Abstract: The article aims to verify whether there is spatial autocorrelation between the EU’s NUTS 2 regions in terms of R&D intensity. Three research methods were employed: literature studies, the analysis of data on the share of R&D expenditure in regional GDP and Moran’s $I$, i.e. the main measure of correlation between observations in the geographical space. As demonstrated by the investigation conducted, there is neither global nor local spatial autocorrelation based on the inverse of the geographical distance between NUTS 2. However, it was found that there was a weak positive spatial autocorrelation based on sharing a common border, in both global and local terms. In the European space, two clusters were identified (including three regions in Belgium and five regions in Germany). On account of significant spatial disproportions between regions in the EU, the existence of clusters is a rare phenomenon. For a research-intensive cluster of regions to be created, it is necessary that the neighbouring regions should have metropolitan centres, extensive university and research infrastructure and developed business communities strongly engaged in R&D; another pre-requisite is regional specialisation in similar knowledge-intensive industries.

Keywords: research and development, regional inequalities, spatial autocorrelation, EU, NUTS 2.

JEL Codes: C21, O30, R12.

Introduction

It is a widespread belief that R&D intensity measured as the share of gross expenditure on research and development (GERD) in GDP represents a key indicator for the assessment of the research and technology potential of a country or region, especially in the context of international or interregional comparisons.

The study aims to verify the existence of spatial autocorrelation between NUTS 2 regions of the EU-28 in terms of R&D intensity. The measurement of spatial correlation is based on Moran’s $I$, used to measure global and local spatial autocorrelation. The analysis makes use of two types of spatial weights matrix, defining neighbourhood as sharing a common land border and as the inverse of the distance between the geometric centres of regions.

The study is composed of four main parts. The first part presents a review of studies concerning EU regions in the context of R&D activities. The second section contains a general description of R&D intensity in NUTS 2. The third part describes the research method. Finally, the fourth section includes the findings from the analysis of spatial autocorrelation between NUTS 2 regions in the EU.
1. A review of the literature

For years, disproportions in the development of European Union regions have been addressed by policy makers and scholars alike. The European Union’s efforts to achieve regional convergence have been made within the framework of the cohesion policy, subject to evaluation and modification/revision [Bachtler, Wren, 2006, pp. 143–153; McCann, Ortega-Argilés, 2015, pp. 1291–1302].

One of the key challenges faced by the EU is to develop a knowledge- and innovation-based economy, with the EU actions taken within the Europa 2020 strategy. The EU continues to be affected by the still significant disparities in R&D potential between Member States [Barber, Scherngell, 2013, pp. 1283–1291; Frietsch, Rammer, Schubert, 2015, pp. 9–15]; although symptoms of convergence have been indicated [Archibugi, Filippetti, 2011], there are certain areas characterised by high concentration, e.g. with regard to business locations [Veugelers, Cincera, 2015, pp. 4–9]. Simultaneously, at the regional level there are not only greater but also increasing disproportions [Bottazzi, Peri, 2002; Stephan, Happich, Geppert, 2005; Gossling, Rutten, 2007, pp. 253–270; European Commission, 2009; Paas, Vahi, 2012; Aristovnik, 2014; European Union, 2017], considered to be major barriers to growth within the Community as a whole [Bilbao-Osorio, Rodríguez-Pose, 2004, pp. 434–455; Sterlacchini, 2008, pp. 1096–1107; Piras, Postiglione, Aroca, 2012, pp. 35–51; Polasek, Sellner, 2013].

Therefore, in both the cohesion policy and the R&D policy, the EU’s focus is on fostering the technological potential of regions. A growing emphasis is on a spatial approach [Martín, Mulas-Granados, Sanz, 2005, pp. 41–61; Maggioni, Uberti, 2007, pp. 230–255; Narula, Santangelo, 2009, pp. 393–403], taking account of the characteristics of each region involving the application of tailored support tools [Benos, Karagiannis, Karkalakos, 2015; McCann, Ortega-Argilés, 2015, pp. 1291–1302; Rodríguez-Pose, 2015]. In accordance with the current approach, the research and technological potential of a region depends on a number of specific factors such as business culture, human capital, education and research institutions, innovation support services, technology transfer mechanisms, regional infrastructure, researchers’ mobility, financing sources and the inventiveness of regional entities [Peiro-Palomino, 2016; European Union, 2017, p. 152] but also on geographical factors, which leads to spatial concentration of the innovation potential and widening interregional disproportions within the EU [Alexiadis, Korres, 2010; de Dominicis, Florax, de Groot, 2011; Furková, Chocholatá, 2017].

