DIFFERENCES IN THE SPATIAL PATTERNS OF SELECTED GERMAN (NUTS3) ECONOMIC FACTORS, WITH SPECIAL REGARDS ON GDP, UNEMPLOYMENT AND ENTERPRISES

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ABSTRACT

The spatial inequalities are main characteristics of the economies. The distribution of the economic indicators is not equal across regions. The cause for it is that in the space does not exist two territories with the same characteristics; their economic, social and cultural indicators are different. In this research will be analysed the spatial patterns of some economic factors of the German economy. Special focus of the analysis will be the spatial autocorrelation analysis of the indicators which measures the role of space in the distribution of the values. The results show some differences between the GDP, enterprises and the unemployment factors.

Keywords: spatial autocorrelation Germany, LISA, GDP, enterprises, unemployment rate

INTRODUCTION

The dispersion of the economic and social factors is not homogeny in space. There are huge inequalities across the regions in almost every country. **[3]** My main research field is the convergence process of the German and Hungarian economy with special regards on their peripheral regions. In this recent research will be analysed the spatial patterns of some economic factors in Germany, like GDP per capita, number of registered enterprises and unemployment rate. According to the spatial autocorrelation theory the values of the neighbouring territories have an influence on each other, which is observable on the spatial patterns of the indicators. The main goal of this research is to examine first the spatial dispersion of selected economic indicators, and prove the validity of the spatial autocorrelation theory in their case.

THEORETICAL BACKGROUND

"Everything is related to everything else, but near things are related than distant things" says Waldo Tobler according to the first law of the geography (1970). So in the dispersion of the economic indicators the spatial connections are important. Spatial econometrics is the theory which analyses the role of space in the distribution of the indicators. The main question is whether the spatial distribution

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of the dates is stochastic or there are kinds of patterns in the space. **[5]** The test method is the spatial autocorrelation technic where autocorrelation means that the neighbouring territories make an influence on each other. If there is no autocorrelation, than the values are independent from each other, the distance of the regions does not matter.
Critical point of the analysis is the selection of the correct contiguity matrix which describes the spatial relations. The most frequently used technics are the rook and queen contiguity, the k-nearest neighbours method (where k is the number of neighbours) and the threshold distance method.
My former analysis in the German convergence process has resulted that there was a small convergence across the economic indicators, but in my opinion it is important to examine also the spatial connections to test the role of space.
In the spatial autocorrelation analysis the Moran's I index is the most common used measure developed by Patrick Alfred Pierce Moran in 1950. The index calculation method is the following:

$$I = \left(\frac{N}{\sum D_{ij}}\right) * \sum\sum(x_i - x) * \left(x_j - x\right) * \frac{D_{ij}}{\sum(x_i - x)^2} \quad (1)$$

where $(x_i - x) * \left(x_j - x\right)$ is the product of the regions values and the difference of the means. D_{ij} is the contiguity matrix and N is the number of territories. The index's maximum is 1 and the minimum equals zero. If $I > -1/N - 1$, then there is a positive and if $I < -1/N - 1$, then there is a negative spatial autocorrelation. **[2]**
Other form of the calculation is the Local Moran I, developed by Luc Anselin in 1995, which creates clusters from regions. The index shows where the homogeny high developed (high-high cluster) and relatively underdeveloped territories (low-low cluster) are in the space, and shows the regions which differ mostly from their neighbours. **[1]** The cluster characteristics can be seen on the following table 1.

1. Table
The characteristics of the Local Moran clusters

Cluster	Characteristics
High-high	The examined NUTS3 territory and their neighbours also have significantly higher values than the average.
High-low	The examined NUTS3 territory has significantly higher value than the average, but their neighbours values are below the average.
Low-high	The examined NUTS3 territory has significantly lower value than the average, but their neighbours values are above the average.
Low-low	The examined NUTS3 territory and their neighbours also have significantly lower values than the average.

Source: compiled by the author according Tóth (2013) **[4]**

Data

In my research I analysed the distribution of some economic indicators in Germany which are the GDP per capita in PPS (power parity standard), the number of the registered enterprises and the unemployment rate. All dates were analysed in the NUTS3 level, which means in Germany 434 districts and city regions. The examined year was 2011. The data sources are shown in next table2.

