UNEMPLOYMENT IN POLISH REGIONS FROM THE PERSPECTIVE OF SPATIAL AUTOCORRELATION

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A b s t r a c t. Unemployment is traditionally a phenomenon analysed by economists. Recently these investigations are often run with use of methods allowing for identification of spatial autocorrelation on the labour market. The aim of the study is to analyse spatial interrelationships of the unemployment rate between Polish regions (NUTS2) and then to verify if any results can be interpreted through a perspective of the urban-rural classification for NUTS 3 regions applied by the European Union. Research covered the period from 2004 to 2014 and was based on the data of the Central Statistical Office of Poland. The global and local Moran's statistics were applied. Results prove existence of spatial patterns on labour market in Poland - local statistics indicate that outliers and clusters of similar regions occur.

INTRODUCTION

The phenomenon of unemployment has been analysed and investigated by many economists in forms of theories of employment and labour market. Different approaches can include both macro- and microeconomic perspectives. On the macro level, attention is paid, for example, to relations between the labour markets and other markets of the economy, whereas the micro level approach examines relations between behaviour of individuals and companies. Labour market is an important part of such macroeconomic theories as classical and neoclassical economics, Keynesian economics or the theory of the natural rate of unemployment. There are a lot of microeconomic theories connected with labour market, e.g. the implicit contract theory initiated by Martin N. Baily [1974] and Costas Azariadis [1975], then developed, among others, by Sanford J. Grossman and Oliver D. Hart [1981], or the efficiency wage model – Carl Shapiro and Joseph E. Stiglitz [1984], Steven C. Salop [1979], Andrew Weiss [1980] or George A. Akerlof and Janet L. Yellen [1990]. A lot of studies and interpretations are connected with the human capital theory [Becker 1962] or job search theories [Stigler 1962, Holt 1970, Mortensen 1970, Alchian 1970].

Labour market analyses have also a spatial aspect. Determinants of regional disparities in unemployment rates are for instance as follows [Mameli et al. 2014]:

– labour supply factors – composition of regional labour force in terms of age, gender, ethnicity, average level of education attainment and skills of individuals,
– labour demand factors – differences between goods markets as determinants of uneven labour demand (e.g. factors affecting location decisions by firms),
– the flexibility of wages – which may be reduced by the existence of minimum wages or union activity.

SITUATION ON THE POLISH LABOUR MARKET

Unemployment is a situation when people who are able to work and are seeking employment cannot find work. It can result from a lack of balance between demand and supply on the labour market. Unemployment has been a problem of the Polish economy since the beginning of the 1990s. It appeared as a new phenomenon in Poland, resulting from the system transformation from the centrally planned economy to the market system. Its registration started at the beginning of the 1990s. Unemployment existed before at least in two forms (frictional and hidden), but it was deliberately concealed by the policy of full employment, which had a social character to a large extent. Poland's accession to the European Union completely changed the labour market. Poland was obliged to implement the goals of the European Employment Strategy, e.g. improvement of quality and efficiency of workplaces as well as strengthening cohesion and social integration. The employment target was defined as the employment rate (% of working-age population) at the level of 75% in the age group 20-64. The national goal for Poland was 71%, but it has not been reached yet, and the goal remains the same in the EU's growth strategy Europe 2020 (see fig. 1 illustrating the employment rate in the period 2002-2013). Moreover, it can be noticed that the female employment rate is lower than the indicator describing the situation of men. Despite the highest educational attainment and willingness to improve their qualifications, women are more often economically passive.

There are also gender differences when the employment rate is analysed in the age groups (fig. 2). In the case of women, the highest activity is registered in the age group

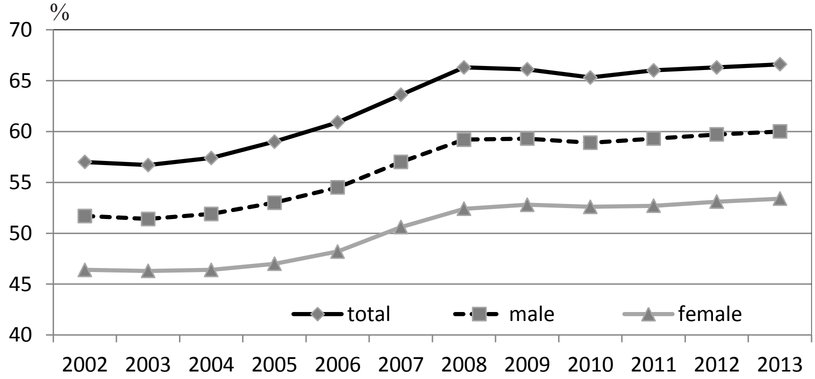


Figure 1. Employment rate according to gender in the period 2002-2013
Source: own calculation based on the data of the Local Data Bank of the Central Statistical Office of Poland.

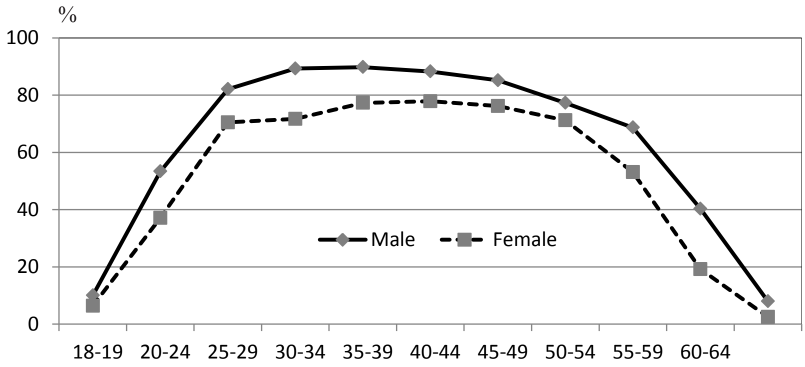


Figure 2. Employment rate in 2014
Source: own calculation based on the data of the Local Data Bank of the Central Statistical Office of Poland.

