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Spatial Modeling of Labor Markets in the Areas of Cracow-Balice and Wroclaw-Strachowice Airports

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Abstract: When describing data on statistical units the key issue is their mutual relations. They can be described in various ways, for example by means of spatial autocorrelation. The study of spatial connections allows to determine what influences their differentiation in the examined aspect. The article analyzes selected characteristics of the labor market in terms of spatial relationships in districts located in the areas of influence of two airports in Poland (Cracow-Balice and Wroclaw-Strachowice). The Moran's I autocorrelation coefficient was selected as the research tool, thanks to which it was possible to identify a given characteristic within the studied area and in relation to a specific location with the neighboring locations. The main issue can be presented in the form of questions: Are the neighboring districts located in the areas of impact of airports characterized by a similar situation? Is it possible to distinguish clusters of districts characterized by a similar specificity? The research hypothesis had both theoretical and practical dimensions. It was formulated as follows: the areas of influence of airports in Poland are characterized by a diversified spatial autocorrelation due to the specificity of the labor market. It was verified during the research procedure.

Keywords: labor market; spatial autocorrelation; quantitative methods; air transport

JEL Classification: R11; O11

1. Introduction

Air transport is a factor accelerating the processes of globalization of the world economy and its markets. It is also an important stimulus to level the chances of social and economic development of countries, regions and continents. It is also important for the growth of regional competitiveness or innovation. In the literature there are more and more positions that research on the impact of transport infrastructure on the economic development of the region is one of the most important ones carried out in the European Union. Apart from the above, there are obvious and strong interdependencies between economic and social development and the development of air transport. The economy and society generate demand for air cargo transportation and the increase in the mobility and mobility of the population supports the growth of the passenger transport market. Some authors showed that recently research into the impact of air transport on regional labor markets has been of great importance. The issue of the situation in the labor markets is important and has become a source of interest for many authors like Bal-Domańska and Sobczak (2018), Malinowski and Jablonska-Porzuczek (2020), Nikulin and Sobiechowska-Ziegert (2018), Szulc and Jankiewicz (2017), Cracolici et al. (2009). The studies (Sardadvar & Rocha-Akis, 2016; Shaikin, 2012; Siserova & Zudelova, 2015) showed that various analytical and research tools are used during

their conduct. Longhi (2007) as well as Cracolici et al. (2009) explained that for example to identify interdependencies spatial methods play an increasingly important role in contemporary research. Their application works well in issues that are located in a specific space (Shaikin, 2012; Szulc & Jankiewicz, 2017). Certainly, they include, among others research on the impact of air transport on regional labor markets. That research can be found in (Surówka, 2019). Verification of this type of phenomena using the tools of econometrics and spatial statistics is helpful in determining the significance of the spatial factor in explaining their variability and thus improves the quality of their description. The aim of the article is to try to identify, by means of the spatial autocorrelation analysis, spatial relationships occurring in districts located in the areas of impact of two selected airports in terms of selected variables characterizing the labor market.

2. Methods of Measuring Spatial Autocorrelation

According to scientific sources spatial autocorrelation is a relationship at different spatial points between different values of the same variable. As some authors rightly point out spatial autocorrelation is directed to many sides and described as the influence of a phenomenon or event on a point or points in space on the course of this event at a completely different point or points. According to the theories preached by geographers, such a dependence of the occurrence of the phenomenon decreases with the decreasing distance separating two points. Consequently, it leads to a correlation between two points in different locations in the value of the phenomena observed in them. Another definition indicates the occurrence of such a relationship when by observing a phenomenon at one point, one can notice an increased or decreased probability of such a phenomenon occurring at other neighboring points. As a relationship it defines the degree of intensity of the relationship between the values of two adjacent features. When the values of the neighboring areas are similar there is a positive autocorrelation. On the other hand, when the values are more diversified than the random distribution would indicate, then the phenomenon of negative autocorrelation is observed. However, the phenomenon of spatial autocorrelation is always associated with the occurrence of spatial dependence which may result from two reasons. The first indicates a close relationship between the analyzed units with others through their commune, voivodeship, village, regional or district affiliation. It can also be a territorial affiliation to the same geographical realm. The existence of a border on the map does not limit people and does not reduce their activity in most phenomena. The second reason points to the economic and social aspect and the dispersion of people's seats in the territorial unit, which largely depend on the location and distance from various objects with which they are associated. The most commonly used coefficients for estimating autocorrelation in space are the Geary and Moran's I autocorrelation coefficients. The existence of a global spatial autocorrelation is checked using the Moran's I statistics. The formula for calculating the Moran's I coefficient can be found in the literature (Kołodziejczyk & Kossowski, 2016). Looks like this:

$$I = \frac{n}{S_0} \times \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij}(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad (1)$$

where:

n – number of units in space,

aij – individual elements of the neighborhood matrix A,

S0 – sum of all elements of matrix A,

yi – value of the phenomenon for the i-th unit,

$\bar{y}$ – generalized arithmetic mean from all areas.

