 sample. In the extended sample of EU27, this figure is even lower as 4.65% (1.55% belong to quadrant LH and 3.10% to the quadrant HL).

[14] The complete results are presented in Appendix C for the restricted sample of 203 regions and in Appendix D for the sample of 258 regions extended to new acceding and candidate countries.

Table 8b Significant LISA at the 5% Bonferroni pseudo-significance level for average annual growth rates of per capita GDP (PPS) for EU15 and EU27 and the 1995–2000 period

	Percentage of significant statistics at the 5% pseudo-significance level	Percentage of significant HH statistics at the 5% pseudo-significance level	Percentage of significant LL statistics at the 5% pseudo-significance level	Percentage of significant LH statistics at the 5% pseudo-significance level	Percentage of significant HL statistics at the 5% pseudo-significance level
EU15	14.78%	4.93%	7.88%	0.00%	1.97%
EU27	12.02%	5.43%	6.20%	0.39%	0.00%

In the EU15 sample, we observe two main areas containing regions characterized by a spatial association pattern of the HH type. The first one is located in Spain and in northern Portugal, and the second one is located in southeastern United Kingdom. Four more regions are characterized by this pattern: three in Greece (Kentriki Makedonia, Ionia, and Crete) and Calabria in southern Italy. Spatial association of the LL type is observed in an area which spreads from center of France to southern Sweden. We can note that seven regions, located in the preceding area, are more dynamic than their neighbors (HL): Denmark, Luxembourg (both at the Bonferroni pseudo-significance level), two central Belgian regions (Vlaams Brabant, Brabant Wallon), and three German regions (Stuttgart, Braunschweig, and Magdeburg). There are nine regions less dynamic than their neighbors (LH): three Portuguese regions (Centro, Alentejo, Algarve), four Greek regions (Anatoliki Makedonia, Dytiki Ellada, Sterea Ellada, Attiki including Athens) and two more regions in the United Kingdom (West Middlands, Devon).

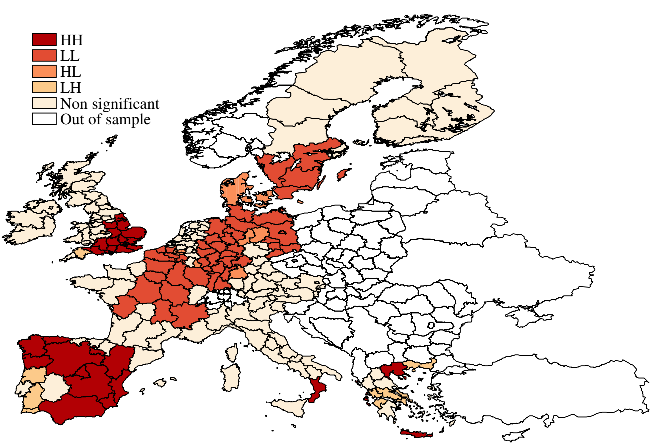

Fig. 10 Moran significance map for average annual growth rates of per capita GDP for EU15 and the 1995–2000 period (5% pseudo-significance level)

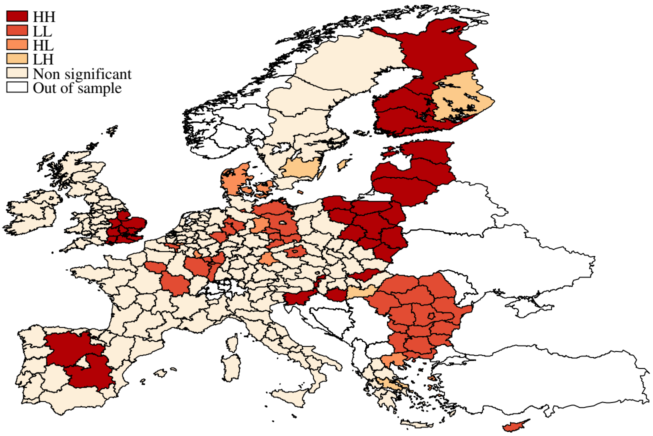

Fig. 11 Moran significance map for average annual growth rates of per capita GDP for EU27 and the 1995–2000 period (5% pseudo-significance level)

The enlargement process modifies this overall picture. First, we can observe three main regional clusters characterized by an HH spatial association pattern. The first one is located near Baltic Sea in northeastern Europe and is made up of four Finnish regions, Baltic States, and nine northern Polish regions (most of them are significant at the Bonferroni pseudo-significance level). The other two clusters are located in southeastern United Kingdom and around Madrid in Spain. Four more central European regions are characterized by this spatial association pattern: two Hungarian regions (Észak-Magyarország and Dél-Dunántúl), Slovenia, and the poorest eastern Austrian region (Burgenland). We can also observe several LL clusters. The most important cluster is located in the southeast of the EU: It is made up of all of the Romanian and Bulgarian regions (all are significant at the Bonferroni pseudo-significance level except Nord-Vest), Anatoliki Makedonia in northern Greece (also significant at the Bonferroni pseudo-significance level). Several regions which belonged to the previous area in the EU15 sample are still characterized by the same spatial association pattern when considering the enlargement process. These regions are located in Germany (13 regions including eastern regions), in northeastern France (Bourgogne, Île de France, Alsace, Lorraine), and in Belgium (Hainault). The Czech region surrounding Prague (Strední Cechy) is also exhibiting a spatial association of the LL type. Eight regions belong significantly to the HL quadrant at the 5% level. These are "diamonds in the rough" characterized by high growth rates surrounded by regions with low growth rates as Brabant Wallon in Belgium, Denmark, Oberpfalz and Magdeburg in Germany, Luxembourg, Kentriki Makedonia and Voreio Aigaio in Greece, and Prague in the Czech Republic. In contrast, four regions belong significantly to the LH quadrant. These are "doughnuts" or regions with low growth rates surrounded by regions with high growth rates: Sterea Ellada in Greece, Itä-Suomi in Finland (significant at the Bonferroni pseudo-level), Småland med öarna in Sweden and Dél-Alföd in Hungary.