40-44 (779 out of 1000 females working) and in the age group 35-39 (717 out of 1000 females working). When the situation of men is considered – the highest employment rate is registered in the age group 35-39 (898 out of 1000 men working). The most significant difference between men and women can be noticed in the age group 30-34, which can be connected with the fertility period in the women's life cycle.

Beside the employment rate, another indicator used to characterize the labour market is the unemployment rate (% of labour force that is unemployed). In Poland, in the period 2002-2013, every year the female unemployment rate was higher than the unemployment rate for men, even during the period when the situation on the labour market was relatively better (2007-2008). Nowadays, it is still higher, reaching 11.2%, while among men it is 9.8%.

GOAL AND RESEARCH METHODS

The aim of this study is to analyse the spatial interrelationships of the gender unemployment rate between Polish regions (NUTS2) and then to verify if any results can be interpreted through a perspective of the urban-rural classification for NUTS 3 regions (fig. 3) applied by the European Union (Eurostat, Urban-rural typology).

Analyses cover the period from 2004 to 2014 and use the data of the Central Statistical Office of Poland. All necessary statistical information and indicators are presented in tables, therefore the descriptive part is limited to the minimum.

For the purpose of spatial analyses, the nearest neighbourhood method was adopted as the criterion. The structure of the relationship based on the common boundary criterion is presented in figure 4.

Based on this type of relationship between regions, weighted matrix W was calculated for spatial autocorrelation. The phenomenon of spatial autocorrelation is based on the values attributed to spatial objects. Spatial autocorrelation is a measure that examines the relationship between close spatial units and describes the degree to which one object is similar to other nearby objects. Positive spatial autocorrelation occurs when similar values cluster together in a map. Research on spatial autocorrelation will be conducted

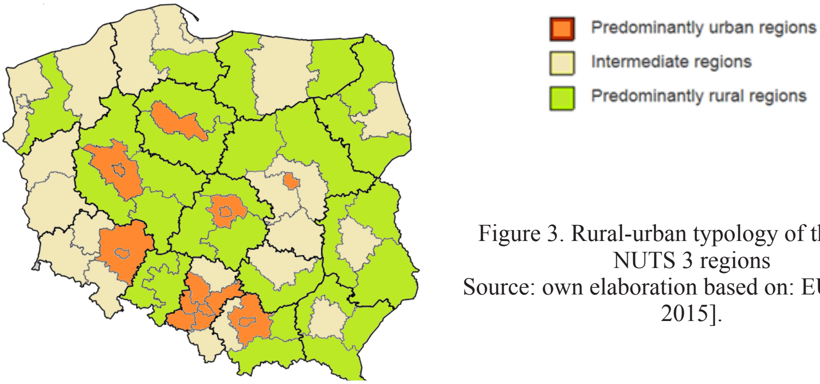


Figure 3. Rural-urban typology of the Polish NUTS 3 regions
Source: own elaboration based on: EUROSTAT 2015].

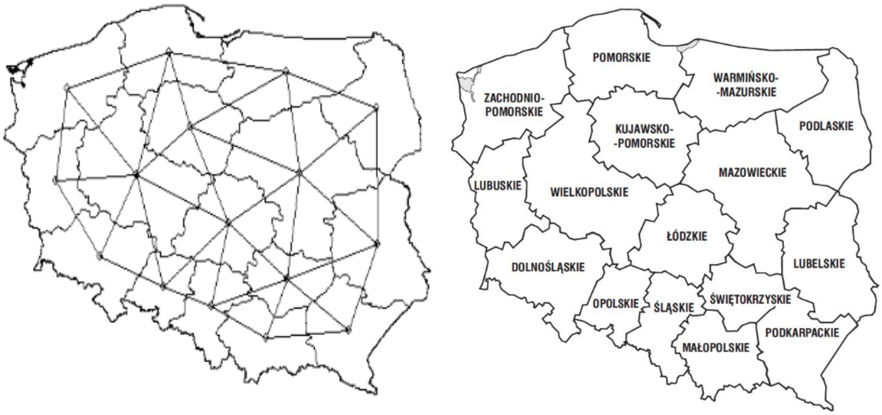


Figure 4. Neighbourhood associations in the weight matrix according to the common boundary criterion in the Polish regions
Source: own study.

using the Moran's statistics. These measures are discussed briefly by Oliver Schabenberger and Carol Gotway [2005]. For labour market analyses they were applied for example by Krzysztof Gołata, Grażyna Dehnel and Hanna Gruchociak [2011] or Nina Drejerska and Mariola Chrzanowska [2014].

The Moran's indicator can be interpreted as a correlation coefficient. Its value generally falls into the interval [-1, 1] and can be classified as:

$I = 0$ – no autocorrelation;

$I < 0$ – negative autocorrelation (objects are different);

$I > 0$ – positive autocorrelation (objects are similar to each other).

The global Moran's statistic is described by the formula (1):

$$I = \frac{n}{W} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \tag{1}$$

w_{ij} – weight of the connections between units i and j (first order matrix standardised according to rows), x_i x_j – value of the variables in spatial units i and j (first order matrix standardised according to rows), $\bar{x}$ – arithmetic mean value of the analysed variable for all spatial units.

To calculate spatial autocorrelation, the Moran scatter plot appears to be a useful tool. The vertical *Y* axis is based on the weighted average or spatial lag (in this particular case: average unemployed rate) of the corresponding observation on the horizontal *X* axis. The Moran scatter plot provides a visual representation of spatial associations; in this case, it is the correlation between the unemployment rate and location to which it refers.