The neighborhood matrix is a key element in creating a spatial analysis of an emerging phenomenon. Another type is the spatial weight matrix. In addition to the matrix form it can take the form of a graph. It reflects the spatial relations that occur between the individual elements of a certain area, as well as the strength and closeness of their dependencies. The arrangement of numbers takes the shape of a square. In matrix notation the relations between the elements *i* = 1,2,3, ... n and j = 1,2,3, ... n are described in a binary system. This is the matrix of weights *aij*, i = 1, ... n, *j* = 1, ... n, in which

$$a_{ij} = \begin{cases} 1, & gdy\ "i"\ i\ "j"\ they\ are\ neighbors \\ 0, & gdy\ "i"\ i\ "j"\ they\ are\ not\ neighbors \end{cases} \quad (2)$$

The elements of the neighborhood matrix can take the form of two digits. Either one, when the two examined areas are adjacent to each other, or if there are no adjacent boundaries the field is completed with zero. Whether two areas are adjacent can be determined in various ways. The most common way of defining this issue is when two areas have a common border with each other. Another way to establish neighborhood is to determine the distance between the focal points of both areas. If the measured distance is less than the distance z, then the areas are assumed to be adjacent. The adjacency determined in this way forms the matrices of A.

Interpretation of this measure allows to determine the degree of spatial autocorrelation. Its occurrence depends on the position in relation to the value of the expression -1 / (n-1). If it is greater than this expression, then it is said to observe a positive autocorrelation, and if it is less than it is said to be negative. When this value is close to -1 / (n-1), the research assumes that the distribution of y values is random. In case the number n has a high value then the value of *i* can be zero, which means there is no spatial autocorrelation. In other words, if the statistic result *i*> 0 then there is a positive autocorrelation, and the values of the observed elements are similar. However, if the result *i* < 0, there is a negative autocorrelation, and the values of the examined units are different. If the result is zero, the checkerboard effect occurs. The significance of the spatial autocorrelation coefficient is very often tested. The hypothesis about the lack of spatial autocorrelation is verified and it is the null hypothesis H_0 and its existence, which is mentioned in the alternative hypothesis H_1. For this purpose the *T (I)* test is used:

$$T(I) = \frac{\mathrm{I} - \mathrm{U(I)}}{\sqrt{Var(I)}} \tag{3}$$

A detailed description of which can be found in the literature, for example Kołodziejczyk and Kossowski (2016). Assuming that the null hypothesis is true *I = UI (I)*, the statistic of the *T(I)* test has a distribution close to the standardized normal, but this convergence is slow. For this reason, this test is rarely used and another permutation with ordered statistics is used. Testing with it is performed by a k-fold process of permutating y_i values between regions. For each process the autocorrelation coefficient is calculated, and the empirical distribution of the *T(I)* statistic is created from them.

Calculation of the coefficient of spatial autocorrelation Moran's *I* is used in detecting the spatial dependence along with its strength and character in the examined area. This method of finding dependencies is comprehensive and global. Determines the averaged pattern of dependence across the area. Importantly it is not sensitive to the existing deviations from the averaged autocorrelation model and does not inform in any way about its instability. This results in the lack of information about extremely strong positive or negative dependence and outliers. In order to thoroughly examine the analyzed space local statistics are carried out which involves calculating the value for each individual unit. This allows you to accurately examine whether a specific region consists of a low or high value of the analyzed variable. One of the methods of such research is the local Moran's *I* statistic, which is effectively used in the identification of agglomeration effects and divides them into sets of low and high values. It allows you to extract the so-called hot spots, i.e. areas where the phenomenon is characterized by a high value of a feature that are adjacent to areas with equally high indices of this feature or conversely with adjacent areas with particularly low values. The last stage of this research method is the preparation of a map of all objects together with the illustration of the occurring similarity (Kołodziejczyk & Kossowski, 2016).

3. Analysis of the Diversification of Regional Labor Markets in the Pressure Area of Cracow-Balice and Wroclaw-Strachowice Airports – Results of Own Research

In the literature areas of impact of airports are also called isochrones or areas of influence. They are differently defined. In practical research, the most common definition is the fields surrounding airports to which passengers are attracted. Otherwise it is an area within a radius of 100 km or 1-2 hours by car from the airport (Kujawiak, 2016) explained the issue. This criterion (100 km) was taken into account by the author in her own research. At this point, a question should be asked how to identify the statistical units located in the studied areas. A helpful tool for their verification is the Geostatistics Portal that can be found in (Surówka, 2019). It was used in the conducted research. The study the text does not include its detailed procedure description. It can be found in literature (Surówka, 2019). Thanks to this approach it was possible to determine the districts located in the areas of the pressure of the ports under study (see table 1) and to obtain statistical information for 27 analyzed indicators which may characterize the situation on local labor markets.

