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Female unemployment and its determinants in Poland in 2016 from the spatial perspective

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Abstract
Research background: Through the cultural progress and socio-economic development in Poland women have obtained the same rights as men in the labour market. Nevertheless, they continuously face discrimination and the difficulty, resulting from their traditional role, in finding or maintaining employment.
Purpose of the article: The main objective of this study was an analysis of female unemployment and its determinants in Poland in 2016 from the spatial perspective. The following research questions were also specified: Is female unemployment dependent on social factors (do they play the key role)? Are the factors determining the level of female unemployment spatially diversified? Is the GWR model an effective tool in analysis of female unemployment?
Methods: The research applied GIS and spatial analysis methods including Geographically Weighted Regression, which enables the identification of the variability of regression coefficients in the geographical space. The analysis was carried out based on statistical data presenting the share of unemployed women in the working age population for 380 Polish districts (NUTS 4, LAU 1) in 2016.
Findings & Value added: The research results showed that in the period 2003–2016 the female unemployment was getting lower, but it was still higher than men. It was also spatially diversified. Moreover, the determinants of female unemployment were diverse in the

geographic space and did not have a significant impact on the variable in all spatial units. The existence of clusters of districts, characterised by similar interactions and its strength, was also confirmed. The results of this analysis proved that non-economic (social) factors largely affected the level of female unemployment in Poland in 2016. Using GWR enabled drawing detailed conclusions concerning the determinants of female unemployment in Poland, it proved to be an effective tool for the analysis of this phenomenon.

Introduction

Having a job is one of the most important goals in life. Employment ensures a position in the society, a good quality of life, a sense of accomplishment and security. Through the cultural progress and socio-economic development in Poland women obtained the same rights as men in the labour market. More and more women have higher education, appropriate qualifications (competences), and show a desire for professional development. Nevertheless, they continuously face discrimination and the difficulty, resulting from their traditional role, in finding or maintaining employment (Drela, 2014, p. 107)

The literature emphasizes the impact of not only economic, but also social factors on the situation of women in the labour market (Musiał-Karg, 2017, pp. 120–139). Women's access to employment is more difficult than men, due to a perception held by potential employers of women having many family responsibilities, which cannot be reconciled with full-time job. Unfortunately, the lack of facilities on the labour market related for example with flexible working hours or the possibility of working partly from home, results in some women putting the good of the family over their own ambitions and give up work (remain unemployed).

The main objective of this study is an analysis of female unemployment and its determinants in Poland in 2016 from the spatial perspective. The study focuses mainly on social factors that could affect female unemployment. The research applies GIS and spatial data analysis methods, including Geographically Weighted Regression, which enables the identification of the variability of regression coefficients in the geographical space. The analysis ware carried out based on statistical data presenting the share of unemployed women in the working age population for 380 Polish districts (NUTS4, LAU1) in 2016. The applied analysis methods allowed to answer the following research questions: Is female unemployment dependent on social factors (do they play the key role)? Are the factors determining the level of female unemployment spatially diversified? Is the GWR model an effective tool in analysis of female unemployment?

This study consists of six parts. Section 2 provides literature review on female unemployment in Poland. It also presents the contribution of this study to the literature. Section 3 presents databank used in the study and a preliminary statistical data analysis using GIS and spatial statistics tools. The fourth section describes the method applied in the analysis of female unemployment in Poland — Geographically Weighted Regression. It also contains a short review of research based on GWR, in particular that related to labour market analysis. Section 5 discusses the analysis results. The final section provides a summary and general conclusion, and points further directions of research.

Literature review

The issue of women's position on the labour market in Poland has been discussed thoroughly in the literature. There are numerous studies on the general situation of women in the labour market in Poland (e.g. Siemieńska, 1996; ASM Centrum Badań i Analiz Rynku, 2006; Auleytner, 2008; Haponiuk, 2013; Ludera-Ruszel, 2016; Witkowska, 2016; Musiał-Karg, 2017; Bieszk-Stolorz, 2017), discrimination against women (Kotowska, 1995; Kalinowska-Nawrotek, 2004; Kołaczek, 2009; Tracz-Dral, 2013,) and the gap between men and women including wage inequalities (Golinowska *et al.*, 2004; Instytut Badań Strukturalnych, 2015; Oczki, 2016; Kopycińska & Kryńska, 2016).