The *Z* test should be used in order to test significance of the *I* Moran's statistic. The following hypotheses should be verified:

H0: Spatial autocorrelation does not exist.

H1: Spatial autocorrelation exists.

The test statistic with a distribution N(0,1) is as follows:

$$Z = \frac{I - E(I)}{\sqrt{\mathrm{var}(I)}} \tag{2}$$

The expected value E(I) is calculated according to the formula:

$$E(I) = -\frac{-1}{n-1} \tag{3}$$

Depending on the assumed distribution of the population from which a sample is derived, the formula for calculating variance is selected [Cliff, Ord 1981, Goodchild 1986]. If the distribution is normal, the variance is described by the following formula:

$$\mathrm{var}(I) = \frac{n^2 S_1 - nS_2 + 3S_0^2}{S_0^2 (n^2 - 1)} - E(I)^2 \tag{4}$$

where:

$$S_0 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij} \quad S_1 = \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \left(w_{ij} + w_{ji} \right)^2 \quad S_2 = \sum_{i=1}^{n} \left(\sum_{j=1}^{n} w_{ij} + \sum_{j=1}^{n} w_{ji} \right)^2 \tag{5}$$

$$k = \frac{\frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^4}{\left[\frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2 \right]^2} \tag{6}$$

If spatial autocorrelation does not exist, the value of the I Moran's statistic is $I \approx -\frac{-1}{n-1}$, and $Z \approx 0$. If there is autocorrelation, then it is positive for $I > -\frac{-1}{n-1}$ $Z > 0$ autocorrelation is positive and negative for $I < -\frac{-1}{n-1}$ and $Z < 0$.

The global Moran's statistic describes only a certain pattern observed in the whole area. Other measures can be used to investigate the changes in individual spatial units. Such indicators are determined separately for each region. In other words, based on local statistics, it can be judged whether the tested area is adjacent to the areas of low or high values. Such analysis enables detecting clusters of areas of high (or low) value in terms of the tested variable. It also identifies unusual areas (values of which significantly differ from their neighbours) by means of the local Moran's statistic[1]. This characteristic can show how the value of one region is formed in comparison with neighbouring regions, as compared to a random distribution of values in the tested area. The measure is described by the formula:

$$I_i = \frac{(x_i - \bar{x})^2 \sum_{i=1}^{n} w_{ij}(x_j - \bar{x})}{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}} \tag{7}$$

Description as previously.

RESEARCH RESULTS

The global Moran's statistic was calculated in order to determine the impact of neighbouring regions on the unemployment rate in a specific region in 2004-2014. Results of this part of research are presented in table 1. As presented in figures 5 and 7., the Moran scatter plot allows the division of objects on spatial regimes: High-High, Low-Low, Low-High, High-Low. The local Moran's statistic values are presented in figure 6 and 8. The following clusters of regions can be found: regions characterized by a low (statistically significant) local Moran's statistic value and surrounded by regions with a low value of local Moran's statistic (Low-Low); as well as regions characterized by a high (statistically significant) local Moran's statistic value and surrounded by regions with a high value of local Moran's statistic (High-High). Random values of the unemployment rate in specific regions are represented by values near 0.

Table 1. Global Moran Statistic for men and women in years 2004-2014

Year	Male			Female		
	E(I) = 0,07 *Var(I)* = 0,02					
	I	Z	P-value	I	Z	P-value
2004	0.08	0.91	0.35	0.30	2.48	0.01
2005	-0.05	0.12	0.91	0.32	2.61	0.01
2006	-0.26	-1.32	0.90	-0.10	-0.24	0.81
2007	-0.27	-1.34	0.17	-0.16	-0.61	0.53
2008	-0.25	-1.23	0.22	-0.34	-1.85	0.06
2009	-0.17	-0.68	0.50	-0.14	-0.51	0.60
2010	-0.16	-0.62	0.54	0.02	-0.16	0.87
2011	-0.05	0.11	0.92	-0.17	-0.67	-0.49
2012	-0.07	-0.04	0.96	-0.02	0.24	0.80
2013	0.04	0.73	0.46	-0.04	0.15	0.88
2014	0.14	1.44	0.15	0.07	0.91	0.37

grey colour – values statistically significant, p-value = 0.05
Source: own calculations.

[1] For more details see: [Anselin 1995].

Taking into account results presented in the table 1, it can be concluded that the global Moran's statistics for the male unemployment rates display some autocorrelation in the period 2005-2012. However, a high p-value for these measures suggests that they are not significant. Therefore, it can be concluded that the male unemployment rates did not present spatial autocorrelation.

When the results of the spatial distribution of the female unemployment rates are considered, it can be noticed that there existed statistically significant autocorrelation in the period 2004-2005. In other words, the female unemployment rates presented a tendency to form clusters of similar values. However, the influence of the female unemployment rates from neighbouring regions on the unemployment rate in a particular region was not very high – did not exceed 10%. Although the values of the Moran's statistic for years 2010 and 2014 were positive, they were not statistically significant. For the rest of the analysed period, negative values of the global Moran's statistic were obtained and they were not statistically significant. Taking the above into account, it can be concluded that female unemployment rates did not present spatial autocorrelation in the period 2006-2014.

In 2004 and 2005 spatial correlations between female unemployment rates in specific regions occurred. Statistically significant values of the local Moran's statistic were obtained. Starting from 2006, no statistically significant correlation occurred. In fact, the slope of the regression function changed sign from positive to negative.