To recapitulate, the review of the literature suggests that one can hardly expect a strong positive spatial autocorrelation between NUTS 2 regions in terms of R&D intensity. It is very likely that there are no or few clusters, in particular clusters grouping regions with high R&D intensity.

2. R&D intensity in NUTS 2

The analysis of NUTS 2 regions characterised by the highest and the lowest R&D intensity shows very significant disparities. As illustrated in Figure 1, in 2013 the
indicator ranged from 8.80% for the Belgian region of Brabant Wallon to 0.06% in the region of Sud-Est in Romania.

The regions characterised by the highest R&D intensity tend to be urbanised regions with a large city (Hannover in Braunschweig, Stuttgart in the region of Stuttgart, Graz in Steiermark, Copenhagen in Hovedstaden, Toulouse in Midi-Pyrénées, Munich in Oberbayern, Karlsruhe in the region of Karlsruhe). It is worth stressing that only the Danish Hovedstaden is the region with the capital city. In the other cases, those are important metropolitan centres in the national economy whose high research and development potential results from the following: (1) the location of major university centres and research institutions, (2) the location in the region of enterprises involved in R&D expenditure, (3) the specialisation of the region in knowledge-intensive industries (Table 1).

Not all of the leading regions have a metropolitan centre but they are highly concentrated on R&D activities thanks to the location of universities and research institutions as well as of businesses from knowledge-intensive industries. The top performer in the ranking, the Belgian region of Brabant Wallon, owes its position to nine universities led by that in Louvain and to various companies based in the region (including those seated in science park) and active in pharmaceuticals (e.g. GlaxoSmithKline Biologicals), IT and chemicals. Not insignificantly, it also neighbours on the region of Brussels. As regards the region of East Anglia, the United Kingdom’s highest R&D intensity is achieved thanks to six universities led by the University of
Cambridge and the University of East Anglia. Although the region in question has relatively minor urban centres, i.e. Norwich, Cambridge, Peterborough and Ipswich, the potential of its universities and of the industrial zone makes the region one of the EU’s leaders. As regards the German region of Tübingen, it is known for the accomplishments of various research institutions oriented towards biological sciences and smart systems, which allows to reach a high share of R&D expenditure in regional GDP.

<table>
<thead>
<tr>
<th>Region</th>
<th>BERD as % of GDP</th>
<th>Share of BERD in GERD (%)</th>
<th>Major industries in the region</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE31: Prov. Brabant Wallon</td>
<td>n.d.</td>
<td>n.d.</td>
<td>pharmaceuticals, IT, chemicals</td>
</tr>
<tr>
<td>DE91: Braunschweig</td>
<td>5.37</td>
<td>73.26</td>
<td>automotive industry, electrical and electronic engineering, IT</td>
</tr>
<tr>
<td>DE11: Stuttgart</td>
<td>5.48</td>
<td>91.33</td>
<td>automotive industry, ICT, creative industry, energy industry</td>
</tr>
<tr>
<td>AT22: Steiermark</td>
<td>3.64</td>
<td>74.74</td>
<td>automotive industry, electronic engineering, green technologies</td>
</tr>
<tr>
<td>DK01: Hovedstaden</td>
<td>3.25</td>
<td>67.29</td>
<td>biotechnology, green technologies, creative industry</td>
</tr>
<tr>
<td>FR62: Midi-Pyrénées</td>
<td>3.38</td>
<td>71.01</td>
<td>aeronautics industries, ICT, pharmaceuticals</td>
</tr>
<tr>
<td>UKH1: East Anglia</td>
<td>2.97</td>
<td>63.06</td>
<td>pharmaceuticals, ICT, electronic engineering, biochemicals</td>
</tr>
<tr>
<td>DE14: Tübingen</td>
<td>3.71</td>
<td>79.78</td>
<td>biological sciences, smart systems</td>
</tr>
<tr>
<td>DE21: Oberbayern</td>
<td>3.32</td>
<td>75.28</td>
<td>automotive industry, robotics industries, mechatronics, pharmaceuticals</td>
</tr>
<tr>
<td>DE12: Karlsruhe</td>
<td>2.64</td>
<td>61.40</td>
<td>automotive industry, IT, electrical and electronic engineering</td>
</tr>
</tbody>
</table>


It is worth emphasising the importance of business to high R&D intensity. In the EU’s top regions, business expenditure on R&D (BERD) usually accounts for more than 70% of regional GERD (with the exception of Karlsruhe, East Anglia and Hovedstaten characterised by lower shares of BERD in GERD), whereas the highest proportion at 91.33% was contributed by the business community of the German region of Stuttgart (Table 1). The location of enterprises with high R&D intensity seems to be of key importance to the R&D potential of a region. Enterprises operating in the region have a vital effect on regional specialisation. Regions with the highest R&D intensity are characterised by a developed network of businesses from knowledge-intensive industries such as the automotive industry, pharmaceuticals, biotechnology, IT, ICT or electrical and electronic engineering.