The literature also presents very interesting studies on female unemployment and its determinants in Poland. According to Kwiatkowska (2012), women are one of the groups facing the most severe joblessness problems on the labour market, next to young people (up to the age of 25), people with low level of education and long-term unemployed. A relatively low employment rate in the group of women, with the observed decline in the unemployment rate in 2000–2010, is explained by the growing number of economically inactive women. The share of women in the total number of economically inactive population exceeded 60% in the analysed period. This points to the necessity of professional activation of women and combating discrimination against them on the labour market. Research carried out by Haponiuk (2013) has shown that unemployment affects young women (under 24) the most. An important reason for the exclusion of young women from the labour market is starting a family (raising children), which often cause long-term unemployment. The reason why women in near-retirement age are leaving the labour market is that they need to take care of grandchildren or look after older family members. The persistence of traditional family structures based on the intergenerational solidarity somehow limits the incorporation of the woman to the labour market. According to ASM (2006), a large group of women, definitely larger than men, does not work due to the continuation of education. Nearly 13% of women remain unemployed because they get benefits that are sufficient to satisfy their needs. Nevertheless, Musiał-Karg (2017) noted that in most cases, unemployment is not a conscious choice of women, but the effect of conditions prevailing on the labour market, limiting the chances for female employment. Unemployment among women can have serious social consequences, because it is a factor which threatens the family's economic status and stability, which may result in a sense of social exclusion. The overall economic growth in the country certainly affects the improvement of the situation of women in the labour market. It affects the greater emancipation of women through an increase in the level of urbanization or education, and thus a greater interest of women in outdoor activities, which in turn translates into a greater participation of women in the labour market. However, it is not enough. Rękas (2013) emphasizes that only a comprehensive approach to building programs combining family and professional life gives an opportunity to change the poor situation of women on the labour market to reduce female unemployment, to create a stable basis for the development of modern society and to improve the demographic situation.

This study contributes to the literature by focusing on female unemployment and its determinants in Poland from the spatial perspective. It complements previous research by using GIS and spatial data analysis methods including GWR, that provides detailed spatial analysis of the phenomenon. Moreover, it fills the gap in the literature, as there is no example of the implementation of GWR in the female labour market analysis in Poland.

Data bank – preliminary analysis

The purpose of this study is an analysis of female unemployment form the spatial perspective at the NUTS 4 level (LAU 1). Unfortunately, it was not possible to calculate unemployment rate for women, due to the lack of statistical information on the economic activity of the population at this level of aggregation of statistical data. That is why, the share of unemployed women in the working age population was analyzed. However, it should be noted that population of working age also includes those who have reached working age (in Poland it is 18 years old) but continue their education and are not registered as unemployed. Therefore, this variable is underestimated. The unemployment rate registered in Poland in 2016 was 8.3%, while the share of unemployment in the working age was 5% for men and 6.4 for women (Figure 1).

The share of female unemployment in the working age population in Poland has varied considerably since 2003. There have been periods when the rate has fallen (2003–2008, 2014–2016) and increased (2009–2013). The highest level of the variable was noticed in 2003 — 14%, in 2016 it was lower by 7.6 percentage points. Changes to the female unemployment level were closely connected with the country's economic and political situation. It was strongly affected by the economic growth (2004–2008), economic crisis (after 2008), and mass migration for economic reasons connected with Poland's accession to the European Union (after 2004). Throughout the analysed period, female unemployment was much higher than men (Figure 1). The biggest difference between men and women occurred in 2006 — 3 percentage points, and the lowest in 2009 — 0.9 percentage points. In 2016 it was 1.4 percentage points. It is worth noting that since 2014 the gap has been getting bigger.

Figure 2 presents the share of unemployed women in the working age population for Polish districts in selected years (2006, 2008, 2010, 2012, 2014 and 2016). In order to compare the level of variable legends on the maps differ only by the minimum and maximum values. In 2006 the maximum value was 25.68%, whereas in 2016 it was 17.63%. In 2006 the difference between districts, characterised by the highest and the lowest unemployment levels, was nearly 22 percentage points, while in 2016 it was about 15. On this basis, it can be stated that the level of female unemployment in Poland has shown considerable spatial diversification throughout the analysed period, nevertheless the situation of women on the labour market has improved in the last 10 years. The highest women unemployment in each year occurred in the northern Poland. In contrast, the lowest values were observed in districts located near large cities like Warsaw, Poznan, Krakow, Wroclaw and the Tricities.