Table 1. Districts and cities with district rights belonging to the 100 km isochrone for Wroclaw-Strachowice and Cracow-Balice Airports

Wroclaw -Strachowice Airport	Areas: bolesławiecki, dzierżoniowski, głogowski, górowski, jaworski, jeleniogórski, kamiennogórski, kłodzki, Legnicki, lubiński, lwówecki, milicki, oleśnicki, oławski, polkowicki, strzeliński, średzki, świdnicki, trzebnicki, wałbrzyski, wołowski, wrocławski, ząbkowicki, złotoryjski, Jelenia Góra, Legnica, Wrocław, żagański, wschowski, sieradzki, wieluński, wieruszowski, brzeski, kluczborski, krapkowicki, namysłowski, nyski, oleski, opolski, prudnicki, strzelecki, Opole, gostyński, jarociński, kaliski, kępiński, kościański, krotoszyński, leszczyński, ostrowski, ostrzeszowski, pleszewski, rawicki, śremski, Kalisz, Leszno
Cracow-Balice Airport	Areas: radomszczański, bocheński, brzeski, chrzanowski, dąbrowski, gorlicki, krakowski, limanowski, miechowski, myślenicki, nowosądecki, nowotarski, olkuski, oświęcimski, proszowicki, suski, tarnowski, tatrzański, wadowicki, wielicki, Cracow, Nowy Sącz, Tarnów, dębicki, jasielski, mielecki, będziński, bielski, cieszyński, częstochowski, gliwicki, lubliniecki, mikołowski, myszkowski, pszczyński, rybnicki, tarnogórski, bieruńsko-lędziński, wodzisławski, zawierciański, żywiecki, Bielsko-Biała, Bytom, Chorzów, Częstochowa, Dąbrowa Górnicza, Gliwice, Jastrzębie-Zdrój, Jaworzno, Katowice, Mysłowice, Piekary Śląskie, Ruda Śląska, Rybnik, Siemianowice Śląskie, Sosnowiec, Świętochłowice, Tychy, Zabrze, Żory, buski, jędrzejowski, kazimierski, kielecki, pińczowski, staszowski, włoszczowski, Kielce

The following variables were selected for the analysis, with the help of which the situation in the local labor markets can be characterized (Surówka, 2019, 2020):

X_1- number of registered unemployed remaining without work for more than 1 year

X_2- percentage of registered unemployed aged 25-34

X_3- percentage of registered unemployed over the age of 45

X_4- percentage of the unemployed with higher education

X_5- percentage of the unemployed with post-secondary or secondary vocational education

X_6- percentage of the unemployed with basic vocational education

X_7- job offers for disabled persons per 1,000 unemployed

X_8- registered unemployment rate

X_9- share of registered unemployed in the working age population

X_{10}- share of the unemployed with higher education in relation to the number of people of working age

X_{11}- share of registered unemployed graduates among the total unemployed

X_{12}- employed per 1,000 population

X_{13}– number of employed in hazardous conditions per 1,000 persons employed in the surveyed population

X_{14}- injured in accidents at work per 1,000 employed persons in total

X_{15}- average monthly gross salary

X_{16} - average monthly gross salary in relation to the national average (Poland = 100)

X_{17}- entities entered in the REGON register for 10 thousand population.

X_{18}- newly registered units in the REGON register for 10 thousand population

X_{19}- natural persons conducting economic activity per 1,000 population

X_{20}- foundations, associations and social organizations per 1,000 inhabitants

X_{21}- newly registered foundations, associations and social organizations with 10,000 inhabitants

X_{22}- entities per 1,000 inhabitants of working age

X_{23}- foreign capital per capita in working age

X_{24}- non-working population per 100 working-age people

X_{25}- post-working age population per 100 people in pre-working age

X_{26}- post-working age population per 100 people of working age

X_{27}- net migration per 1,000 people

Their selection was dictated by the research experience to date and the possibility of obtaining statistical data that is explained by Surówka (2019) and Pancer-Cybuska et al. (2014). In order to detect the nature and strength of the observed spatial relationships in a given area the spatial autocorrelation coefficient Moran's *I* is used in scientific research. It has a global reach which makes it possible to determine the impact on space. By determining its value, it is possible to determine such a relationship in the following way: when the determined value is smaller than the expression -1 / (n-1) we deal with a negative spatial autocorrelation, otherwise (the value of the coefficient is greater than this expression) with autocorrelation positive. However, it should be borne in mind that when close values appear, the distribution of x values is random in space. Besides, for large values of n (i.e. the number of spatial units) this often means no spatial correlation. This is due to the fact that the value of the expression does not differ significantly from zero. In order to determine the significance of the obtained results the autocorrelation coefficient significance test is most often used. In the course of the research procedure, using analytical and statistical programs, the values of the global measure Moran's *I* were determined and then the autocorrelation. A matrix of common boundary was used in the study. The results obtained are synthetically summarized in tables 1-2. Then the values of the expression 1 / (n-1) were determined, which were respectively -0.018 (for Wroclaw-Strachowice Airport) and -0.015 (for the Cracow-Balice Airport) which in the next stage were compared with the determined values of the Moran's *I* coefficients. Thanks to this, it was possible to determine the autocorrelation according to the criterion:

For the Cracow Airport

- $I > -0{,}015$ positive autocorrelation, which in the table is marked with the symbol +
- $I < -0{,}015$ negative autocorrelation, which in the table is marked with the symbol -

For the Wroclaw Airport

- $I > -0{,}018$ positive autocorrelation, which in the table is marked with the symbol +
- $I < -0{,}018$ negative autocorrelation, which in the table is marked with the symbol -

The results obtained are synthetically summarized in tables 2-3.