6 Conclusion

The aim of this paper was to analyze European regional income disparities in the context of the enlargement process using ESDA. The spatial distribution of regional per capita GDP in logarithms is therefore studied throughout the 1995–2000 period using two different samples: the first one is based on 203 regions from EU15, and the second one is based on 258 regions including regions from new Central and Eastern European member States, which joined the EU on May 1, 2004 and Romania and Bulgaria which are still candidate countries (EU27). We found strong evidence of global and local spatial autocorrelation in both samples highlighting the fact that the per capita GDP level for a given region is not independent of neighboring regions per capita GDP levels. The analysis of average annual growth rates of per capita GDP also showed strong evidence in favor of spatial autocorrelation: the economic dynamism of a given region is highly correlated to the economic dynamism of neighboring regions.

In addition, using the Moran scatterplot and the LISA, we highlighted the new North–West/East polarization pattern which appears with the enlargement process to Central and Eastern European countries and which replaces the previous North–South polarization pattern often underlined in the literature for EU15. However, this new picture should not completely mask clusters of “previously” poor European regions in the implementation of future regional and cohesion policies. We also found evidence of a fringe made up of relatively poor regions belonging to Central and Eastern European countries, which have better came through the economic transition to market structures and democracy.

These results have important implications on the way regional and cohesion policies have to be designed because the criteria used by the European Commission for the eligibility under different objectives of the Structural Funds has traditionally neglected this spatial dimension. Therefore, the expected effects of such policies on a given region could be over- or under-estimated depending on the spatial interaction pattern characterizing it. Indeed, spillovers and spatial externalities underlying the spatial autocorrelation detected in both samples are likely to affect regional development processes and therefore should be seriously taken into account as in the theoretical framework proposed by Ertur and Koch (2005). Their spatially augmented Solow model includes technological interdependence working through spatial externalities between economies and underlines the impact of location and neighborhood effects on growth and convergence. Further research agenda cover development of policy recommendations on the basis of such models.

Finally, the measure and the treatment of regional inequalities in the future enlarged EU seem much more complex than what is suggested by the “statistical effect”, i.e., fall in average per capita GDP in the Community as a result of the recent accession of ten new Member States, often discussed by the European Commission. The European regional and cohesion policy also should take into account spatial interactions between regions.

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Appendix A

Eurostat-Regio database

The data are extracted from the Eurostat-Regio database. Eurostat is the Statistical Office of the European Communities. Its task is to provide the EU with statistics at European level that enable comparisons between countries and regions. These statistics are used by the European Commission and other European institutions so that they can define, implement, and analyze community policies. The Regio database is the official source of harmonized annual data at the regional level throughout the 1980–1995 period for the EU, and per capita GDP is likely to be one of the most reliable series in this database.

We use the Eurostat 1995 nomenclature of statistical territorial units, which is referred to as NUTS. The aim is to provide a single uniform breakdown of territorial units for the production of regional statistics for the EU. In this nomenclature, NUTS1 means European Community Regions while NUTS2 means Basic Administrative Units. For practical reasons to do with data availability and the implementation of regional policies, this nomenclature is based primarily on the institutional divisions currently in force in the Member States following "normative criteria". Eurostat defines these criteria as follows: "Normative regions are the expression of political will; their limits are fixed according to the tasks allocated to the territorial communities, according to the size of population necessary to carry out these tasks efficiently and economically, and according to historical and cultural factors." (Regio database, user's guide, Methods and Nomenclatures, Eurostat 1999, p. 7). It excludes territorial units specific to certain fields of activity or functional units in favor of regional units of a general nature. The regional breakdown adopted by Eurostat appears therefore as one of the major shortcomings of the Regio database, which can have some impact on our spatial weight matrix and estimation results (scale problems).

We use the series E2GDP95 for EU15 and XE_GDP for new acceding and candidate countries based on ESA95 measured in PPS per inhabitant over the 1995–2000 period. We use per capita GDP expressed in PPS because it takes into account price levels variations between countries not reflected by prevailing exchange rates and because it is widely used as a key indicator for assessing levels of economic development in regions and disparities between them in cross-region international comparisons. In addition, the eligibility condition under Objective 1 of Structural Funds is also expressed in PPS and not in Euro. Using PPS allows a better understanding of the consequences of the enlargement process on the eligibility criteria.

The first sample contains 203 NUTS2 regions for EU15 and the second contains 258 NUTS2 regions for EU27: Belgium (11), Denmark (1), Germany (40), Greece (13), Spain (16), France (22), Ireland (2), Italy (20), Luxembourg (1), Netherlands (12), Austria (9), Portugal (5), Finland (6), Sweden (8), United Kingdom (37) for EU15 and Czech Republic (8), Estonia (1), Hungary (7), Lithuania (1), Latvia (1), Poland (16), Slovenia (1), Slovakia (4), Malta (1), Cyprus (1), for the new acceding countries and Romania (8), and Bulgaria (6) for candidate countries for EU27.

We exclude some geographically isolated regions in both of our samples: the Canary Islands and Ceuta y Mellila for Spain, the Azores and Madeira for Portugal, and Guadeloupe, Martinique, French Guyana and Réunion for France.

The choice of the NUTS2 level as our spatial scale of analysis may appear to be quite arbitrary and may have some impact on our inference results. Regions in NUTS2 level may be too large in respect to the variable of interest and the unobserved heterogeneity may create an ecological fallacy, so that it might have been more relevant to use NUTS3 level. In contrast, they may be too small so that the spatial autocorrelation detected could be an artifact that comes out from slicing homogenous zones in respect to the variable considered, so that it might have been more relevant to use NUTS1 level. Even if, ideally, the choice of the spatial scale should be based on theoretical considerations, we are constrained in empirical studies by data availability. Moreover, our preference for the NUTS2 level rather than the NUTS1 level, when data are available, is based on European regional development policy considerations: Indeed, it is the level at which eligibility under Objective 1 of Structural Funds is determined since their reform in 1989. Our empirical results are indeed conditioned by this choice and could be affected by different levels of aggregation and even by missing regions. Therefore, they must be interpreted with caution.