In order to characterize the spatial structure of female unemployment in Poland, the global Moran's *I* statistic was applied. The values for this statistic fall into the <-1,1> interval, where "-1" means that dissimilar values of the analyzed variable in districts which are next to each other, and "1" means that similar values are clustered together in geographic space. It examines the global tendency in spatial variations in the sample by concerning hypotheses: H_0: observed values of the variable are randomly distributed, hence there is no spatial autocorrelation between specific locations, H_1: there is spatial autocorrelation. To evaluate the significance of that index, the so-called randomization tests are performed (Le Gallo &

Ertur, 2003, pp. 175–201). The obtained results are presented above the maps in Figure 2 (for the spatial weights matrix in the queen configuration, the results are statistically significant). The values of Moran's *I* statistics range from 0.58 in 2006 (maximum value) to 0.51 in 2012 (minimum value). In 2016 it was 0.52. This means that the share of unemployed women in the working age population in Poland was characterised by a relatively high and positive spatial autocorrelation. There were spatial relationships among the districts that affected the female unemployment. Therefore, clusters of districts occurred in the geographic space, characterised by similar female unemployment. In 2016, clusters of lowest female unemployment (the share of unemployed women in the working age population under 5%) included the districts located mainly in wielkopolskie, mazowieckie, śląskie and małopolskie voivodeships. The clusters of districts with the highest female unemployment (the share of unemployed women in the working age population over 15%) occurred in kujawsko-pomorskie, warmińsko-mazurskie and mazowieckie voivodeships.

The statistical database used in this study, except for the share of unemployed women in the working age population (UW), contained eleven potential economic and social determinants presented in Table 1. These factors were specified on the basis of female labour market theories presented in the literature (see: Section 2). Regrettably, not all variables significant to the analysis of female unemployment were available from Polish public statistics for a NUTS 4 spatial cross-section. Data were collected for 380 districts (NUTS 4) of Poland in 2016.

All of the explanatory variables showed positive spatial autocorrelation in 2016, which means that there are clusters of districts in geographic space characterised by similar levels of variables, e.g. high values tend to be geographic neighbours of high values. The highest values of Moran's *I* statistic were received for the amount of family allowances, number of live birds, number of economic entities and social assistance. In turn, the lowest (but still statistically significant) values were obtained for investment outlays in companies, districts' budgetary incomes and job offers. Thus, there were spatial relationships (of different intensities) among districts that affected the values of those variables (Table 2).

Research method

A regional and local unemployment is typically characterised by positive spatial autocorrelation (Lewandowska-Gwarda, 2012, pp. 133–145; Khamis, 2012, pp. 17–27; Netrdová & Nosek, 2016, pp. 701–706; Kantar & Aktaş, 2016, pp. 1–9; Lewandowska-Gwarda, 2018, pp. 4–5). Therefore, spatial statistics and econometrics methods and models are increasingly used in analysis of this phenomenon. One of the tools that enables the identification of the variability of regression coefficients in the geographical space is Geographically Weighted Regression (GWR). This method was introduced to the economic context as *local linear regression* in 1996 by McMillen. Than it was extended by Fotheringham, Brunsdon and Charlton (1996, 1997, 2009) and renamed *GWR.*

GWR generates a separate regression equation for each observation (spatial unit — district), which can be expressed as follows (Brunsdon *et al.*, 1996, p. 284):

$$y_i = \beta_0(u_i, v_i) + \sum \beta_k(u_i, v_i)x_{ik} + \varepsilon_i, \quad (1)$$

where:
y_i is the dependent variable,
β_k is the coefficients,
x_{ik} is the independent variables,
(u_i,v_i) are the co-ordinate location of I,
ε_i is the error term.

It results in a set of local parameter estimates for each relationship which can be mapped to produce a parameter surface across the study region. Along with producing localized parameter estimates, the GWR technique produces localized versions of all standard regression diagnostics including goodness-of-fit measures (Brunsdon *et al.*, 1996, p. 284).

GWR is a tool that is increasingly used in socioeconomic research, especially in research related to healthcare, environmental protection, the real estate market, poverty and migration. The method is also used in labour market research, including the analysis of unemployment. Salvati (2015) developed a local-scale analysis of Okun's law for short-term changes in district production and unemployment rate in 686 labour market areas in Italy (2004–2005) based on a GWR. The analysis results highlighted the spatial patterns characterising Okun's law at the local scale. The elasticity of district income to unemployment rate showed spatial variations that were higher in dynamic rural districts around metropolitan areas. The highest model performance was found in areas in northern and southern Italy.