Table 2. Spatial analysis of regional labor markets in the area of impact of Cracow-Balice Airport isochrone based on the global Moran's I statistics (2011-2015).

	Variable X_1				**Variable X_2**				**Variable X_3**			
	I	Z	p-value	AK	I	Z	p-value	AK	I	Z	p-value	AK
2015	0.178	2.59	0.0097	+	0.453	6.29	<0.000001	+	0.614	8.41	<0.000001	+
2014	0.319	4.47	0.0000	+	0.400	5.55	<0.000001	+	0.610	8.36	<0.000001	+
2013	0.369	5.15	<0.000001	+	0.318	4.46	0.0000	+	0.567	7.81	<0.000001	+
2012	0.394	5.48	<0.000001	+	0.266	3.79	0.0002	+	0.567	7.91	<0.000001	+
2011	0.426	5.89	<0.000001	+	0.184	2.66	0.0078	+	0.612	8.38	<0.000001	+
	Variable X_4				**Variable X_5**				**Variable X_6**			
2015	0.178	2.64	0.0084	+	0.515	7.12	<0.000001	+	0.278	3.93	0.0000	+
2014	0.165	2.46	0.0139	+	0.518	7.19	<0.000001	+	0.300	4.24	0.0000	+
2013	0.157	2.34	0.0192	+	0.525	7.32	<0.000001	+	0.269	3.81	0.0001	+
2012	0.148	2.22	0.0264	+	0.515	7.12	<0.000001	+	0.305	4.29	0.0000	+
2011	0.170	2.53	0.0114	+	0.500	6.96	<0.000001	+	0.276	3.90	0.0000	+
	Variable X_7				Variable X_8				Variable X_9			
2015	-0.005	0.136	0.8917	+	0.339	4.76	0.0000	+	0.507	7.01	<0.000001	+
2014	0.052	1.05	0.2947	+	0.358	5.01	0.0000	+	0.526	7.24	<0.000001	+
2013	0.113	1.81	0.070	+	0.347	4.86	0.0000	+	0.527	7.27	<0.000001	+
2012	0.026	0.79	0.4322	+	0.339	4.73	0.0000	+	0.501	6.94	<0.000001	+
2011	-0.005	0.136	0.8917	+	0.362	5.06	<0.000001	+	0.507	7.01	<0.000001	+
	Variable X_{10}				Variable X_{11}				Variable X_{12}			
2015	0.478	6.67	<0.000001	+	0.505	6.94	<0.000001	+	0.312	4.44	0.0000	+
2014	0.478	6.67	<0.000001	+	0.578	7.91	<0.000001	+	0.330	4.68	0.0000	+
2013	0.481	6.70	<0.000001	+	0.574	7.86	<0.000001	+	0.348	4.923	0.0000	+
2012	0.459	6.38	<0.000001	+	0.532	7.32	<0.000001	+	0.359	5.06	<0.000001	+
2011	0.535	7.37	<0.000001	+	-	-	-	+	0.366	5.15	<0.000001	+
	Variable X_{13}				Variable X_{14}				Variable X_{15}			
2015	0.476	6.71	<0.000001	+	-	-	-	-	0.117	1.86	0.0628	+
2014	0.477	6.72	<0.000001	+	0.570	7.85	<0.000001	+	0.103	1.74	0.0822	+
2013	0.491	6.89	<0.000001	+	0.560	7.70	<0.000001	+	0.104	1.76	0.0788	+
2012	0.508	7.09	<0.000001	+	0.560	7.73	<0.000001	+	0.100	1.69	0.0908	+
2011	0.480	6.72	<0.000001	+	0.616	8.46	<0.000001	+	0.064	1.20	0.2307	+
	Variable X_{16}				Variable X_{17}				Variable X_{18}			
2015	0.117	1.86	0.0624	+	0.288	4.11	0.0000	+	0.255	3.71	0.0002	+
2014	0.103	1.74	0.0814	+	0.297	4.23	0.0000	+	0.327	4.64	0.0000	+
2013	0.104	1.76	0.0779	+	0.300	4.27	0.0000	+	0.291	4.18	0.0000	+
2012	0.100	1.69	0.0912	+	0.307	4.35	0.0000	+	0.278	3.99	0.0000	+
2011	0.064	1.20	0.2297	+	0.313	4.43	0.0000	+	0.300	4.28	0.0000	+
	Variable X_{19}				Variable X_{20}				Variable X_{21}			
Lata	I	Z	p-value	AK								
2015	0.350	4.93	0.0000	+	0.150	2.23	0.0256	+	-0.006	0.122	0.9030	+
2014	0.355	4.98	0.0000	+	0.152	2.26	0.0241	+	0.030	0.600	0.5487	+
2013	0.353	4.95	0.0000	+	0.170	2.50	0.0124	+	0.063	1.058	0.2902	+
2012	0.358	5.02	0.0000	+	0.170	2.49	0.0127	+	-0.188	-0.053	0.9577	+
2011	0.360	5.05	<0.000001	+	0.176	2.57	0.0101	+	0.009	0.324	0.7458	+
	Variable X_{22}				Variable X_{23}				Variable X_{24}			
2015	0.271	3.884	0.0001	+	-	-	-	-	0.151	2.229	0.0258	+
2014	0.277	3.96	0.0000	+	0.011	0.42	0.6756	+	0.228	3.25	0.0011	+
2013	0.276	3.95	0.0000	+	0.006	0.34	0.7334	+	0.344	4.81	0.0000	+
2012	0.280	3.99	0.0000	+	-0.019	-0.06	0.9498	-	0.476	6.59	<0.000001	+
2011	0.283	4.03	0.0000	+	0.015	0.503	0.6147	+	0.555	7.67	<0.000001	+