As regards regions with the lowest R&D intensity, those are primarily peripheral areas without major urban centres, mainly in Bulgaria and Romania, with the exception of one British region (Cornwall and Isles of Scilly), one Polish region (Opolskie) and one Belgian region (Prov. Luxembourg). In accordance with the regional division of labour, it must be assumed that those regions pursue activities other than research and development and their very low R&D intensities directly result from modest R&D
expenditure in absolute terms. It is worth pointing out that those are mostly regions from the new EU Member States.

In general, it must be stated that the new EU Member States are characterised by low R&D intensity (Table 2). Only for Slovenia the share is above the EU-28 average, whereas most of the other countries spend less than 1% of GDP on R&D, the worst performers being Romania (0.39%), Latvia (0.61%) and Bulgaria (0.63%). With the exception of the above-mentioned Slovenia, relatively high (even though below the EU average) R&D intensity characterises the Czech Republic (1.9%), Estonia (1.72%) and Hungary (1.39%).

Table 2. R&D intensity in regions of the new EU Member States in 2013

<table>
<thead>
<tr>
<th>country</th>
<th>GERD as % of national GDP</th>
<th>the country’s distance to the EU-28 average</th>
<th>number of NUTS2 regions</th>
<th>region with the highest R&amp;D intensity</th>
<th>region with the lowest R&amp;D intensity</th>
<th>number of regions with intensity below the national average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>0.63</td>
<td>-1.39</td>
<td>6</td>
<td>1.11</td>
<td>0.15</td>
<td>5</td>
</tr>
<tr>
<td>Croatia</td>
<td>0.81</td>
<td>-1.21</td>
<td>2</td>
<td>1</td>
<td>0.42</td>
<td>1</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1.90</td>
<td>-0.12</td>
<td>8</td>
<td>2.84</td>
<td>0.36</td>
<td>5</td>
</tr>
<tr>
<td>Estonia</td>
<td>1.72</td>
<td>-0.30</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lithuania</td>
<td>0.95</td>
<td>-1.07</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.61</td>
<td>-1.41</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Malta</td>
<td>0.77</td>
<td>-1.25</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Poland</td>
<td>0.87</td>
<td>-1.15</td>
<td>16</td>
<td>1.55</td>
<td>0.23</td>
<td>12</td>
</tr>
<tr>
<td>Romania</td>
<td>0.39</td>
<td>-1.63</td>
<td>8</td>
<td>0.81</td>
<td>0.06</td>
<td>7</td>
</tr>
<tr>
<td>Slovakia</td>
<td>0.82</td>
<td>-1.20</td>
<td>4</td>
<td>1.67</td>
<td>0.34</td>
<td>3</td>
</tr>
<tr>
<td>Slovenia</td>
<td>2.58</td>
<td>+0.56</td>
<td>2</td>
<td>3.01</td>
<td>2.09</td>
<td>1</td>
</tr>
<tr>
<td>Hungary</td>
<td>1.39</td>
<td>-0.63</td>
<td>7</td>
<td>1.77</td>
<td>0.73</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: own study based on Eurostat [access: 10/01/2018].

The analysis of R&D intensity at the NUTS 2 level in the new Member States allows to observe that regional research and development activity is limited and relatively higher intensity is found in the case of capital regions as those are distinguished, against the backdrop of the country as a whole, by the best developed business centres and universities; therefore, only the capital regions have R&D intensity above the national average in Bulgaria, Croatia, Poland, Romania, Slovakia and Hungary. It reflects major interregional disproportions within individual countries where the national research potential is concentrated in the capital region and lacking in the other regions. One exception in that regard is the Czech Republic: the region characterised by the highest R&D intensity is Jihovychod (CZ06) with the agglomeration of Brno as a university and business centre and slightly ahead of the capital region (CZ01). The third best-performing region – Stredni Czechy (CZ02), benefiting from close proximity to the capital city and the location of the automotive industry, has significant R&D expenditure in the Czech Republic. It must be pointed out that four of the new Member States (Estonia, Lithuania, Latvia and Malta) only represent single NUTS 2 regions, which precludes any analysis of intraregional differences within those countries.