Appendix B

Getis–Ord statistics for log per capita GDP measured in PPS and average annual growth rates, 1995 and 2000 for EU15 and EU27

Code	Regions	EU15 2000	EU27	EU15 1995	EU27	EU15 Growth rates	EU27
	Belgium						
be1	Région Bruxelles-capitale	+	+*	+	+	–	–
be21	Antwerpen	+*	+*	+*	+*	–	–
be22	Limburg (B)	+*	+*	+*	+*	–	–
be23	Oost-Vlaanderen	+	+*	+	+*	–	–
be24	Vlaams Brabant	+*	+*	+	+*	–	–
be25	West-Vlaanderen	+	+*	+	+*	–	–
be31	Brabant Wallon	+	+*	+	+*	–*	–
be32	Hainaut (Objective 1)	+	+*	+	+*	–*	–
be33	Liège	+	+*	+	+*	–	–
be34	Luxembourg (B)	+*	+*	+	+*	–	–
be35	Namur	+	+*	+	+*	–*	–
	Denmark						
Dk	Denmark	+*	+*	+	+*	–*	–
	Germany						
de11	Stuttgart	+*	+**	+*	+*	–*	–
de12	Karlsruhe	+*	+*	+*	+*	–*	–
de13	Freiburg	+*	+**	+*	+*	–*	–
de14	Tübingen	+**	+**	+**	+**	–	–
de21	Oberbayern	+*	+**	+*	+**	–	–
de22	Niederbayern	+*	+	+*	+	–	–
de23	Oberpfalz	+	+	+	+	–	–*
de24	Oberfranken	+	+	+	+	–	–

de25	Mittelfranken	+*	+*	+*	+*	–	–
de26	Unterfranken	+*	+*	+*	+*	–	–
de27	Schwaben	+**	+**	+**	+**	–	–
de3	Berlin (Objective 1, East Berlin)	–*	–	–**	–	–	–
de4	Brandenburg (Objective 1)	–*	–	–**	–	–*	–*
de5	Bremen	+*	+*	+	+*	–**	–*
de6	Hamburg	+	+	+	+	–**	–
de71	Darmstadt	+*	+*	+	+*	–*	–
de72	Gießen	+*	+**	+*	+*	–*	–
de73	Kassel	+	+*	+	+*	–	–
de8	Mecklenburg-Vorpommern (Objective 1)	–	+	–	+	–*	–
de91	Braunschweig	+	+	+	+	–*	–
de92	Hannover	+*	+*	+	+*	–**	–*
de93	Lüneburg	+	+*	+	+*	–*	–
de94	Weser-Ems	+*	+*	+	+*	–	–
dea1	Düsseldorf	+	+	+	+	–*	–
dea2	Köln	+	+*	+	+	–*	–
dea3	Münster	+	+*	+	+*	–	–
dea4	Detmold	+*	+*	+	+*	–**	–*
dea5	Arnsberg	+*	+*	+	+*	–**	–*
deb1	Koblenz	+*	+**	+*	+*	–*	–
deb2	Trier	+	+*	+	+*	–*	–
deb3	Rheinhessen-Pfalz	+*	+*	+	+*	–**	–*
dec	Saarland	+	+*	+	+	–**	–
ded1	Chemnitz (Objective 1)	–	–	–	–	–**	–*
ded2	Dresden (Objective 1)	–	–	–*	–	–*	–**
ded3	Leipzig (Objective 1)	–	–	–*	–	–*	–*
dee1	Dessau (Objective 1)	–*	–	–*	–	–*	–*
dee2	Halle (Objective 1)	–	+	–	–	–	–
dee3	Magdeburg (Objective 1)	–	+	–	+	–**	–
def	Schleswig-Holstein	+	+*	+	+*	–*	–
deg	Thüringen (Objective 1)	–	+	–	+	–	–
	Greece						
gr11	Anatoliki Makedonia, Thraki (Objective 1)	–**	–**	–**	–**	+*	–**
gr12	Kentriki Makedonia (Objective 1)	–**	–**	–**	–**	+	–*
gr13	Dytiki Makedonia (Objective 1)	–**	–*	–**	–*	+	–
gr14	Thessalia (Objective 1)	–**	–	–**	–	+	–
gr21	Ipeiros (Objective 1)	–**	–	–**	–	+	+
gr22	Ionia Nisia (Objective 1)	–**	–	–**	–	+*	+
gr23	Dytiki Ellada (Objective 1)	–**	–	–**	–	+*	+
gr24	Sterea Ellada (Objective 1)	–**	–*	–**	–	+*	+
gr25	Peloponnisos (Objective 1)	–**	–	–**	–	+	+
gr3	Attiki (Objective 1)	–**	–	–**	–	+	+
gr41	Voreio Aigaio (Objective 1)	–**	–*	–**	–*	+	–
gr42	Notio Aigaio (Objective 1)	–**	–*	–**	–*	+	–
gr43	Kriti (Objective 1)	–**	–	–**	–	+	+
	Spain						
es11	Galicia (Objective 1)	–**	–	–*	–	+*	+
es12	Principado de Asturias (Objective 1)	–*	–	–*	+	+*	+
es13	Cantabria (Objective 1)	–	+	–	+	+	+
es21	Pais Vasco	–	+	–	+	+	+
es22	Comunidad Foral de Navarra	–	+	–	+	+	+
es23	La Rioja	–	+	–	+	+*	+
es24	Aragón	–	+	–	+	+	+
es3	Comunidad de Madrid	–*	–	–*	+	+*	+
es41	Castilla y León (Objective 1)	–*	+	–	+	+*	+
es42	Castilla-la Mancha (Objective 1)	–*	+	–	+	+*	+
es43	Extremadura (Objective 1)	–**	–	–**	–	+	+
es51	Cataluña	–	+	–	+	+	+