In 2004-2005, there was only one region characterized by a statistically significant local Moran's statistic value – lubelskie (three out of four subregions are predominantly rural). This region is surrounded by regions with a similar female unemployment rate (mazowieckie, świętokrzyskie, warmińsko-mazurskie and podkarpackie). In 2006, spatial correlations between unemployment rates in specific regions did not occur. In 2007, the female unemployment rate in swiętokrzyskie (intermediate and predominantly rural) was significantly higher than in neighbouring regions. The same situation was reported for kujawsko-pomorskie (predominantly urban and predominantly rural) in 2010 and 2014. In 2008-2009 there is a region (pomorskie: intermediate and predominantly rural) where the situation was opposite than in the neighbouring ones. In 2011, the only significant spatial correlation was recorded in lubuskie (intermediate) region. Statistically significant spatial correlations did not occur in other regions. In 2012-2013, only one region – mazowieckie (covering all three types of territories according to the urban-rural typology) – with unemployment lower than in the neighbourhood (with high values) appeared on the map.

In 2004-2014, spatial correlations between male unemployment rates in specific regions did not occur. However, the slope of the regression function also changed sign from positive to negative.

The analysis of the male unemployment rates proved that there is only one region (lubelskie: where three out of four subregions are predominantly rural) which belonged to the L-L group (Low-Low). It means that it is a region with a low male unemployment rate surrounded by regions with low male unemployment. For example, lubuskie (intermediate region) was characterized by a high male unemployment rate, as well as the neighbouring regions – the High-High group (H-H). There were also some outliers, for instance wielkopolskie region (consisting predominantly rural and predominantly urban subregions) in the period 2006-2007 and podkarpackie region (three out of four subregions are predominantly rural) in the period 2012-2014. Both of them were classified to the Low-High group (L-H), which means that the unemployment rate was considerably lower there comparing to their neighbours. The opposite situation is observed for regions: dolnośląskie (predominantly

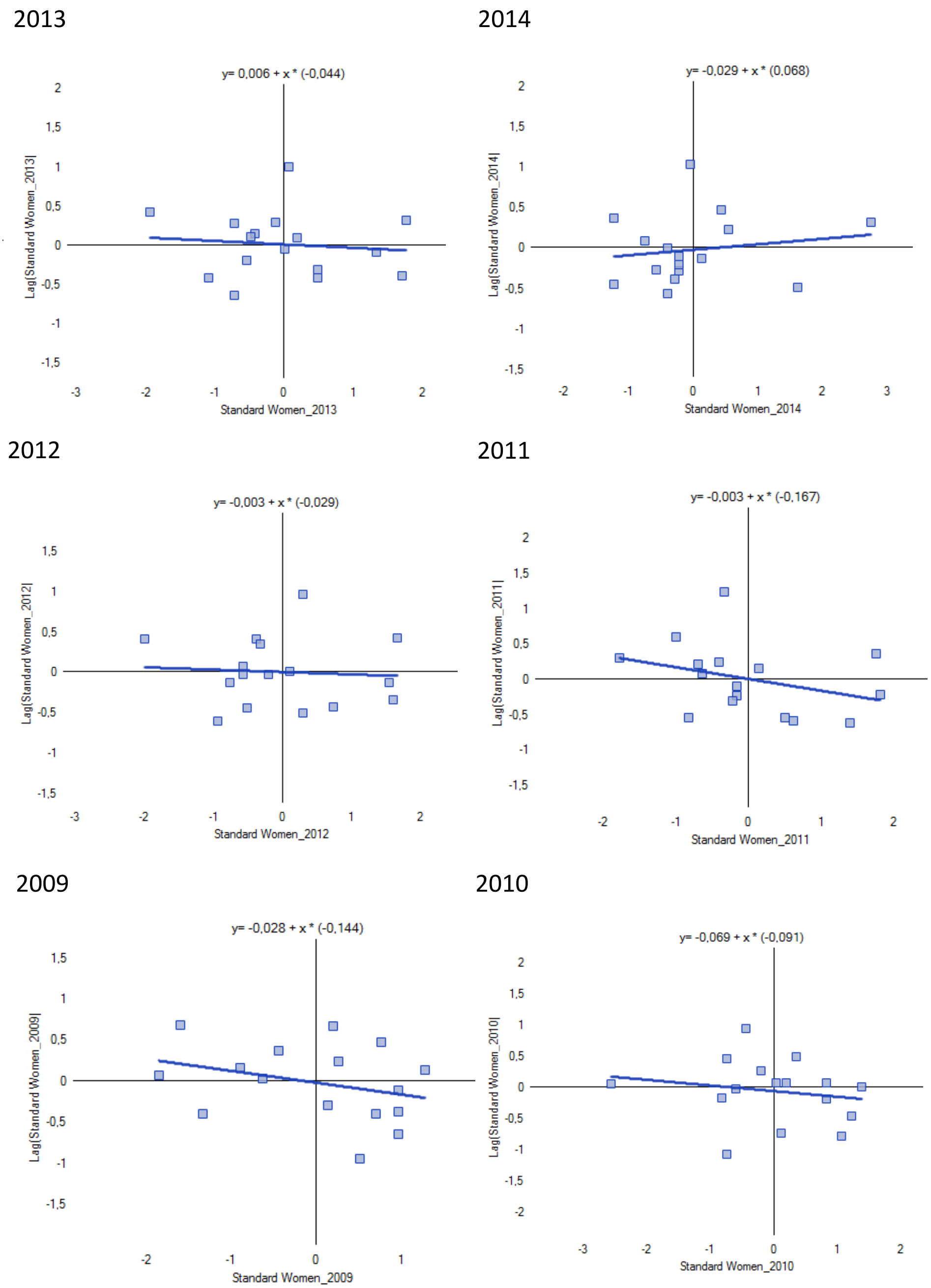


Figure 5. Moran scatter plots for female unemployment rate in individual region
Source: own calculations.