Weaknesses of the new EU Member States in terms of research and development potential must be attributed to the lower development level than in the EU-15. Nevertheless, it is not insignificant that in the geographical space of the European Union the countries concerned have peripheral locations, which is not conducive to
regional specialisation in research and development activities. This is perfectly illustrated in the regional map of R&D intensity in the EU (Figure 2).

![Regional Map of R&D Intensity in the EU-28 Regions in 2013 (%)](image)

*Figure 2. R&D intensity in the EU-28 regions in 2013 (%)*

Source: own study based on Eurostat data [access: 07/03/2017] with the use of the STATA software.

In 2013, the R&D intensity in the EU-28 was 2.02% but there were significant differences between regions, with a strong trend towards geographical concentration. The level of 3% of GDP allocated to R&D was only exceeded by thirty NUTS 2 regions, ten of which are located in Germany, five in the United Kingdom, four in Austria and another four in Finland, two in Belgium, one in France and one in Denmark. Those regions accounted for more than one-third of gross expenditure on R&D in the European Union. As already mentioned, the geographical concentration of R&D expenditure results from competitive advantages connected with the existence of major university and research centres and the location of high-technology enterprises as well as with favourable environments attracting start-ups and skilled personnel [European Union 2017, pp. 151–156]. In certain cases, high R&D intensity characterised capital or neighbouring regions, e.g. with regard to Swedish, Finnish, Austrian regions, the regions of Berlin, Stockholm, Helsinki, Copenhagen and Vienna. However, some of the leading regions are not geographically close to the capital city and their R&D potential is determined by traditionally strong R&D activities (the French region of Midi Pyrénées, British and Belgian regions, German regions).
Outside the top thirty NUTS 2 regions, one must indicate the relatively modest performance of other western and northern regions of the EU and distinctly low R&D intensity in the case of eastern and southern regions. In addition, there were very large disproportions between regions within individual countries where regions with the highest R&D intensity frequently neighbour on regions characterised by very low R&D intensity. Furthermore, an unusual situation was found in four capital regions (of the Netherlands, Ireland, the United Kingdom and Belgium) whose R&D intensities were below the national average.

3. Description of the research method

Spatial autocorrelation is a statistical measure of correlation between observations in the geographical space (between spatial units for which a phenomenon was observed and measured). The measurement of spatial autocorrelation is based on Moran’s \( I \), used to measure both global and local spatial autocorrelation. Moran’s \( I \) is a measure of global spatial autocorrelation developed by Moran [1948, 1950]:

\[
I = \frac{N}{\sum_i \sum_j w_{ij}} \sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x}) \frac{\sum_i (x_i - \bar{x})^2}{\sum_i (x_i - \bar{x})^2} [1],
\]

where \( N \) is the number of spatial units indexed by \( i \) and \( j \); \( x \) is the variable of interest; \( \bar{x} \) is the mean of variable \( x \) and \( w_{ij} \) is an element of a matrix of spatial weights (neighbourhood matrix).

If the spatial weights matrix is a row-standardised matrix, the \( I \) coefficient takes values from the closed interval from \(-1\) to \(+1\). Negative (positive) values indicate negative (positive) spatial autocorrelation. The zero value of \( I \) implies a random spatial pattern. In addition, the values of \( I \) can be statistically significant or insignificant. The expected value of Moran’s \( I \) under the null hypothesis of no spatial autocorrelation is \( E(I) = -1/(N-1) \). Positive and statistically significant values of \( I \) indicate the existence of clusters (spatial units with similar low or high values of the variable of interest). In contrast, negative and statistically significant values of \( I \) imply the presence of the so-called outliers, i.e. individual spatial units surrounded by units with different values of the variable of interest – for more see Cliff and Ord [1973, 1981], Goodchild [1986] and Kopczewska [2006]. Additionally, local Moran’s \( I_i \) measures whether the spatial unit indexed by \( i \) is surrounded by units with similar or different values of the variable of interest (as compared to a random spatial distribution of these values). A negative and statistically significant value of \( I_i \) indicates that spatial unit \( i \) is an outlier. In contrast, a positive and statistically significant value of \( I_i \) informs that spatial unit \( i \) is part of a cluster [Kopczewska 2006].