es52	Comunidad Valenciana (Objective 1)	–	+	–	+	+*	+
es53	Illes Balears	–	+	–	+	+	+
es61	Andalucia (Objective 1)	–**	–	–**	–	+	+
es62	Murcia (Objective 1)	–*	+	–	+	+*	+
	France						
fr1	Île de France	–	+	–	+	–*	–
fr21	Champagne-Ardenne	+	+*	+	+	–*	–
fr22	Picardie	+*	+*	+	+*	–*	–
fr23	Haute-Normandie	+	+*	+	+*	+	+
fr24	Centre	+	+	–	+	–	–
fr25	Basse-Normandie	+	+	+	+*	+	+
fr26	Bourgogne	+	+	–	+	–*	–
fr3	Nord-Pas-de-Calais	+*	+**	+*	+*	–*	–
fr41	Lorraine	+	+*	+	+	–*	–
fr42	Alsace	+	+*	+	+*	–**	–*
fr43	Franche-Comté	+*	+*	+*	+*	–	–
fr51	Pays de la Loire	+	+	+	+	–	–
fr52	Bretagne	–	+	–	+	+	+
fr53	Poitou-Charentes	+	+	+	+	–	–
fr61	Aquitaine	–	+	–	+	+	+
fr62	Midi-Pyrénées	–	+	–	+	–	–
fr63	Limousin	+	+	+	+	–	–
fr71	Rhône-Alpes	+	+	+	+	–*	–
fr72	Auvergne	+	+	+	+	–	–
fr81	Languedoc-Roussillon	+	+	–	+	–	–
fr82	Provence-Alpes-Côte d'Azur	+	+*	+	+	–	–
fr83	Corse (Objective 1)	+*	+*	+*	+*	–	–
	Ireland						
ie01	Border, Midlands and Western (Objective 1)	–	+	–	+	+	+
ie02	Southern and Eastern (Objective 1)	–	+	–	+	+	+
	Italy						
it11	Piemonte	+*	+*	+*	+*	–	–
it12	Valle d'Aosta	+*	+*	+	+*	–	–
it13	Liguria	+**	+**	+**	+**	+	+
it2	Lombardia	+**	+**	+**	+**	+	+
it31	Trentino-Alto Adige	+**	+**	+**	+**	+	+
it32	Veneto	+**	+**	+**	+**	+	+
it33	Friuli-Venezia Giulia	+**	+*	+**	+*	+	+
it4	Emilia-Romagna	+*	+*	+*	+*	+	+
it51	Toscana	+*	+*	+*	+*	+	+
it52	Umbria	+	+*	+	+*	+	+
it53	Marche	+	+*	+	+*	+	+
it6	Lazio	–	+	+	+	+	+
it71	Abruzzo (Objective 1)	+	+	+	+	+	+
it72	Molise (Objective 1)	–	+	–	+	+	+
it8	Campania (Objective 1)	–	+	–	+	+	+
it91	Puglia (Objective 1)	–*	–	–*	+	+	+
it92	Basilicata (Objective 1)	–*	+	–	+	+	+
it93	Calabria (Objective 1)	–**	–	–**	–	+	+
ita	Sicilia (Objective 1)	–	–	–	+	+	+
itb	Sardegna (Objective 1)	+	+*	+	+*	+	+
	Luxembourg						
lu	Luxembourg	+	+	–	+	–**	–*
	Netherlands						
nl11	Groningen	+	+*	+	+*	–	–
nl12	Friesland	+	+*	+	+*	+	+
nl13	Drenthe	+	+*	+	+*	–	–
nl21	Overijssel	+	+*	+	+	–	–

nl22	Gelderland	+	+*	+	+*	+	+
nl23	Flevoland (Objective 1)	+	+*	+*	+*	+	+
nl31	Utrecht	+	+*	+	+*	+	+
nl32	Noord-Holland	+	+*	+	+*	+	+
nl33	Zuid-Holland	+**	+**	+**	+**	–	–
nl34	Zeeland	+*	+*	+	+*	–	–
nl41	Noord-Brabant	+*	+*	+*	+*	+	+
nl42	Limburg (NL)	+	+*	+	+*	–	–
	Austria						
at11	Burgenland (Objective 1)	+	–	+*	–	+	+
at12	Niederösterreich	+	–	+	–	–	–
at13	Vienna	+	–	+	–	+	+
at21	Kärnten	+*	+*	+**	+*	+	+
at22	Steiermark	+*	+	+*	+	+	+
at31	Oberösterreich	+*	+	+*	+	+	–
at32	Salzburg	+*	+	+*	+	+	+
at33	Tirol	+**	+**	+**	+**	–	–
at34	Vorarlberg	+**	+**	+**	+**	–	–
	Portugal						
pt11	Norte (Objective 1)	–**	–	–**	–	+	+
pt12	Centro (PT) (Objective 1)	–**	–	–**	–	+	+
pt13	Lisboa e Vale do Tejo (Objective 1)	–**	–	–**	–	+	+
pt14	Alentejo (Objective 1)	–**	–	–**	–	+	+
pt15	Algarve (Objective 1)	–**	–	–**	–	+	+
	Finland						
fi13	Itä-Suomi	+	–	+	–	+	+**
fi14	Väli-Suomi	+	–	+	+	+	+**
fi15	Pohjois-Suomi	+	+	+	+	+	+*
fi16	Uusimaa (suuralue)	+	–	+	–	+	+**
fi17	Etelä-Suomi	+	–	+	–	+	+**
fi2	Åland	+	+	+	+	–	+
	Sweden						
se01	Stockholm	+	–	+	–	–	+
se02	Östra Mellansverige	+	–	+	+	–*	+
se04	Sydsverige	–	–	–	–	–*	–
se06	Norra Mellansverige	+	+	+	+	–	+
se07	Mellersta Norrland	+	+	+	+	–	+
se08	Övre Norrland	+	+*	+	+*	+	+
se09	Småland med öarna	+	–	+	–	–	+*
se0a	Västsverige	+	+	+	+	–**	–
	United Kingdom						
ukc1	Tees Valley and Durham	–	+	–	+	+	+
ukc2	Northumberland, Tyne and Wear	–	+	–	+	–	–
ukd1	Cumbria	–	+	–	+	–	+
ukd2	Cheshire	–	+	–	+	+	+
ukd3	Greater Manchester	–	+	–	+	+	+
ukd4	Lancashire	–	+	–	+	+	+
ukd5	Merseyside (Objective 1)	–	+	–	+	+	+
uke1	East Riding and North Lincolnshire	–	+	–	+	+	+
uke2	North Yorkshire	–	+	–	+	+	+
uke3	South Yorkshire	–	+	–	+	+	+
uke4	West Yorkshire	–	+	–	+	+	+
ukf1	Derbyshire and Nottinghamshire	–	+	–	+	+	+
ukf2	Leicestershire, Rutland and Northants	+	+	+	+*	+*	+
ukf3	Lincolnshire	+	+	+	+	+**	+*
ukg1	Herefordshire, Worcestershire and Warks	+	+	+	+	+	+
ukg2	Shropshire and Staffordshire	–	+	–	+	+	+
ukg3	West Midlands	+	+	+	+	+*	+