However, the classical Okun negative relationship between district product and unemployment rate was mainly observed in northern Italy, while the reverse pattern was identified primarily in southern Italian districts. Lewandowska-Gwarda (2018) used GWR in the analysis of local unemployment in Poland in 2015. Based on this research, it was noticed that the determinants of unemployment were diverse in the geographical space, as a result of political, economic and cultural differences among individual parts of the country. The results of this analysis confirm the significant impact of districts' budgetary incomes on unemployment rates in spatial units located in the north-eastern and south-western parts of the country. In turn, capital investments exerted the strongest influence on the fall in unemployment in districts located in the warminsko-mazurskie, podlaskie, lubelskie and swietokrzyskie voivodeships. Expenditure on social assistance has an almost nationwide impact on the rise in the unemployment rate, which is very important conclusion for social policy in Poland.

Results and discussion

Several attempts were made to build the model describing female unemployment in Poland in 2016, taking into account the various forms of functions and the different sets of explanatory variables, based on the analysis of correlation between variables, collinearity in the model, Akaike Information Criterion and coefficient of determination. Apart from the lack of statistical data, the biggest problem in the analysis of female unemployment was the fact that some of the listed potential determinants were highly correlated with each other, which is a common problem in the analysis of regional or local unemployment (Elhorst, 2003, pp. 709–748). The highest correlation was observed between wages and other variables, as well as the number of marriages and divorces. On the other hand, the low correlation coefficient among dependent, and some independent, variables resulted in lack of statistical significance in the model. The biggest surprise was the lack of impact on the female unemployment variables such as: districts' budgetary incomes (which is an economic development measure at the local level), number of job offers and amount of family allowances. Eventually, the model took the following form:

$$UW_i = \beta_0(u_i, v_i) \cdot E_i^{\beta_1(u_i,v_i)} \cdot I_i^{\beta_2(u_i,v_i)} \cdot D_i^{\beta_3(u_i,v_i)} \cdot \\ \cdot LB_i^{\beta_4(u_i,v_i)} \cdot SA_i^{\beta_5(u_i,v_i)} \cdot e^{\varepsilon_i}, \tag{2}$$

where:
β_0 is the absolute term,
β_k is the structural parameters,
(u_i, v_i) are the longitude and latitude of districts' centroids,
E_i is the number of economic entities per 10.000 people,
I_i is the capital investments in enterprises per capita in PLN,
D_i is the number of divorces per 1.000 people,
LB_i is the number of live births per 10.000 people,
SA_i is the budgetary expenditure of municipalities and towns with district rights on social assistance per capita in PLN.
UW_i is the share of unemployed women in the working age population,
ε_i is the random element.

To compare the results obtained based on the GWR model, the parameters of the global model, that produce just one coefficient for each variable, were also estimated. The global model took the following form:

$$UW_i = \beta_0 \cdot E_i^{\beta_1} \cdot I_i^{\beta_2} \cdot D_i^{\beta_3} \cdot LB_i^{\beta_4} \cdot SA_i^{\beta_5} \cdot e^{\varepsilon_i} \tag{3}$$

The parameters of the global model were estimated using OLS. The estimation of GWR model parameters used an estimator given by the following formula (Charlton & Fotheringham, 2009, p. 2):

$$\boldsymbol{\beta}' = [\mathbf{X}^T\mathbf{W}(u_i, v_i)\mathbf{X}]^{-1}\mathbf{X}^T\mathbf{W}(u_i, v_i)\mathbf{Y}, \tag{4}$$

where:
$\mathbf{W}(u_i,v_i)$ is the square matrix of weights relative to the position of (u_i,v_i) in the study area,
$\mathbf{X}^T\mathbf{W}(u_i,v_i)\mathbf{X}$ is the geographically weighted variance-covariance matrix (the estimation requires its inverse to be obtained),
$\mathbf{Y}$ is the vector of the values of the dependent variable.

The $\mathbf{W}(u_i,v_i)$ matrix contains the geographical weights in its leading diagonal and 0 in its off-diagonal elements.

Although there are several options for the estimation methods of bandwidth in GWR models, the bi-square type kernel function was employed because it fitted the best to the model. In order to select the optimum bandwidth, Corrected AIC was employed. The bandwidth where this statistic exhibit the smallest values is judged to be optimal. Table 3 presents the measures of goodness of fit used to compare both models. All measures indicate that the GWR model has a markedly better fit with the empirical data. The value of AIC declined from 243.31 in global model to 157.36 in GWR. The value of adjusted R^2 improved as well, increasing from 0.51 in OLS to 0.70 (average value of adjusted local R^2) in GWR. As Yu (2006) noted, GWR will usually produce better fitting models than global OLS. It often provides a stronger result by having accounted for spatial heterogeneity of the relationship between the dependent and independent variables. Nevertheless, there is still a quite high unexplained variation, which must be addressed in future studies.