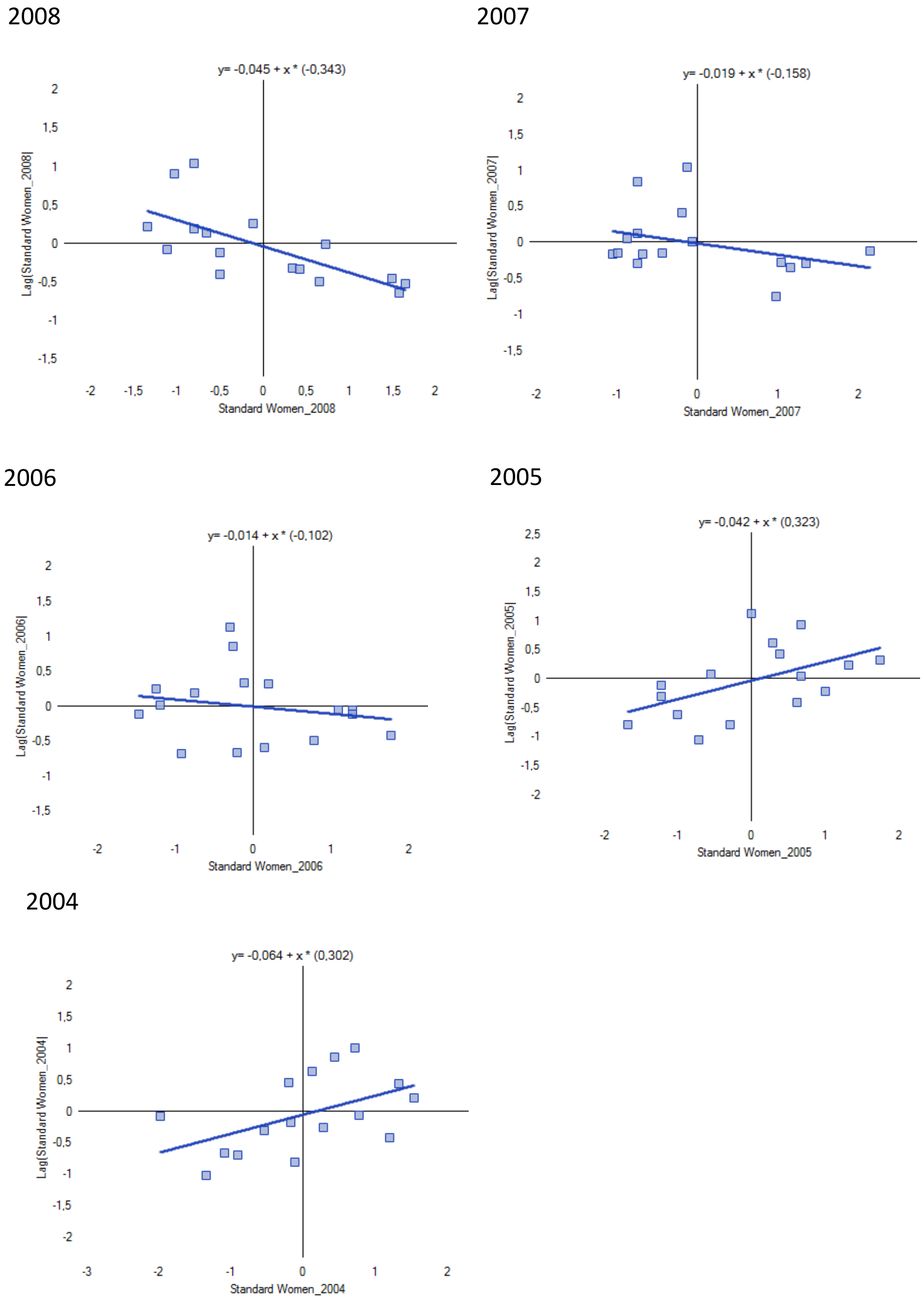


Figure 5. Cont. Moran scatter plots for female unemployment rate in individual region
Source: own calculations.