ukh1	East Anglia	+	+*	+	+*	+**	+*
ukh2	Bedfordshire, Hertfordshire	+	+*	+*	+*	+**	+*
ukh3	Essex	+	+*	+*	+*	+**	+*
uki1	Inner London	+	+	+	+*	+**	+*
uki2	Outer London	+	+*	+*	+*	+**	+*
ukj1	Berkshire, Bucks and Oxfordshire	+	+*	+*	+*	+**	+*
ukj2	Surrey, East and West Sussex	+	+*	+*	+*	+**	+*
ukj3	Hampshire and Isle of Wight	+	+*	+*	+*	+**	+
ukj4	Kent	+	+*	+*	+*	+**	+*
ukk1	Gloucestershire, Wiltshire and North Somerset	+	+	+	+	+*	+
ukk2	Dorset and Somerset	−	+	−	+	+*	+
ukk3	Cornwall and Isles of Scilly	−	+	−	+	+	+
ukk4	Devon	−	+	−	+	+	+
ukl1	West Wales and The Valleys	−	+	−	+	+	+
ukl2	East Wales	−	+	−	+	+	+
ukm1	North Eastern Scotland	−	+	−	+	−	−
ukm2	Eastern Scotland	−	+	−	+	−	−
ukm3	South Western Scotland	−	+	−	+	−	−
ukm4	Highlands and Islands (Objective 1)	−	+	−	+	−	−
ukn	Northern Ireland (Objective 1)	−	+	−	+	+	+

*Significant at the 5% significance level based on normal approximation

**Significant at the 5% Sidàk pseudo-significance level

Objective 1 Eligible regions which have benefited from Objective 1 Structural Funds throughout the 1995–2000 period taking into account NUTS modifications

Appendix C

LISA for log per capita GDP measured in PPS and average annual growth rates, 1995 and 2000 for EU15 and EU27

Code	Regions	EU15 2000	EU27	EU15 1995	EU27	EU15 Growth rates	EU27
	Belgium						
be1	Région Bruxelles-capitale	HH	HH*	HH	HH*	LL*	LL
be21	Antwerpen	HH*	HH**	HH*	HH**	LL	LL
be22	Limburg (B)	HH*	HH**	LH*	HH**	LL	LL
be23	Oost-Vlaanderen	HH*	HH**	HH	HH*	LL*	LL
be24	Vlaams Brabant	HH*	HH**	HH	HH*	HL*	HL
be25	West-Vlaanderen	HH*	HH**	HH	HH*	LL*	LL
be31	Brabant Wallon	HH*	HH**	HH	HH*	HL**	HL*
be32	Hainaut (Objective 1)	LH*	LH**	LH	LH*	LL*	LL*
be33	Liège	LH	HH*	LH	HH*	LL	LL
be34	Luxembourg (B)	LH*	HH**	LH*	HH**	LL	LL
be35	Namur	LH*	HH**	LH	LH*	LL*	LL
	Denmark						
dk	Denmark	HH*	HH**	HH	HH*	HL**	HL*
	Germany						
de11	Stuttgart	HH**	HH**	HH*	HH**	HL*	HL
de12	Karlsruhe	HH*	HH**	HH*	HH**	LL*	LL
de13	Freiburg	HH**	HH**	HH*	HH**	LL*	LL
de14	Tübingen	HH**	HH**	HH**	HH**	LL	LL
de21	Oberbayern	HH**	HH**	HH*	HH**	HL	HL

de22	Niederbayern	HH*	HH	HH*	HH	LL	LL
de23	Oberpfalz	HH	HH	HH	HH	HL	HL*
de24	Oberfranken	HH	HH*	HH	HH*	LL	LL
de25	Mittelfranken	HH*	HH**	HH*	HH**	LL	LL
de26	Unterfranken	HH*	HH**	HH*	HH**	LL*	LL
de27	Schwaben	HH**	HH**	HH**	HH**	LL	LL
de3	Berlin (Objective 1, East Berlin)	HL**	HL	HL**	HL	LL*	LL
de4	Brandenburg (Objective 1)	LL*	LL	LL**	LL	LL*	LL*
de5	Bremen	HH*	HH**	HH	HH*	LL**	LL*
de6	Hamburg	HH	HH*	HH	HH	LL**	LL*
de71	Darmstadt	HH*	HH**	HH*	HH*	LL*	LL
de72	Gießen	HH**	HH**	HH*	HH**	LL*	LL
de73	Kassel	HH*	HH*	HH	HH*	LL*	LL
de8	Mecklenburg-Vorpommern (Objective 1)	LL	LH	LL	LH	LL**	LL*
de91	Braunschweig	HH	HH*	HH	HH*	HL*	HL
de92	Hannover	HH*	HH**	HH*	HH*	LL**	LL*
de93	Lüneburg	LH*	HH*	LH	HH*	LL*	LL
de94	Weser-Ems	HH*	HH**	LH*	HH*	LL*	LL
dea1	Düsseldorf	HH	HH*	HH	HH	LL*	LL
dea2	Köln	HH	HH*	HH	HH*	LL*	LL
dea3	Münster	HH*	HH**	LH	HH*	LL*	LL
dea4	Detmold	HH*	HH**	HH	HH*	LL**	LL*
dea5	Arnsberg	HH*	HH**	HH*	HH**	LL**	LL*
deb1	Koblenz	HH**	HH**	LH*	HH**	LL*	LL
deb2	Trier	LH*	HH**	LH	HH*	LL*	LL
deb3	Rheinhessen-Pfalz	HH*	HH**	HH	HH*	LL**	LL*
dec	Saarland	HH	HH*	HH	HH*	LL**	LL*
ded1	Chemnitz (Objective 1)	LL	LL	LL*	LL	LL**	LL*
ded2	Dresden (Objective 1)	LL*	LL	LL*	LL	LL*	LL**
ded3	Leipzig (Objective 1)	LL*	HL	LL*	LL	LL*	LL*
dee1	Dessau (Objective 1)	LL*	LL	LL**	LL	LL**	LL*
dee2	Halle (Objective 1)	LL	LH	LL*	LL	LL	LL
dee3	Magdeburg (Objective 1)	LL	LH	LL	LH	HL**	HL*
def	Schleswig-Holstein	HH*	HH*	HH	HH*	LL*	LL
deg	Thüringen (Objective 1)	LL	LH	LL	LH	HL	HL
	Greece						
gr11	Anatoliki Makedonia, Thraki (Objective 1)	LL**	LL**	LL**	LL**	LH*	LL**
gr12	Kentriki Makedonia (Objective 1)	LL**	LL**	LL**	LL**	HH*	HL*
gr13	Dytiki Makedonia (Objective 1)	LL**	LL*	LL**	LL*	HH	HL
gr14	Thessalia (Objective 1)	LL**	LL*	LL**	LL*	HH	HL
gr21	Ipeiros (Objective 1)	LL**	LL	LL**	LL	HH	HH
gr22	Ionia Nisia (Objective 1)	LL**	LL	LL**	LL	HH*	HH
gr23	Dytiki Ellada (Objective 1)	LL**	LL*	LL**	LL	LH*	LH
gr24	Sterea Ellada (Objective 1)	LL**	HL*	LL**	HL	LH*	LH*
gr25	Peloponnisos (Objective 1)	LL**	LL	LL**	LL	HH	HH
gr3	Attiki (Objective 1)	LL**	LL*	LL**	LL	LH*	LH
gr41	Voreio Aigaio (Objective 1)	LL**	LL*	LL**	LL*	HH	HL*
gr42	Notio Aigaio (Objective 1)	LL**	LL*	LL**	HL*	HH	HL
gr43	Kriti (Objective 1)	LL**	LL	LL**	LL	HH*	HH
	Spain						
es11	Galicia (Objective 1)	LL**	LL	LL**	LL	HH*	HH
es12	Principado de Asturias (Objective 1)	LL**	LL	LL*	LH	HH*	HH
es13	Cantabria (Objective 1)	LL	LH	LL	HH	HH	HH
es21	Pais Vasco	HL	HH	HL	HH	HH	HH
es22	Comunidad Foral de Navarra	HL	HH	HL	HH	HH	HH
es23	La Rioja	LL	HH	LL	HH	HH*	HH
es24	Aragón	LL	HH	LL	HH	HH*	HH
es3	Comunidad de Madrid	HL**	HL	HL*	HH	HH*	HH
es41	Castilla y León (Objective 1)	LL*	LH	LL*	LH	HH*	HH*