Figure 3 presents detailed information on adjusted R^2 in GWR model — for each localisation (district). The map shows that the model has a poor fit with data for districts located in the central and south-eastern parts of the country, particularly in the lodzkie, świętokrzyskie, lubelskie and pod-karpackie voivodeships. The model most accurately describes the studied phenomenon in the northern part of the country, in the districts located in the pomorskie, zachodniopomorskie, wielkopolskie and kujawsko-pomorskie voivodeships. The map clearly indicates that the model properly describes the studied phenomenon for a majority of spatial units.

Correlations between exogenous variables used in the model are weak (correlation coefficients do not exceed 0.45). There are, therefore, grounds for arguing that there is no issue of collinearity in both models, neither GWR nor global. In the global model, VIF (Variance Inflation Factors) do not exceed 1.5 for all variables, therefore it can be concluded that there is no issue of collinearity[1]. Nevertheless, collinearity is potentially more of an issue in GWR because its effects can be more pronounced with the smaller spatial samples used in each local estimation, and if the data are spatially heterogeneous in terms of its correlation structure, some localities may exhibit collinearity, while others may not (Wheeler, 2007, pp. 2464–2481). Fortunately, the GWR tool in ArcMap solves this problem and simply do not present the results when there is either global or local multicollinearity in the model[2]. Based on the results of the study, it can be stated that there is no issue of collinearity in both models (global and GWR).

[1] The general rule of thumb is that VIF of 5 and above is not good for regression model because it might render other significant variables redundant (Akinwande *et al.*, 2015, pp. 754–767).

[2] In case of collinearity (global or local), the program shows an error no 040038, that stands for: “results cannot be computed because of severe model design problems” and indicates ways to deal with the problem.

Table 4 shows the values of the regression coefficients obtained on the basis of the GWR and global models. In the global model, one parameter was obtained for each explanatory variable. In the GWR model, the number of parameters (for each variable) equalled the number of districts, hence Table 4 shows the minimum, maximum and median values. Based on the obtained results, it can be seen that the parameters' values fluctuated around the median of the GWR model coefficients in the global model. The minimum and maximum values, however, indicate a large diversity of parameters in analysed districts. Therefore, the global model does not reflect the complexity of the phenomenon being studied.

Figure 4 presents the values of the regression coefficients and the statistical significance (Student's t-statistics) for each analysed spatial unit (district). The maps presenting significance figures clearly show that parameters were not statistically significant for each location. This is a further proof of the diversity of the relationships among the variables within the geographic space. The maps showing the parameters' values reveal that the variables affected one another with varying intensity in the different districts. The phenomenon of clustering coefficients of similar values in the geographical space also occurred in that case.

The GWR model of female unemployment in Poland in 2016 contains only two economic variables. A negative correlation between the number of economic entities and female unemployment was observed in the northern and western parts of Poland. The highest impact was noticed in the groups of districts located in the pomorskie, lubuskie, dolnośląskie, kujawsko-pomorskie and wielkopolskie voivodeships. New economic entities create new jobs, therefore their impact on reducing the unemployment is clear and obvious. A negative correlation was also observed between the investment level and the analysed variable, mainly in the north of Poland. The highest impact was noticed in the districts situated not only in the podlaskie but also in the podkarpackie voivodeship. The situation in the labour market to a large extent depends on the level of investments made by enterprises. The number of new jobs depends on the volume and type of investments. New development-oriented investments contribute to increased demand for labour. On the other hand, current replacement investments enable already existing jobs to be maintained. It should be emphasized that not all investments contribute to creating or maintaining jobs, as they increase the productivity of workforce (Bremond *et al.*, 2005, p. 134). However, greater workforce productivity enables enterprises to operate more effectively, hence, making them more competitive, which improves employment in the long run.