	Variable X_{25}				Variable X_{26}				Variable X_{27}			
2015	0.499	6.87	<0.000001	+	0.418	5.78	<0.000001	+	-	-	-	-
2014	0.501	6.89	<0.000001	+	0.411	5.69	<0.000001	+	0.176	2.65	0.0080	+
2013	0.504	6.94	<0.000001	+	0.401	5.55	<0.000001	+	0.164	2.46	0.0137	+
2012	0.511	7.03	<0.000001	+	0.406	5.62	<0.000001	+	0.165	2.46	0.0137	+
2011	0.518	7.12	<0.000001	+	0.410	5.69	<0.000001	+	0.163	2.46	0.0141	+

In the course of in-depth analyzes it was possible to draw detailed and multi-threaded conclusions. Some of them were as follows. Analyzing the information in tables 2-3 we notice that almost all the characteristics have a positive spatial autocorrelation, and their values vary considerably. Moreover, for most of the characteristics a high stability of the spatial autocorrelation of regional labor markets can be observed within individual measures (2011-2015). Therefore, it may be considered justified to suppose that the tendency to focus the examined objects due to the features selected for examination characterizes the examined objects. In the study the significance of the obtained values was assessed using the autocorrelation coefficient significance test (Tables 2-3). As a result of the analysis, we can observe that in the entire period under consideration almost all characteristics of the Cracow Airport are statistically significant. The exceptions are X_7, X_{15}, X_{21} and X_{16}. Therefore, the phenomenon of autocorrelation of the examined features can be considered statistically significant. These results are much more unfavorable in the area of influence of the Wrocław-Srachowice Airport. For a smaller number of variables, the determined Moran's I autocorrelation statistics can be considered important from the point of view of the research. These include X_1, X_2 (2012), X_4, X_7, X_{12}, X_{14}, X_8 (2013), X_{19} (2012) and X_{21} (2011). Analyzing the feature of the number of registered unemployed persons who have been unemployed for more than 1 year we observe a tendency to concentrate within a given location areas with similar values of the analyzed variable in districts located in the pressure area of the Cracow-Balice Airport. However, as mentioned above, its absence is observed in the area of the isochrone at Wroclaw-Strachowice Airport. This is confirmed, for example, in the negative autocorrelation in the period 2014-2015. Detailed analysis of the data of this feature for the Cracow-Balice Airport allows to distinguish groups of neighboring districts. The first group includes objects located in the south-eastern part of the study area. Its lowest level in the entire period under consideration is typical for the following districts: Staszowski, Jaworzno, Zory and Ruda Slaska. It should be noted that these are units that also belong to the area of influence of Katowice-Pyrzowice Airport. A group of the Wielicki, Myślenicki and Suski districts also formed a separate group. They are located in the malopolskie voivodship. In the study some authors have shown that it is characterized by a large spatial differentiation in the level of long-term unemployment, understood as continuous unemployment for over a year. The increase in the significance of p-value level of the X_2 variable after 2012 may indicate the ongoing process of improving the situation on local labor markets due to the examined feature. Its lowest value in the entire research period is observed in Bielsko-Biala. Like the previous one another feature (percentage of registered unemployed aged over 45) is characterized by a positive spatial autocorrelation. The statistics of Moran's I fluctuate here in the ranges 0.497-0.529 (isochrone of Wroclaw-Strachowice Airport) and 0.567-0.614