es42	Castilla-la Mancha (Objective 1)	LL*	LH	LL*	LH	HH*	HH*
es43	Extremadura (Objective 1)	LL**	LL	LL**	LL	HH	HH
es51	Cataluña	HL	HH	HL	HH	HH	HH
es52	Comunidad Valenciana (Objective 1)	LL	LH	LL	HH	HH*	HH
es53	Illes Balears	HL	HH	HL	HH	HH	HH
es61	Andalucia (Objective 1)	LL**	LL	LL**	LL	HH*	HH
es62	Murcia (Objective 1)	LL*	LH	LL*	LH	HH*	HH
	France						
fr1	Île de France	HL	HH	HL	HH	LL**	LL*
fr21	Champagne-Ardenne	HH	HH*	HH	HH*	LL*	LL
fr22	Picardie	LH*	HH**	LH	HH*	LL*	LL
fr23	Haute-Normandie	HH	HH*	HH	HH*	LH	LH
fr24	Centre	HH	HH	LL	HH	LL*	LL
fr25	Basse-Normandie	LH	HH*	LH	HH*	LH	LH
fr26	Bourgogne	HH	HH*	LL	HH	LL**	LL*
fr3	Nord-Pas-de-Calais	LH**	HH**	LH*	HH**	LL*	LL
fr41	Lorraine	LH	HH*	LH	HH*	LL**	LL*
fr42	Alsace	HH*	HH**	HH	HH*	LL**	LL*
fr43	Franche-Comté	LH*	HH**	LH*	HH**	LL	LL
fr51	Pays de la Loire	LH	HH*	LH	HH*	LL	LL
fr52	Bretagne	LL	HH	LL	HH	LH	LH
fr53	Poitou-Charentes	LH	HH*	LH	HH	LL*	LL
fr61	Aquitaine	HL	HH	LL	HH	LH	LH
fr62	Midi-Pyrénées	LL	HH	LL	HH	LL	LL
fr63	Limousin	LH	HH	LH	HH	LL	LL
fr71	Rhône-Alpes	HH	HH*	HH	HH	LL*	LL
fr72	Auvergne	LH	HH*	LH	HH	LL*	LL
fr81	Languedoc-Roussillon	LH	HH	LL	HH	LL	LL
fr82	Provence-Alpes-Côte d'Azur	HH	HH*	LH	HH*	LL	LL
fr83	Corse (Objective 1)	LH*	HH**	LH*	HH**	LL	LL
	Ireland						
ie01	Border, Midlands and Western (Objective 1)	LL	LH	LL	HH	HH	HH
ie02	Southern and Eastern (Objective 1)	HL	HH	HL	HH	HH	HH
	Italy						
it11	Piemonte	HH*	HH**	HH*	HH**	HL	HL
it12	Valle d'Aosta	HH*	HH**	HH*	HH**	LL	LL
it13	Liguria	HH**	HH**	HH**	HH**	HH	HH
it2	Lombardia	HH**	HH**	HH**	HH**	HH	HH
it31	Trentino-Alto Adige	HH**	HH**	HH**	HH**	HH	HH
it32	Veneto	HH**	HH**	HH**	HH**	HH	HH
it33	Friuli-Venezia Giulia	HH**	HH**	HH**	HH**	LH	LH
it4	Emilia-Romagna	HH*	HH**	HH*	HH**	HH	HH
it51	Toscana	HH*	HH**	HH*	HH**	HH	HH
it52	Umbria	HH	HH*	HH	HH*	HH	HH
it53	Marche	HH	HH*	HH*	HH*	HH	HH
it6	Lazio	HL	HH	HH	HH	HH	HH
it71	Abruzzo (Objective 1)	LH	HH	LH	HH*	LH	LH
it72	Molise (Objective 1)	LL	HH	LL	HH	HH	HH
it8	Campania (Objective 1)	LL	LH	LL	LH	HH	HH
it91	Puglia (Objective 1)	LL*	LL	LL*	LH	HH	HH
it92	Basilicata (Objective 1)	LL*	LH	LL*	LH	HH	HH
it93	Calabria (Objective 1)	LL**	LL	LL**	LL	HH*	HH
ita	Sicilia (Objective 1)	LL*	LL	LL	LH	HH	HH
itb	Sardegna (Objective 1)	LH	LH*	LH	HH*	HH	HH
	Luxembourg						
lu	Luxembourg	HH	HH	HL	HH	HL**	HL*
	Netherlands						
nl11	Groningen	HH	HH*	HH	HH*	LL	LL