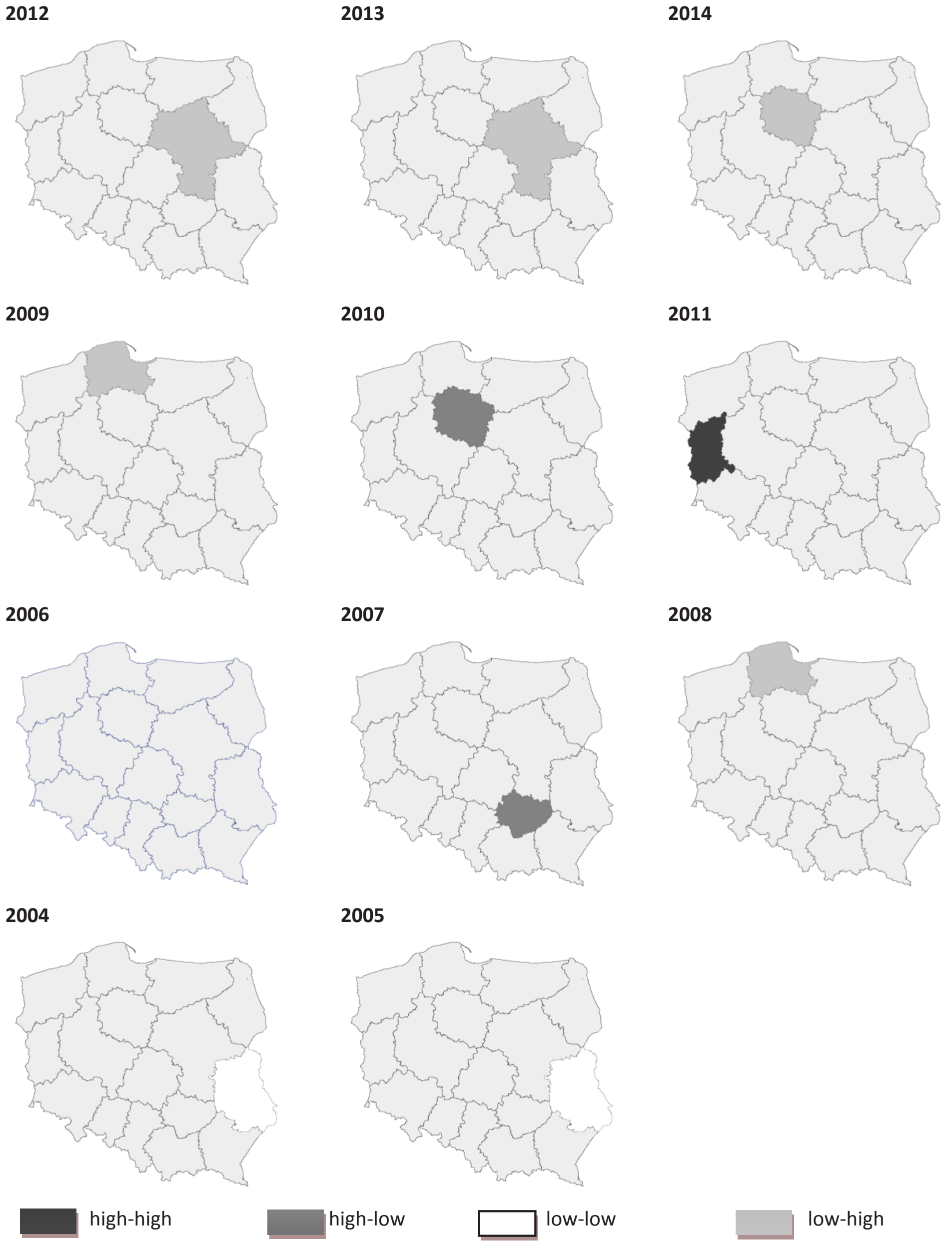


Figure 6. Location of statistically significant Moran's values for female unemployment rate (in %) by regions
Source: own calculations.

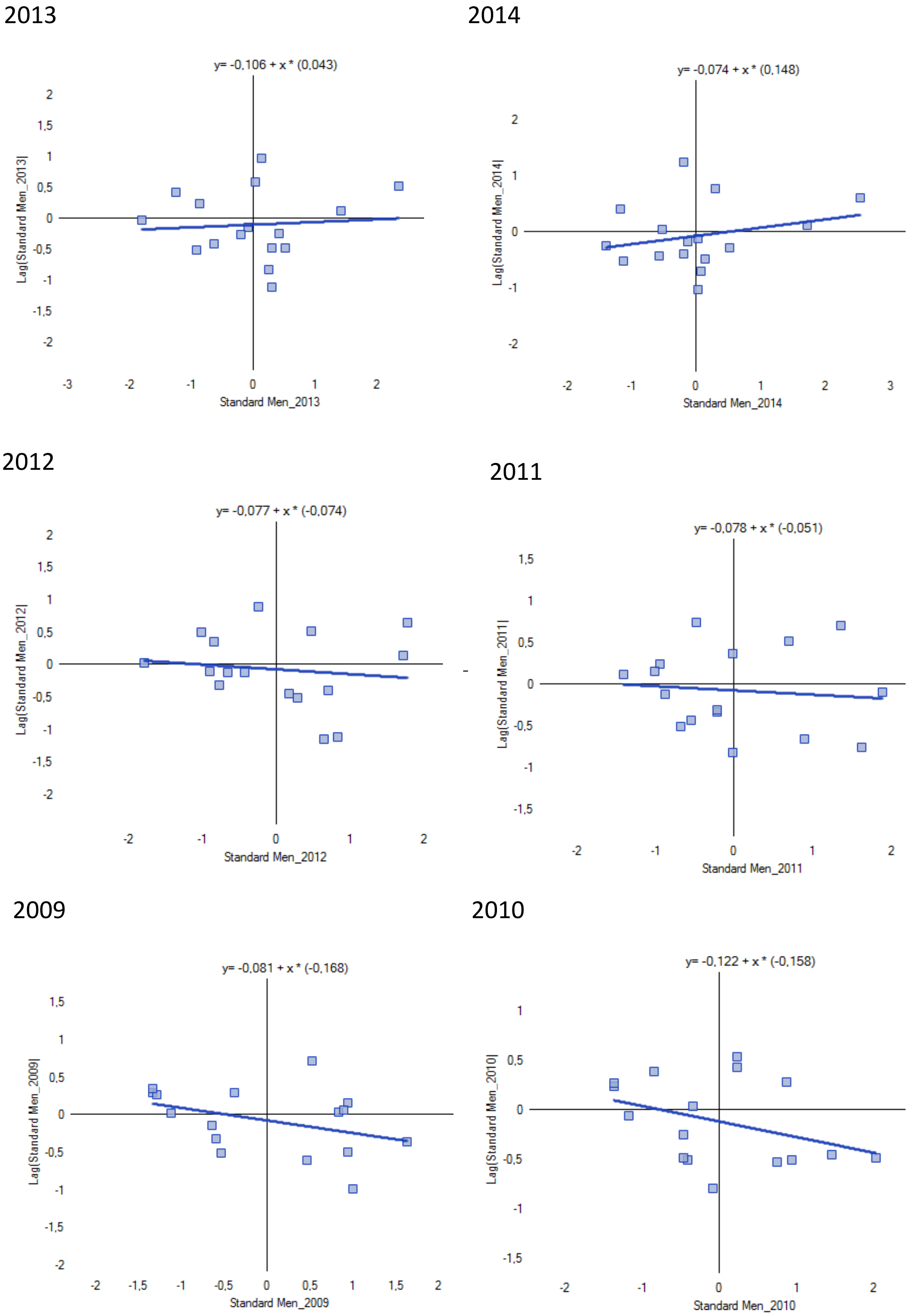
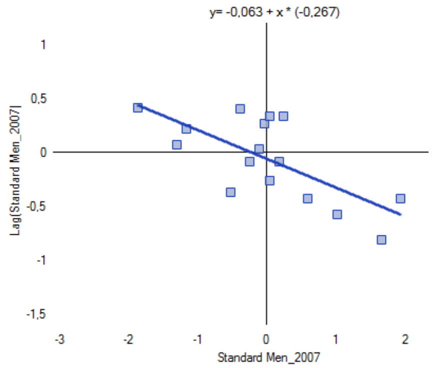
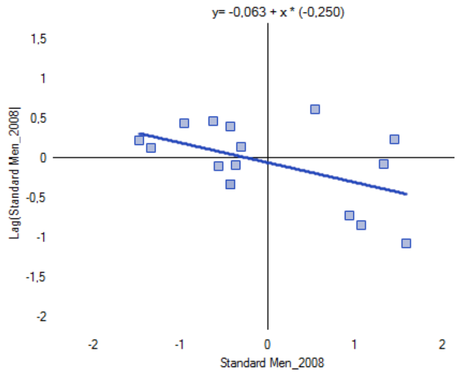