(isochrone of Cracow-Balice Airport). The hypothesis of its irrelevance is rejected with a p-value of 0.05. Based on the results it can be assumed that this phenomenon is empirically confirmed. It is also possible to identify global clusters of high and low values of this measure, which have a constant character. The first are the following objects: staszowski, buski, dabrowski, kazimierski and proszowicki. They are characterized by its lowest level. They are also characterized by the lowest percentage of employees in recent years. The labor market in the study was also defined by means of measures characterizing the unemployed according to the level of education (variables X_4-X_6). When analyzing the results for the area of impact of the Cracow-Balice Airport we note that the lowest percentage of people with higher education is observed in Bytom. This object forms a separate group. A separate cluster was also created by the following districts: dąbrowski, kazimierski, proszowicki. The lowest increase in the unemployment rate for these facilities should be considered a positive symptom. Another group consists of the following districts: wadowicki, żywiecki, suski, nowotarski and tatrzański. They are characterized by the lowest level of long-term unemployment. When analyzing the statistical data for the variable percentage of the unemployed with post-secondary or secondary vocational education in the area where the Cracow-Balice Airport is located we can distinguish two groups. On the one hand there is one homogeneously compact area with low values located in the districts located in the south-western part of the studied area, and on the other hand, a similar cluster was observed for the rest of the districts. The first, less numerous, includes the following districts: tatarzański, suski, żywiecki, Bielski, Biesko-Biała, pszczyński, Jastrzębie-Zdrój, Żory, mikołowski, Katowice, Ruda Śląska and Gliwice. The second rest of the studied objects (except the dąbrowski district). The obtained results show the stability of the spatial autocorrelation of the level of the examined features in the period adopted for the study. In the course of the conducted research there was no statistically significant tendency to cluster districts for the variable characterizing job offers for disabled persons per 1,000 unemployed between adjacent districts. In the case of this variable one can distinguish small spatial clusters (clusters) of units with similar values on the impact ranges of both examined ports. Their occurrence is caused by the similar values of this indicator in the case of most objects.

Table 3. Spatial analysis of regional labor markets in the area of impact of Wroclaw-Strachowice Airport isochrone based on the global Moran's I statistics (2011-2015).

	Variable X_1				**Variable X_2**				**Variable X_3**			
	I	Z	p-value	AK	I	Z	p-value	AK	I	Z	p-value	AK
2015	-0.102	-1.03	0.300	-	0.397	5.12	<0.000001	+	0.529	6.72	<0.000001	+
2014	-0.057	-0.48	0.634	-	0.409	5.25	<0.000001	+	0.528	6.70	<0.000001	+
2013	-0.002	0.201	0.841	+	0.175	2.39	0.0168	+	0.501	6.37	<0.000001	+
2012	0.076	1.149	0.250	+	0.087	1.30	0.1953	+	0.497	6.34	<0.000001	+
2011	-0.001	0.209	0.834	+	0.121	1.70	0.0886	+	0.533	6.75	<0.000001	+
	Variable X_4				**Variable X_5**				**Variable X_6**			
2015	0.071	1.15	0.2498	+	0.280	3.73	0.0002	+	0.119	1.72	0.0855	+
2014	0.080	1.27	0.266	+	0.239	3.18	0.0015	+	0.138	1.94	0.0517	+
2013	0.068	1.11	0.268	+	0.241	3.23	0.0012	+	0.151	2.09	0.0367	+
2012	0.093	1.43	0.153	+	0.215	2.90	0.0037	+	0.167	2.28	0.0225	+
2011	0.068	1.11	0.268	+	0.183	2.51	0.0119	+	0.148	2.06	0.0396	+