4. Results of the spatial autocorrelation analysis

In order to analyse the existence of spatial autocorrelation between NUTS 2 regions in the EU-28 in terms of R&D intensity, a sample of 251 NUTS 2 regions from the 28

\[^2\text{Otherwise, values of } I \text{ can be above } +1 \text{ or below } -1, \text{ although they usually range from } -1 \text{ to } +1 \text{ (closed interval).} \]
EU Member States was adopted. The sample covers all the NUTS 2 regions excluding those with no land border with a European Union neighbour.

The study was based on data concerning GERD as a percentage of GDP for the last year available, i.e. 2013, from the Eurostat database [access: 07/03/2017]. Due to the lack of data for two German regions (DE22 and DE23), the average value for Germany (2.55%) was adopted for those regions.

The following two spatial weights matrix were created and then row-standardised:

- **W₁**: based on the concept that if two regions share a common land border, they are treated as neighbouring regions (a value of 1 in the neighbourhood matrix; otherwise, a value of 0 in the neighbourhood matrix);
- **W₂**: based on the concept that the strength of spatial correlation is measured by the inverse of the distance between the geometric centres of regions.

<table>
<thead>
<tr>
<th>Variable/spatial weights matrix</th>
<th>W₁</th>
<th>W₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D intensity</td>
<td>I = 0.140***</td>
<td>I = 0.022***</td>
</tr>
</tbody>
</table>

*** indicates statistical significance at the level of 1%

Source: own calculations in the STATA software.

In the case of the W₁ matrix, the analysis confirmed the existence of a very weak (and statistically significant at the level of 1%) spatial autocorrelation. It means that neighbouring regions are characterised by slightly similar values of R&D intensity. For the W₂ matrix, no spatial autocorrelation was found (Table 3).

In addition, a very weak or even no spatial autocorrelation was confirmed by local Moran’s I values. In the case of the W1 matrix, we can only identify two clusters (statistically significant, positive and high – above 1 or close to 1 – local Moran’s I values in brackets): the Belgian regions BE21 (1.032***), BE24 (2.628***), and BE31 (1.828***), as well as the German regions DE11 (1.402***), DE12 (1.786***), DE14 (2.775***), DE25 (1.068***), and DE71 (0.791***). In the case of the W2 matrix, there are no clusters at all.

The former cluster is composed of three Belgian regions: Antwerpen (BE21), Vlaams-Brabant (BE24) and Brabant Wallon (BE31). In 2013, R&D intensity in the regions was 2.69%, 3.96% and 8.8% respectively. It must be emphasised that the regions in question are the best performers among Belgian regions in terms of R&D potential, Brabant Wallon is a leader in the EU and Vlaams-Brabant ranks among the top thirty EU regions. In each of the regions there are renowned universities (Universiteit Antwerpen, Katholieke Universiteit Leuven, Université Catholique de Louvain) and technology research institutes, including Knowledge and Innovation Communities of the European Institute of Technology (in the regions of Antwerpen and Vlaams-Brabant). All the three regions have science parks attracting high-technology enterprises. The economy of Antwerpen is based on machinery, chemicals, pharmaceuticals (the location of Janssen Pharmaceutica) and on the creative industry [https://www.provincieantwerpen.be/ provinciebestuur.html]. The region of Vlaams...
Brabant is distinguished by developed knowledge-intensive services, IT and the medical devices industry [https://www.vlaamsbrabant.be/]. Finally, the economy of Brabant Wallon is based on the medical devices industry (also on the pharmaceutical industry with Glaxo SmithKline Biologicals), IT and chemicals [http://www.brabantwallon.be/bw/]. Therefore, it is possible to indicate specialisations in knowledge-intensive industries common for the three regions, i.e. medical devices/pharmaceuticals, chemicals and IT. Such specialisation orientations of enterprises in the regions can matter to the formation of various linkages, including business relationships. It seems that factors important to the creation of the cluster also include cultural and historical issues as the official language in Antwerpen and Vlaams-Brabant is Danish (both provinces are located in Flanders), whereas Vlaams-Brabant and Brabant Wallon formed a single region until 1995.