nl12	Friesland	LH*	HH**	HH*	HH**	HH	HH
nl13	Drenthe	LH*	HH*	LH	HH*	LL	LL
nl21	Overijssel	HH	HH*	HH	HH*	HL	HL
nl22	Gelderland	HH	HH*	HH	HH*	HH	HH
nl23	Flevoland (Objective 1)	LH*	HH*	LH*	HH**	HH	HH
nl31	Utrecht	HH	HH*	HH	HH*	HH	HH
nl32	Noord-Holland	HH	HH*	HH	HH*	HH	HH
nl33	Zuid-Holland	HH**	HH**	HH**	HH**	HL	HL
nl34	Zeeland	HH*	HH**	HH*	HH**	LL	LL
nl41	Noord-Brabant	HH*	HH**	HH**	HH**	HH	HH
nl42	Limburg (NL)	HH*	HH**	HH	HH*	HL	HL
	Austria						
at11	Burgenland (Objective 1)	LH*	LL	LH*	LL	HH	HH*
at12	Niederösterreich	LH	HL	HH	HL	HL	HL
at13	Vienna	HL	HL	HH	HL	LH	LH
at21	Kärnten	HH*	HH*	HH**	HH**	HH	HH
at22	Steiermark	LH*	HH	HH*	HH	HH	HH
at31	Oberösterreich	HH*	HH	HH*	HH	HH	HL
at32	Salzburg	HH*	HH*	HH*	HH*	HH	HH
at33	Tirol	HH**	HH**	HH**	HH**	HL	HL
at34	Vorarlberg	HH**	HH**	HH**	HH**	HL	HL
	Portugal						
pt11	Norte (Objective 1)	LL**	LL	LL**	LL	HH*	HH
pt12	Centro (PT) (Objective 1)	LL**	LL	LL**	LL	LH*	LH
pt13	Lisboa e Vale do Tejo (Objective 1)	HL**	HL	HL**	HL	HH	HH
pt14	Alentejo (Objective 1)	LL**	LL	LL**	LL	LH*	LH
pt15	Algarve (Objective 1)	LL**	LL	LL**	LL	LH*	LH
	Finland						
fi13	Itä-Suomi	LH	LL	LH	LL	LH	LH**
fi14	Väli-Suomi	LH	HL	LH	HH	HH	HH**
fi15	Pohjois-Suomi	LH	HH	LH	HH	HH	HH*
fi16	Uusimaa (suuralue)	HH	HL*	HH	HL	HH	HH**
fi17	Etelä-Suomi	LH	HL	HH	HL	HH	HH**
fi2	Åland	HH	HH	HH	HH	HL	HH
	Sweden						
se01	Stockholm	HH	HL	HH	HL	HL	HH
se02	Östra Mellansverige	HH	HL	LH	HH	LL*	LH
se04	Sydsverige	HL	HL	HL*	HL	LL**	LL
se06	Norra Mellansverige	HH	HH	LH	HH	LL	LH
se07	Mellersta Norrland	HH	HH	HH	HH	LL	LH
se08	Övre Norrland	HH	HH*	LH	HH*	LH	LH
se09	Småland med öarna	HH	HL	HH	HL	LL*	LH*
se0a	Västsverige	HH	HH	HH	HH	LL**	LL
	United Kingdom						
ukc1	Tees Valley and Durham	LL	HH	LL	LH	LH	LH
ukc2	Northumberland, Tyne and Wear	LL	HH	LL	HH	LL	LL
ukd1	Cumbria	HL	HH	LL	HH	LL	LH
ukd2	Cheshire	HL	HH	HL	HH	HH	HH
ukd3	Greater Manchester	LL	HH	LL	HH	HH	HH
ukd4	Lancashire	LL	HH	LL	HH	LH	LH
ukd5	Merseyside (Objective 1)	LL	LH	LL	LH	HH	HH
uke1	East Riding and North Lincolnshire	LL	HH	HL	HH	HH*	HH
uke2	North Yorkshire	LL	HH	HL	HH	HH	HH
uke3	South Yorkshire	LL	LH	LL	LH	HH	HH
uke4	West Yorkshire	LL	HH	LL	HH	HH	HH
ukf1	Derbyshire and Nottinghamshire	LL	HH	LL	HH	HH*	HH
ukf2	Leicestershire, Rutland and Northants	HH	HH*	HH	HH*	HH*	HH*
ukf3	Lincolnshire	LH	HH	LH	HH*	HH**	HH*

ukg1	Herefordshire, Worcestershire and Warks	HH	HH	HH	HH*	HH	HH
ukg2	Shropshire and Staffordshire	LL	HH	LL	HH	HH	HH
ukg3	West Midlands	HH	HH	HH	HH*	LH*	LH
ukh1	East Anglia	HH	HH*	HH*	HH**	HH**	HH*
ukh2	Bedfordshire, Hertfordshire	HH	HH*	HH*	HH**	HH**	HH*
ukh3	Essex	LH	HH*	HH*	HH**	HH**	HH*
uki1	Inner London	HH	HH*	HH	HH*	HH**	HH*
uki2	Outer London	LH	HH*	LH*	HH**	HH**	HH*
ukj1	Berkshire, Bucks and Oxfordshire	HH	HH*	HH*	HH**	HH**	HH*
ukj2	Surrey, East and West Sussex	HH	HH*	HH*	HH**	HH**	HH*
ukj3	Hampshire and Isle of Wight	HH	HH*	HH*	HH**	HH**	HH*
ukj4	Kent	LH	HH**	HH*	HH**	HH**	HH*
ukk1	Gloucestershire, Wiltshire and North Somerset	HH	HH	HH	HH*	HH*	HH
ukk2	Dorset and Somerset	LL	HH	LL	HH	HH*	HH
ukk3	Cornwall and Isles of Scilly	LL	LH	LL	LH	HH	HH
ukk4	Devon	LL	HH	LL	HH	LH*	LH
ukl1	West Wales and The Valleys	LL	LH	LL	LH	HH	HH
ukl2	East Wales	HL	HH	HL	HH	LH	LH
ukm1	North Eastern Scotland	HL	HH	HL	HH	LL	LL
ukm2	Eastern Scotland	HL	HH	HL	HH	LL	LL
ukm3	South Western Scotland	LL	HH	LL	HH	LL	LL
ukm4	Highlands and Islands (Objective 1)	LL	HH	LL	LH	LL	LL
ukn	Northern Ireland (Objective 1)	LL	HH	LL	HH	LH	LH