2. Table

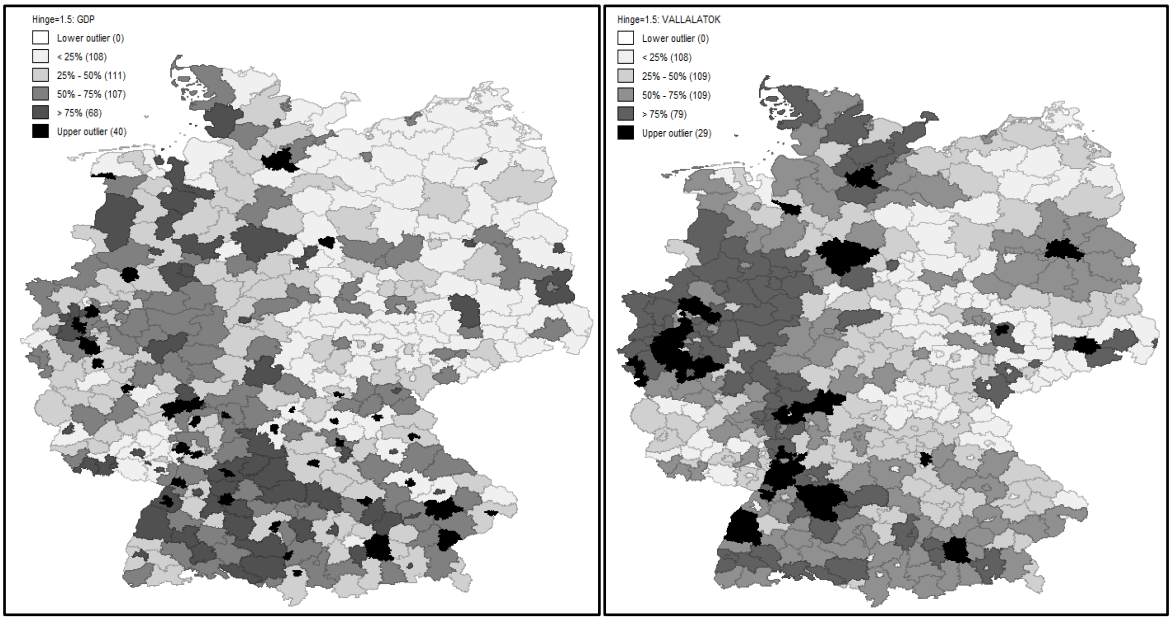
The source of the data

Indicator	Data source
GDP per capita in PPS	Eurostat data bank
Number of the registered enterprises	Statistisches Bundesamt Deutschland – Regional Data Bank
Unemployment rate	Statistisches Bundesamt Deutschland – Regional Data Bank

Source: compiled by the author

DIFFERENCES IN THE DISTRIBUTION OF THE DATES

In my analysis first I examined the dispersion of the indicators across the NUTS3 territories, to see the differences. To compare the different units of the indices there was used a scale transformation technic and the type of the graphic analysis was also carefully chosen. I used the box map analysis with hinge 1,5 criteria.
First I assumed that there is a kind of similarity in the distribution of the GDP per capita and the registered enterprises, because the more enterprises can help to increase the regions GDP.

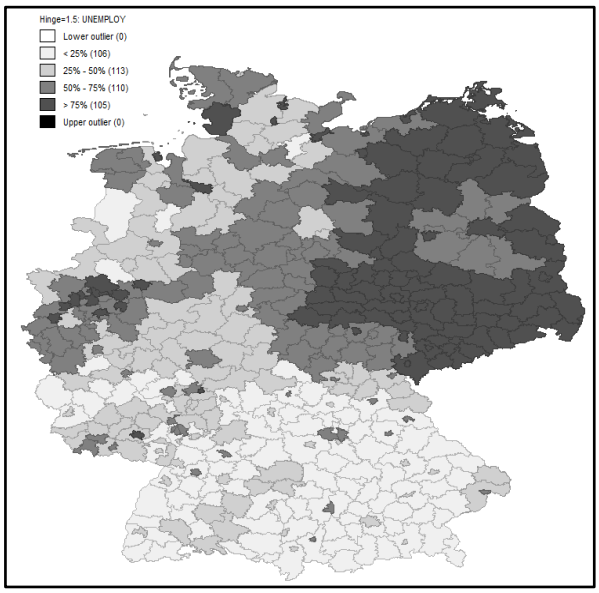


1. Figure

Distribution of the GDP per capita (left) and number of the registered enterprises (right)