Figure 7. Moran scatter plots for male unemployment rate in individual region
Source: own calculations.

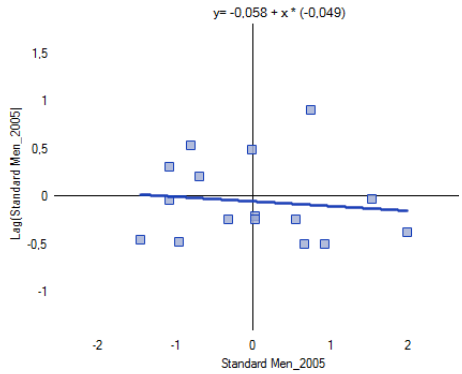
2007



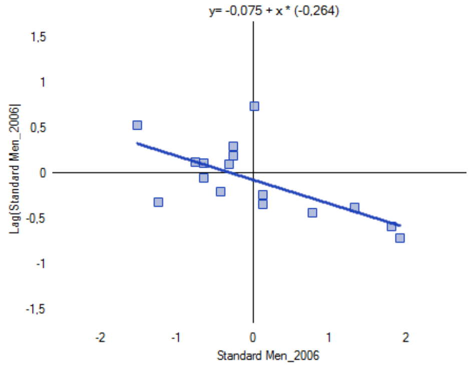
2008



2005



2006



2004

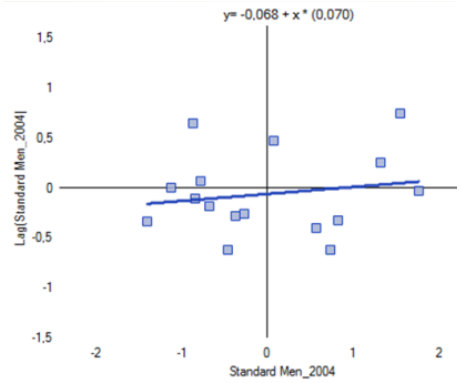


Figure 7. Cont. Moran scatter plots for male unemployment rate in individual region
Source : own calculations.