	Variable X_7				Variable X_8				Variable X_9			
2015	-0.004	0.18	0.8536	+	0.267	3.50	0.0005	+	0.175	2.38	0.0174	+
2014	0.017	0.46	0.6400	+	0.262	3.43	0.0006	+	0.183	2.46	0.0138	+
2013	0.042	0.78	0.4340	+	0.287	3.72	0.0002	+	0.201	2.68	0.0074	+
2012	-0.004	0.20	0.8414	+	0.302	3.90	0.0000	+	0.256	3.36	0.0008	+
2011	-0.004	0.18	0.8536	+	0.268	3.49	0.0005	+	0.213	2.82	0.0048	+
	Variable X_{10}				Variable X_{11}				Variable X_{12}			
2015	0.193	2.63	0.0085	+	0.6203	7.76	<0.000001	+	0.0090	0.34	0.7334	+
2014	0.0917	1.35	0.1763	+	0.5663	7.11	<0.000001	+	0.0092	0.34	0.7331	+
2013	0.086	1.29	0.1971	+	0.5559	7.02	<0.000001	+	0.0107	0.36	0.7175	+
2012	0.1566	2.18	0.0295	+	0.563	7.07	<0.000001	+	-0.004	0.18	0.8564	+
2011	0.1206	1.70	0.0883	+	-	-	-	-	-0.004	0.18	0.8564	+
	Variable X_{13}				Variable X_{14}				Variable X_{15}			
2015	0.196	2.81	0.0050	+	-	-	-	-	0.152	2.62	0.0089	+
2014	0.207	2.93	0.0033	+	0.014	0.42	0.6746	+	0.164	2.85	0.0044	+
2013	0.189	2.65	0.0080	+	0.108	1.57	0.1168	+	0.139	2.57	0.0102	+
2012	0.136	1.99	0.0464	+	0.062	0.99	0.3185	+	0.0988	1.95	0.0512	+
2011	0.235	3.26	0.0011	+	0.066	1.10	0.2723	+	0.110	2.08	0.0375	+
	Variable X_{16}				Variable X_{17}				Variable X_{18}			
2015	0.110	2.08	0.0375	+	0.181	2.52	0.0118	+	0.333	4.37	0.0000	+
2014	0.165	2.85	0.0044	+	0.171	2.39	0.0167	+	0.294	3.91	0.0000	+
2013	0.139	2.57	0.0101	+	0.173	2.42	0.0156	+	0.036	1.38	0.1680	+
2012	0.099	1.95	0.0509	+	0.161	2.26	0.0236	+	0.305	3.99	0.0000	+
2011	0.110	2.08	0.0377	+	0.161	2.26	0.0239	+	0.370	4.83	0.0000	+
	Variable X_{19}				Variable X_{20}				Variable X_{21}			
2015	0.120	1.71	0.0874	+	0.128	1.82	0.0681	+	0.134	1.87	0.0610	+
2014	0.120	1.71	0.0876	+	0.131	1.86	0.0633	+	0.147	2.06	0.0396	+
2013	0.118	1.69	0.0905	+	0.141	1.97	0.0484	+	0.169	2.31	0.0211	+
2012	0.112	1.62	0.1056	+	0.158	2.18	0.0295	+	0.172	2.32	0.0204	+
2011	0.113	1.63	0.1041	+	0.158	2.18	0.0294	+	0.074	1.14	0.2550	+
	Variable X_{22}				Variable X_{23}				Variable X_{24}			
2015	0.167	2.34	0.0192	+	-	-	-	-	0.218	2.93	0.0034	+
2014	0.158	2.23	0.0258	+	0.159	2.27	0.0235	+	0.285	3.76	0.0017	+
2013	0.160	2.25	0.0245	+	0.180	2.56	0.0104	+	0.376	4.87	0.0000	+
2012	0.148	2.09	0.0336	+	0.179	2.53	0.0114	+	0.449	5.72	<0.000001	+
2011	0.149	2.11	0.0347	+	0.214	3.03	0.0024	+	0.457	5.808	<0.000001	+
	Variable X_{25}				Variable X_{26}				Variable X_{27}			
2015	0.333	4.326	0.0000	+	0.124	1.767	0.0772	+	-	-	-	-
2014	0.322	4.190	0.0000	+	0.129	1.83	0.0668	+	0.184	3.13	0.0017	+
2013	0.304	3.981	0.0000	+	0.144	2.01	0.0442	+	0.210	3.42	0.0006	+
2012	0.318	4.149	0.0000	+	0.200	2.70	0.0070	+	0.247	3.96	0.0000	+
2011	0.315	4.102	0.0000	+	0.228	3.03	0.0025	+	0.233	3.85	0.0000	+

Table description: I- global Moran's I statistics, AK – spatial

By analyzing the results obtained for the Wroclaw Airport we can draw the following conclusions. As far as the analysis of the trait of the percentage of registered young people aged 25-34 is concerned, we note that its highest characteristic level is for the leszczyński district, and the lowest for jeleniogórski district. In the case of this variable four clusters can be distinguished. One is composed of districts: milicki, trzebnicki, Wroclaw i średzki. They are characterized by a positive birth rate in recent years. The second group includes districts located in the south-eastern part of the studied area (namysłowski, brzeski, strzeliński and

nyski). The systematically analyzed level of unemployment shows that for years the most difficult situation has been taking place in these districts. It is visible, for example, in the significant increase in the number of long-term unemployed. Another group consists of the following districts: kłodzki, wałbrzyski, kamieniogórski, jeleniogórski and lwówecki. On the other hand, taking into account higher education, there is a continuing downward trend for graduates of master's studies in the jeleniogorskim and walbrzyskim subregions. In the course of research carried out by other authors it was noticed that the offer of study courses is modest, especially in the case of sciences. A positive feature is that the expenditure of Local Government Units on tourism per capita in the wałbrzyski and jeleniogórski subregions is much higher than in other subregions of the voivodeship. As a result of a detailed analysis of the value of the feature of the percentage of the unemployed with post-secondary or secondary vocational education in the area of influence of the Airport in Wroclaw we can distinguish several groups. One of them consists of districts located in the south-eastern part of the studied area. These include: opolski, strzelecki, krapkowicki, prudnicki and nyski. Some of them are also located in the area of the Katowice-Pyrzowice Airport. These are also facilities with the highest percentage of people employed in hazardous conditions. The persistently high percentage of unemployed graduates in almost all surveyed counties should be considered a disturbing phenomenon. In terms of this feature the situation is most favorable in wieruszowski region.