Source: compiled by the author

From the distribution of the data can be made a statement that the dispersion of the GDP per capita and the enterprises shows some similar tendencies across the territories. Both of the indicators show western concentration. The highest values are in both cases in Nordrhein-Westfalen Bundesland (mainly in the Ruhr area), in Hamburg, Bremen, München and in the Western part of Baden-Württemberg. There is also observable that by the GDP there are more hot spots in the space which indicate city regions. Another difference between the indicators, that the density of the enterprises is high in the whole Nordrhein-Westfalen and Niedersachsen Bundeslands, but the GDP per capita is not so dominant in the area.
The lowest and mostly underdeveloped territories can be found in the Eastern part of the country, mainly on the area of Mecklenburg-Vorprommern, Sachsen and Sachsen-Anhalt. The capital and its neighbourhood seems like relatively high developed region according the number of enterprises, but the GDP per capita verifies it only as middle-developed area.
The distribution of the unemployment rate is a little different from the above, although shows also some similarities. There are high unemployment rates in the Eastern part of the country; almost the whole former GDR has very high rates. The unemployment is also high in the Ruhr area, and in Northern-Germany. Although there are a lot of enterprises in the Ruhr area, in some parts of it the GDP is relatively low and unemployment is high. These can be sign, that there are a lot of small and medium sized enterprises in this territory which employment is not high.



2. Figure
Distribution of the unemployment rate in Germany (NUTS3)
Source: compiled by the author

The unemployment rate is the lowest in the southern part of Germany: Bayern, Baden-Württemberg, and Rheinland-Pfalz have the lowest values in the whole county. In these regions the GDP and the number of enterprises is very high, so it can be some connection between the indicators.
That is why I tested the linear correlation of the dates, which verified between the GDP per capita and the number of enterprises weak, but significant positive

correlation. Between the GDP per capita and the unemployment rate can be justified a negative, weak correlation. The results are summarized in following table3.

3. Table

The linear correlation results of the indicators

Factors	Linear correlation
GDP per capita – number of the registered enterprises	0,243**
GDP per capita – unemployment rate	-0,104*
Number of the registered enterprises – unemployment rate	0,03
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Other cases non-significant correlation.	

Source: compiled by the author

SIGNIFICANT SPATIAL EFFECTS

I supposed that the neighbourhood effects are important in the distribution of the dates, mainly by the unemployment rate, because in that case there are big similar areas in the space. By analysing the spatial autocorrelation of the dates it was used three different contiguity technics to prove the validity of the results. By the explanation of the results will be represent the 5 nearest neighbours method, which calculates in every region with determined number of neighbours (5). This method is one of the most common used technic in the spatial modelling literature. I used by the analysis also the queen contiguity model, where every common point of two regions matters, and the threshold distance method with 35 miles. I used in every case 999 permutations which is enough number to eliminate the random error.
The results for the three indicators are the following:

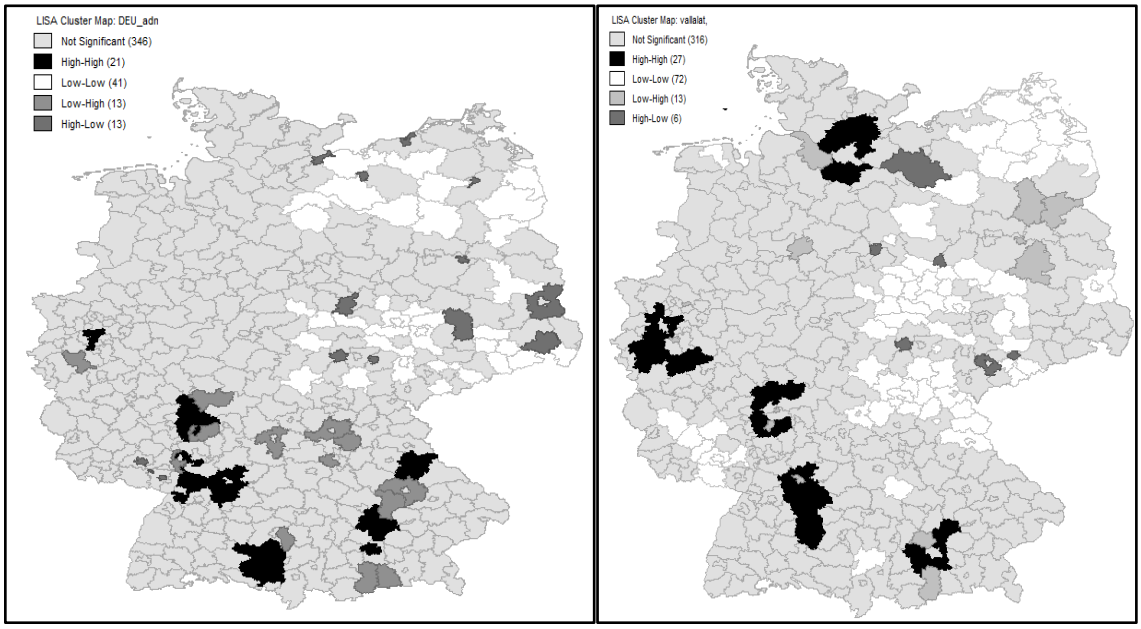
4. Table

The spatial autocorrelation results of the indicators with different contiguity matrix

	queen contiguity	k nearest neighbours (5)	threshold distance (mean centres; arc miles: 35)
GDP per capita			
Moran I	0,0706892	0,117476	0,0917743
pseudo-p value	0,021	0,001	0,001
z score	2,2265	4,1514	4,4625
significance	0,1%-5%	0,1%-5%	0,1%-5%
Number of registered enterprises			
Moran I	0,117203	0,113055	0,08539
pseudo-p value	0,004	0,002	0,006
z score	4,4758	4,6874	4,2453
significance	0,1%-5%	0,1%-5%	0,1%-5%
Unemployment rate			
Moran I	0,769442	0,729426	0,729426
pseudo-p value	0,001	0,001	0,001
z score	24,5642	33,8434	33,9506
significance	0,1%-5%	0,1%-5%	0,1%-5%

Source: compiled by the author

From table4 can be made a statement that in the case of the GDP per capita and the number of enterprises there is significant, but weak spatial autocorrelation, so the neighbourhood effects has not got great influence on the distribution of the values across the territories. By the unemployment rate the results show strong positive and significant spatial autocorrelation. It means that here the neighbours have big effects on each other. It is observable that by the indicators in all of the cases (with every contiguity method) the pseudo-p values and the values of the z score also underline the validity of the spatial autocorrelation.
So in the case of the GDP per capita and the enterprises the Moran I index shows weak autocorrelation across the NUTS3 territories. According the Local Moran index of dates four group of regions can be created.
The Local Moran index by the GDP per capita is not significant by 350 territories. To the high-high cluster, where the territory and their neighbours have also higher GDP than the national average belong 20 territories almost from the southern and south-western parts of the country (Bayern, Baden-Württemberg and Nordrhein Westfalen Bundesland), where the GDP per capita is the highest. These territories are highly developed spaces, sometimes city regions, like Karlsruhe, Mannheim and Frankfurt am Main. The members of the low-high cluster can be found also in the southern and south-western parts of Germany, which are territories with relatively lower GDP, but their neighbours are highly developed. These are 15 territories, for example Regensburg, Helmstedt, Rhein-Erft Kreis, and Darmstadt-Dieburg.
The members of the low-low cluster are mainly in the territory of the former GDR, so in the eastern Bundeslands (Mecklenburg-Vorprommern, Sachsen, Sachsen-Anhalt, Brandenburg and Thüringen). These are relatively underdeveloped spaces, a kind of peripheries (a sum of 38 regions). Some examples are Lüneburg, Chemnitzer Land, Dresden, Löbau-Zittau, Bitterfeld, Gera, Uckermark and Nordwest-Mecklenburg.
The fourth cluster of the Local-Moran analysis is the high-low cluster which means in the case of the GDP per capita 15 members. They are mainly in the eastern and south-western part of the country. Almost every member is a city region, like Kaiserslautern, Coburg, Erfurt, Jena, Schwerin, Neubrandenburg, Lübeck and Rostock, so they are like hot spots in the space.
In the case of the registered enterprises, the Local Moran clusters show some similarity to the GDP values. In 316 territories the autocorrelation is not significant. The high-high cluster (27 regions) can be found mainly in the southern and south-western parts of Germany, similar to the GDP, but by the enterprises the Ruhr area is more dominant. To the high-high cluster belongs by both indicator Mettmann, Main-Taunus Kreis, Gross-Gerau, Heilbronn, Ludwigsburg and Freising. The low-high cluster members are partly also in these regions, and four of them are in Brandenburg Bundesland.