As regards the latter of the clusters identified, it covers five German regions: Stuttgart (DE11), Karlsruhe (DE12), Tubingen (DE14), Mittelfranken (DE25) and Darmstadt (DE71), characterised by high R&D intensity (Table 4). The first three (in Baden-Württemberg) rank among the top ten regions in the EU in terms of R&D intensity. The other two, the Bavarian region of Mittelfranken and Darmstadt (from Hesse), are among the top thirty regions in the EU. All the five regions have large university centres and research institutions (including the Knowledge and Innovation Community of the European Institute of Technology in the region of Karlsruhe, the European Space Operations Centre in Darmstadt, the Max Planck Institute in Tubingen). In every region, the business community is very active in R&D expenditure and accounts for over three-fourths of regional R&D (with the exception of the region of Karlsruhe), whereas the respective proportion for the region of Stuttgart is nearly 92% (Table 4).

Table 4. Characteristics of the regions in the German cluster

<table>
<thead>
<tr>
<th>region</th>
<th>GERD as % of GDP</th>
<th>BERD as % of GERD</th>
<th>dominant industries</th>
<th>firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE11</td>
<td>5.97</td>
<td>91.79</td>
<td>automotive industry, ICT, IT, energy industry, creative industry</td>
<td>Daimler, Porsche, Robert Bosch, HP, IBM, Alcatel-Lucent, Neoplan</td>
</tr>
<tr>
<td>DE12</td>
<td>4.26</td>
<td>61.97</td>
<td>automotive industry, electrical and electronic engineering, IT, chemicals</td>
<td>Michelin, Daimler, Siemens, Robert Bosch, L'Oreal, Pfizer, ABB, Caterpillar, IBM, Unilever</td>
</tr>
<tr>
<td>DE14</td>
<td>4.64</td>
<td>79.96</td>
<td>IT, chemicals, medical devices/biotechnology</td>
<td>CHT/BEZEMA, Zanker, Walker</td>
</tr>
<tr>
<td>DE25</td>
<td>3.75</td>
<td>74.40</td>
<td>electrical and electronic engineering, automotive industry, optical industry, medical devices</td>
<td>Siemens, Robert Bosch, Man, AEG, Novartis, GFK, Schaeffler, Puma, Adidas, Nestle, Apollo Optic, Areva</td>
</tr>
<tr>
<td>DE71</td>
<td>3.09</td>
<td>79.29</td>
<td>chemicals, IT, finance industry</td>
<td>Merck, Wella, Deutsche Bank, ING, Software AG, Rowenta, Danfoss, Honda, Hyundai, Hoechst</td>
</tr>
</tbody>
</table>

It is possible to indicate similarities in the specialisation of economies in the automotive industry (in 3 regions), IT (in 4 regions), chemicals (in 2 regions), electrical and electronic engineering (in 2 regions), medical devices (in 2 regions). Furthermore, domestic corporations such as Daimler, Bosch, Siemens have their entities in the regions forming the cluster (Table 4), which certainly stimulates interregional business linkages. In addition, Honda and Hyundai established their research and development centres in Darmstadt on account of the neighbouring region of Stuttgart, the location of domestic manufacturers from the automotive industry (Daimler, Porsche).

Summary

To recapitulate, the statistical analysis confirmed the existence of a very weak global and local spatial autocorrelation in the case of the land border neighbourhood of NUTS 2 regions and the lack of spatial autocorrelation for neighbourhood based on the inverse of the geographical distance between regions.

Sharing a land border seems to be conducive to the creation of clusters of regions similar in terms of research potential, especially in regions with appropriate critical mass (high R&D intensity). Presumably, it stimulates processes of establishing economic relationships with neighbouring regions. However, it must be borne in mind that the analysis only allowed to identify two clusters, even if concentrated on the EU’s top regions in terms of R&D intensity, but it is no rule. Probably, the existence of clusters of NUTS 2 regions is connected with complex economic as well as socio-cultural and political conditions. The importance of political factors is reflected in the fact that each of the revealed clusters is located within a single country (Belgium and Germany).

There are certain patterns in the existence of clusters, namely that neighbouring regions are characterised by similar regional specialisation, favourable for establishing business relationships. Firms located in the region are significantly involved in R&D expenditure. In addition, an important role is played by strong university and research centres with the power to attract cooperating enterprises from outside the region and to provide human capital.

It is also necessary to mention the limitations on this study. Firstly, Moran’s $I$ has a number of defects and represents a rather archaic tool, even though it continues to be the main measure of spatial autocorrelation, as Pearson’s $r$ for linear correlation. Secondly, the spatial weights matrices were solely based on land border neighbourhood and the inverse of the geographical distance; perhaps it would make sense to also take account of infrastructural, social or political factors.

References


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