4. Discussion and Conclusion

The pace of development of European countries depends on many different factors. One of the most important is the improvement of the situation on regional labor markets, which can be determined in the course of research and data analyzes. The article is a continuation of the author's own research in the field of regional development, innovation, the impact of air transport on local labor markets and competitiveness of European Union regions. The subject of interest in the text are the areas of influence of the Cracow-Balice Airport and Wroclaw-Strachowice. In the course of such research the research hypothesis was positively verified. Therefore, the statement that the districts located in the areas of impact in the analyzed ports is characterized by a different (positive or negative) spatial autocorrelation of the situation on regional labor markets should be considered justified. Moreover, the examined objects are distinguished by statistically significant differentiation. The analysis of the features selected for the study allowed to indicate where this differentiation is particularly noticeable. In addition to the results included in the main content, we can also draw conclusions. In the analyzed period, the persistence of a high percentage of graduates among the unemployed in the areas of pressure in the ports under study should be considered a negative phenomenon. Moreover, the districts located near the analyzed ports have particularly low values of this measure. When analyzing the results of own research, it is possible to observe a certain similarity of districts in terms of selected indicators describing the situation on local labor markets in the south-eastern part of the studied area. The fact that the development of transport is conducive to the settlement of new residents in the studied

area is evidenced by for example the lowest migration balance. It can be said with certainty that the districts located near the port are the most attractive places.

References

Bal-Domanska, B., & Sobczak, E. (2018). Educational Potential and the Situation of the Youth on the Labour Market in the European Union. In *Hradec Economic Days 2018* (Vol. 8, pp. 20-31).

Cracolici, M. F., Cuffaro, M., & Nijkamp, P. (2009). A spatial analysis on Italian unemployment differences. *Statistical Methods and Applications*, *18*(2), 275–291. https://doi.org/10.1007/s10260-007-0087-z

Kołodziejczyk, A., & Kossowski, T. (2016). Wykorzystanie metody autokorelacji przestrzennej do analizy ubóstwa na obszarach wiejskich. *Wiadomości statystyczne*, *10*(665), 22-32.

Kujawiak, M. (2016). Analiza obszaru oddziaływania portu lotniczego – przegląd metod badawczych. In *Studia Oeconomica Posnaniensia, Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu*. (No. 4., pp. 112-124).

Longhi, S., & Nijkamp, P. (2007). Forecasting Regional Labor Market Developments under Spatial Autocorrelation. *International Regional Science Review*, *30*(2), 100–119. https://doi.org/10.1177/0160017606298428

Malinowski, M., & Jabłońska-Porzuczek, L. (2020). Female activity and education levels in selected European Union countries. *Research in Economics*, *74*(2), 153–173. https://doi.org/10.1016/j.rie.2020.04.002

Nikulin, D., & Sobiechowska-Ziegert, A. (2018). Informal work in Poland - a regional approach: Informal work in Poland - a regional approach. *Papers in Regional Science*, *97*(4), 1227–1246. https://doi.org/10.1111/pirs.12306

Pancer-Cybulska, E., Cybulski, L., Olipra, Ł., & Surówka, A. (2014). *Transport lotniczy a regionalne rynki pracy w Polsce*. Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu.

Sardadvar, S., & Rocha-Akis, S. (2016). Interregional migration within the European Union in the aftermath of the Eastern enlargements: a spatial approach. *Review of regional research-jahrbuch fur regionalwissenschaft*, *3*, 51-79.

Shaikin, D. (2012). Population's economical activity as an indicator of labour potential development (The republic of kazakhstan case study). *Actual problems of economics*, *134*, 531-538.

Siserova, M., & Zudelova, M. (2015). Spatial Econometric Modelling of Internal Labour Mobility. In *Central European Conference on Finance and Economics (CEFE)* (pp. 663-670).

Surówka, A. (2019). Taksonomiczna analiza zróżnicowania sytuacji na lokalnych rynkach pracy na obszarze ciążenia Lotniska Chopina w Warszawie jako metodologia zarządzania rozwojem regionalnym. *Economic and Regional Studies*, *12*(4), 230-240. https://doi.org/10.2478/ers-2019

Surówka, A. (2020). Comparative Analysis of the Dynamics of Indicator Changes GDP per Capita in the Regions of Greece, Germany and Romania. In *Proceedings of the International Scientific Conference Hradec Economic Days 2020* (Vol. 10, pp. 749-760). https://doi.org/10.36689/uhk/hed/2020-01-085

Surówka, A. (2019). Portal Geostatystyczny jako narzędzie badawcze nierówności na lokalnych rynkach pracy. *Zeszyty Naukowe Uniwersytetu Rzeszowskiego Nierówności społeczne a wzrost gospodarczy*, *59*(3), 162-172.

Szulcl, E., & Jankiewicz, M. (2017). *The labour market situation in medium-sized urban centres of the Kujawsko-Pomorskie voivodeship and the problem of unemployment in the province* (11th ed). Professor.