3. Figure

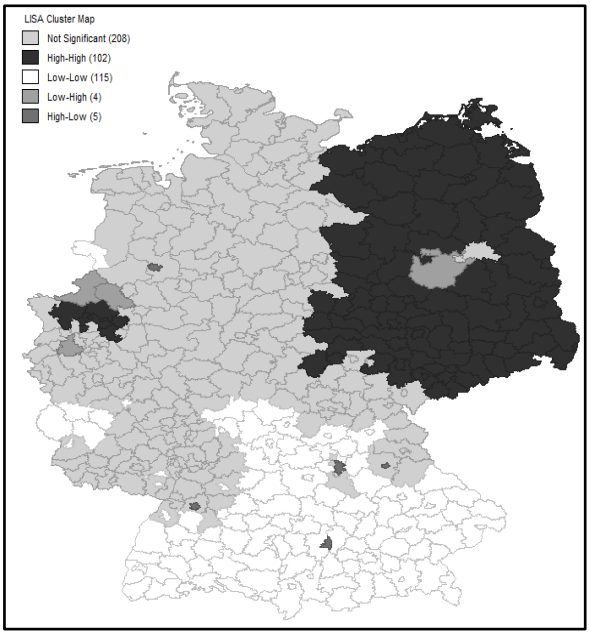
Local Moran map of the GDP per capita (left) and number of the registered enterprises (right)

Source: compiled by the author

The low-low cluster is observable in the eastern part of the country, on the territory of the so called new Bundeslands (new parts of Germany after the reunification of the country). In the low-low cluster there are many similar points to the GDP, a sum of 13 districts are the same in both cases (for example: Birkenfeld, Bernburg, Nordhausen, Sangerhausen, Prignitz and Ucker-Randow). The high-low cluster (7 member) indicates also by the enterprises high developed city regions, five of the cluster members are cities (Braunschweig, Magdeburg, Erfurt, Leipzig, Chemnitz), and four of them are in the eastern part of the country.

The spatial autocorrelation was in the case of the unemployment rate positive and strong. Then the neighbourhood relations have great influence on the distribution of the values, they show grouping tendencies, as it was seen also on figure2. This tendency is also observable by the Local Moran map of the dates.

From Figure4 can be seen that the high-high cluster members (where the examined NUTS3 territory and their neighbours also have higher unemployment rates than the national average) are spatially concentrated in the eastern part of Germany and the Ruhr area. Only Berlin and Potsdam Mittelmark are the exceptions in the eastern part. The low-low cluster can be seen in the southern Bundeslands (Bayern, Baden-Württemberg and Rheinland-Pfalz). These areas are also continuous. The low-high and the high-low cluster have in the case of the unemployment rate only few members.



4. Figure
Local Moran map of the unemployment rate
Source: compiled by the author

CONCLUSIONS

In this recent research I analysed the distribution of selected economic indicators in Germany, like the GDP, enterprises and unemployment. There can be made a statement that the dispersion of the GDP per capita and the enterprises show some similarities, and in their cases the role of the neighbours is weak. The values of the neighbouring territories have not got a great influence on each other.
In the distribution of the unemployment rate the concentration of the dates is observable. This process can be verified also with the spatial autocorrelation which is strong in the country.

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