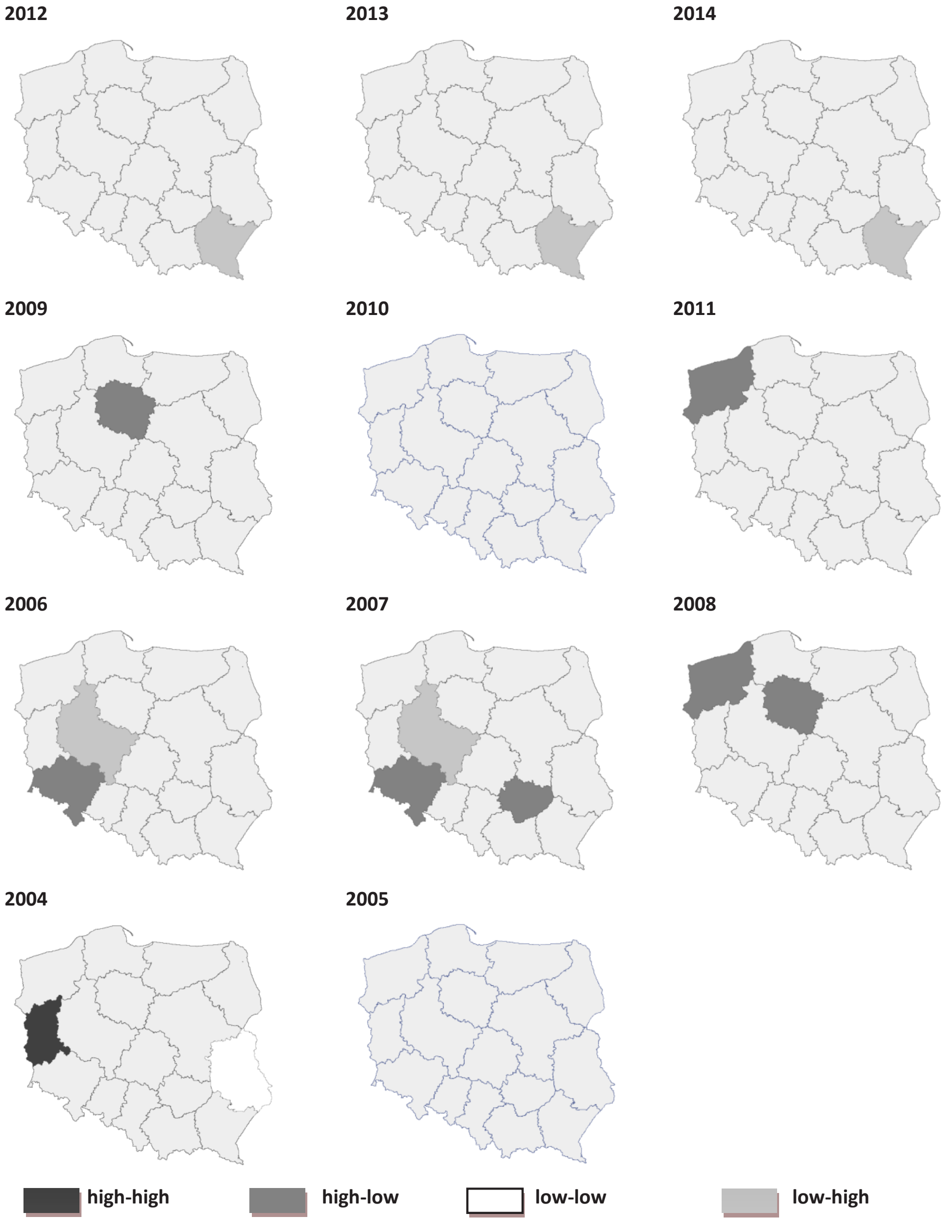


Figure 8. Location of statistically significant Moran's values for male unemployment rate (in %) by regions
Source: own calculations.

Table 2. Regions of statistically significant value of the Moran statistics

Year	Male			
	H-H	L-L	L-H	H-L
2004	lubuskie	lubelskie		
2005				
2006			wielkopolskie	dolnośląskie
2007			wielkopolskie	dolnośląskie, święto-krzyskie
2008				kujawsko-pomorskie, zachodnio-pomorskie
2009				kujawsko-pomorskie
2010				
2011				zachodnio-pomorskie
2012			podkarpackie	
2013			podkarpackie	
2014			podkarpackie	
	Female			
	H-H	L-L	L-H	H-L
2004		lubelskie		
2005		lubelskie		
2006				
2007				świętokrzyskie
2008			pomorskie	
2009			pomorskie	
2010				kujawsko-pomorskie
2011	lubuskie			
2012			mazowieckie	
2013			mazowieckie	
2014			kujawsko-pomorskie	

Source: own calculations.

urban and intermediate) (2006-2007), świętokrzyskie (intermediate and predominantly rural) (2007), kujawsko-pomorskie (consisting predominantly rural and predominantly urban subregions) (2008-2009), zachodnio-pomorskie (intermediate and predominantly rural) (2008, 2011). These regions were characterized by a higher unemployment rate than neighbouring regions.

The next step of the study was to indicate the regions for which the value of the Moran statistics was statistically significant and similar in both groups.

Taking into account unemployment rates, it should be stated that there did not occur a region classified to the first group (H-H) for both female and male. There was only one region in the L-L group – lubelskie (three out of four subregions are predominantly rural) in the 2004, which means that female and male unemployment there was at a similar level as in neighbouring regions. However, there is also region where the situation was opposite than in the neighbouring ones: świętokrzyskie (intermediate and predominantly rural) where the female and male unemployment rate was higher than in the neighbouring regions (H-L group).

CONCLUSIONS

Analyses conducted for the purpose of this study prove that global spatial autocorrelation of unemployment rates according to gender did not occur in the investigated period. Thus, spatial correlation did not occur within the whole country. However, some spatial patterns can be identified when local statistics are considered – then outliers and clusters of similar regions occur. However, clusters are not numerous and they cannot be unequivocally interpreted through the perspective of the urban-rural typology. Nevertheless, this kind of analysis can be useful for identifying regions characterized by similar or different features, which enables monitoring these phenomena. Knowledge of the spatial structure facilitates improvement of structural organization and implementation of programmes reducing negative phenomena.

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BEZROBOCIE W POLSKICH REGIONACH Z PERSPEKTYWY AUTOKORELACJI PRZESTRZENNEJ

Streszczenie

Bezrobocie jest zjawiskiem tradycyjnie badanym przez ekonomistów. Obecnie w analizach tego zagadnienia wykorzystywane są często metody pozwalające na identyfikację autokorelacji przestrzennej na rynku pracy. Celem opracowania jest analiza relacji przestrzennych w zakresie stopy bezrobocia na poziomie regionalnym (NUTS2) w Polsce, a następnie weryfikacja, czy uzyskane rezultaty mogą być interpretowane przez pryzmat klasyfikacji obszarów wiejskich opracowanej na poziomie NUTS3 przez Unię Europejską. Badanie z wykorzystaniem danych GUS objęło lata 2004-2014. Zastosowano globalną i lokalną statystykę Morana. Wyniki potwierdziły istnienie zależności przestrzennych na rynku pracy w Polsce – statystyki lokalne wskazały na istnienie regionów nietypowych oraz klastrów regionów o podobnych charakterystykach rynku pracy.

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