*Significant at the 5% significance level based on normal approximation**Significant at the 5% Sidàk pseudo-significance level*Objective 1* Eligible Regions which have benefited from Objective 1 of Structural Funds throughout the 1995–2000 period taking into account NUTS modifications

Appendix D

Getis–Ord statistics and LISA for log per capita GDP measured in PPS and average annual growth rates, 1995 and 2000 for new acceding and candidate countries

Code	Regions	2000		1995		Growth rates	
		Gi	LISA	Gi	LISA	Gi	LISA
	Cyprus						
cy	Cyprus	–**	HL**	–**	HL**	–*	LL**
	Czech Republic						
cz01	Praha	−	HL*	−	HL	–*	HL*
cz02	Strední Cechy	−	LL	+	LH	–*	LL*
cz03	Jihozápad	+	LH	+	LH	−	LL
cz04	Severozápad	−	LL	−	LL	−	LL
cz05	Severovýchod	−	LL	−	LL	−	LL
cz06	Jihovýchod	−	LL	−	LL	−	LL
cz07	Strední Morava	–*	LL*	–*	LL*	−	LL
cz08	Moravskoslezko	–**	LL**	–**	LL**	+	LH
	Estonia						
ee	Estonia	−	LL	−	LL*	+**	HH**

	Hungary						
hu01	Közép-Magyarország	–**	HL**	–**	LL**	+	HH
hu02	Közép-Dunántúl	–	LL*	–*	LL*	+	HH
hu03	Nyugat-Dunántúl	–	LL	–	LL	+	HH
hu04	Dél-Dunántúl	–	LL	–	LL	+*	HH*
hu05	Észak-Magyarország	–**	LL**	–**	LL**	+*	HH**
hu06	Észak-Alföld	–**	LL**	–**	LL**	+	LH
hu07	Dél-Alföld	–**	LL**	–**	LL**	+	LH*
	Lithuania						
lt	Lithuania	–**	LL**	–**	LL**	+**	HH**
	Latvia						
lv	Latvia	–*	LL*	–**	LL**	+**	HH**
	Malta						
mt	Malta	–	LL	–	LL	+	HH
	Poland						
pl01	Dolnoslaskie	–**	LL**	–*	LL*	–	HL
pl02	Kujawsko-Pomorskie	–**	LL**	–**	LL**	+**	HH**
pl03	Lubelskie	–**	LL**	–**	LL**	+**	HH**
pl04	Lubuskie	–*	LL*	–	LL*	–	HL
pl05	Lódzkie	–**	LL**	–**	LL**	+*	HH*
pl06	Malopolskie	–**	LL**	–**	LL**	+	HH
pl07	Mazowieckie	–**	LL**	–**	LL**	+**	HH**
pl08	Opolskie	–**	LL**	–**	LL**	–	LL
pl09	Podkarpackie	–**	LL**	–**	LL**	+*	HH*
pl0a	Podlaskie	–**	LL**	–**	LL**	+**	HH**
pl0b	Pomorskie	–**	LL**	–**	LL**	+**	HH**
pl0c	Slaskie	–**	LL**	–**	LL**	+	HH
pl0d	Swietokrzyskie	–**	LL**	–**	LL**	+**	HH**
pl0e	Warminsko-Mazurskie	–**	LL**	–**	LL**	+**	HH**
pl0f	Wielkopolskie	–**	LL**	–**	LL**	+	HH
pl0g	Zachodniopomorskie	–*	LL*	–*	LL*	+	HH
	Slovenia						
si	Slovenia	+	LH	+	LH	+	HH*
	Slovakia						
sk01	Bratislavský	–	HL*	–	HL*	–	HL
sk02	Západné Slovensko	–	LL	–	LL	+	HH
sk03	Stredné Slovensko	–**	LL**	–**	LL**	+	HH
sk04	Východné Slovensko	–**	LL**	–**	LL**	+	HH
	Bulgaria						
bg01	Severozapaden	–**	LL**	–**	LL**	–**	LL**
bg02	Severen Tsentralen	–**	LL**	–**	LL**	–**	LL**
bg03	Severoiztochen	–**	LL**	–**	LL**	–**	LL**
bg04	Yugozapaden	–**	LL**	–**	LL**	–**	LL**
bg05	Yuzhen Tsentralen	–**	LL**	–**	LL**	–**	LL**
bg06	Yugoiztochen	–**	LL**	–**	LL**	–**	LL**
	Roumania						
ro01	Nord-Est	–**	LL**	–**	LL**	–**	LL**
ro02	Sud-Est	–**	LL**	–**	LL**	–**	LL**
ro03	Sud	–**	LL**	–**	LL**	–**	LL**
ro04	Sud-Vest	–**	LL**	–**	LL**	–**	LL**
ro05	Vest	–**	LL**	–**	LL**	–*	LL**
ro06	Nord-Vest	–**	LL**	–**	LL**	–*	LL*
ro07	Centru	–**	LL**	–**	LL**	–**	LL**

ro08	Bucuresti	–**	LL**	–**	LL**	–**	LL**

*Significant at the 5% significance level based on the normal approximation for Getis–Ord statistics and on 10,000 permutations for LISA**Significant at the 5% Sidàk pseudo-significance level for Getis–Ord statistics and at the 5% Bonferroni pseudo-significance level for LISA

Appendix E

LISA for log per capita GDP measured in PPS and average annual growth rates, 1995 and 2000 for EU15 and EU27, using Bonferroni pseudo-significance level

Significant LISA at the Bonferroni 5% pseudo-significance level for log per capita GDP (PPS) for 1995 and 2000, EU15

Years	Percentage of significant statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant HH statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant LL statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant LH statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant HL statistics at the 5% Bonferroni pseudo-significance level
2000	18.23%	5.91%	11.33%	0.00%	0.99%
1995	20.20%	7.39%	10.84%	0.49%	1.48%

Significant LISA at the Bonferroni 5% pseudo-significance level for log per capita GDP (PPS) for 1995 and 2000, EU27

Years	Percentage of significant statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant HH statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant LL statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant LH statistics at the 5% Bonferroni pseudo-significance level	Percentage of significant HL statistics at the 5% Bonferroni pseudo-significance level
2000	31.40%	16.28%	14.34%	0.00%	0.78%
1995	34.88%	19.38%	14.73%	0.39%	0.39%

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