The model shows that there was a strong impact of social variables on female unemployment in Poland in 2016. A positive correlation was noticed between the number of divorces and female unemployment, mostly in the eastern part of the country. The highest impact was noticed in the districts located in the podlaskie voivodship. The reason for this can be the fact that it is hard to reconcile responsibilities connected with rising a child and work for a single woman. In addition, women often receive financial support from former husbands. It should be emphasized that this relation occurred in less developed areas. Emancipation of women in this part of Poland is weaker than in the west of the country, or in the biggest cities like Poznan, Wroclaw or Krakow. A negative and very strong correlation occurred between the number of live births and the analysed variable. The coefficients are statistically significant for 286 districts. The highest impact was noticed in the groups of spatial units situated in the wielkopolskie, lubuskie and zachodniopomorskie voivodeships. Childbirth increases the awareness of parents, who must provide care and are more likely to work even below their qualifications. The second important reason for this dependence is the fact that in Poland a common practice is to hire pregnant women, who after a short period of the employment go on sick leave, where salaries and benefits are paid by the state. A positive correlation was also observed between the amount of social assistance and female unemployment. The highest values of coefficients were noticed in the districts located in zachodniopomorskie, warmińsko-mazurskie, mazowieckie and kujawsko-pomorskie voivodships. Unemployment adversely affects social conditions and causes the loss of livelihood and qualifications, as well as increased crime and social pathology. Thus, the state can intervene in the labour market using instruments of the so-called passive labour market policy, which are usually connected with financial assistance. Excessive protectionism does not solve the problems as it may contribute to a further fall of the society's activity in the labour market, which results in increased unemployment.

Conclusions

On the basis of analysis results, it was noticed that since 2013, female unemployment in Poland has been getting lower. In 2016, the share of unemployed women in the working age population was 6,4%. Nevertheless, it is always higher than men. Since 2014, the gap between men and women has been getting bigger. In 2016 it was 1,4 percentage points. The level of female unemployment in Poland has shown considerable spatial diversification. The highest values of variable occurred in the northern Poland. In contrast, the lowest were observed in districts located near large cities like Warsaw, Poznan, Krakow, Wroclaw and the Tricities.

The main objective of this study was an analysis of female unemployment and its determinants in Poland in 2016, from the spatial perspective. Based on the analysis results, it was demonstrated that the determinants of female unemployment were diverse in the geographical space, and did not have a significant impact on the formation of analysed variable in all districts. The existence of clusters of districts characterised by a similar interactions and its strength has been confirmed.

The results of this analysis confirm that non-economic (social) factors largely affected the level of female unemployment in Poland in 2016 (the model in which most variables have a social character described the studied phenomenon on average in 70%). The number of live births had an almost nationwide impact on the female unemployment. The highest occurred in the groups of spatial units located in the wielkopolskie, lubuskie and zachodniopomorskie voivodships. In turn, expenditure on social assistance exerted the strongest influence on the analysed variable in districts situated in the zachodniopomorskie, warmińsko-mazurskie, mazowieckie and kujawsko-pomorskie voivodships. Moreover, the number of divorces affected the female unemployment mostly in the eastern part of the country.

GWR proved to be an effective tool for the analysis of female unemployment. The GWR model had a considerably better fit with empirical data than the global model. It enabled the drawing of detailed conclusions concerning the spatial diversification of female unemployment determinants in Poland. However, the model did not show sufficient goodness of fit to data for all analysed spatial units (e.g. for districts located in the central and south-eastern parts of the country).

In 2016, a family-oriented and pro-demographic “Family 500 plus” program was introduced in Poland. According to data published by Central Statistical Office in February 2018, female economic activity is currently the lowest in nineteen years. Therefore, an important stage of further research will be an analysis of the impact of the “Family 500 plus” program on female unemployment and indication parts of the country where this impact is the strongest. Another direction for further research will be an attempt to take into account space-time data in panel GWR model, which will describe not only female unemployment differentials in geographic space, but also over time.

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Annex

Table 1. Potential determinants of female unemployment in Poland

Type of variable	Symbol	Description of the variable
economic	*BI*	districts' budgetary incomes per capita in Polish zloty (PLN)
	E	number of economic entities per 10.000 people
	I	capital investments in enterprises per capita in PLN
	JO	number of job offers per 10.000 people of economically productive age
	W	average wages in PLN
social	*C*	children aged 3-5 years per one place in a pre-school education center
	D	number of divorces per 1.000 people
	FA	amount of family allowances per 1.000 people
	LB	number of live births per 10.000 people
	M	number of marriages per 1.000 people
	SA	budgetary expenditures of municipalities and towns with district rights on social assistance (division 852) per capita in PLN

Table 2. Values of Moran's *I* statistics for potential determinants of the share of unemployed women in the working age population in 2016

Variable	Moran's Statistic *I* =
BI	0.14*
C	0.23*
D	0.29*
E	0.46*
I	0.11*
FA	0.53*
JO	0.18*
LB	0.51*
M	0.29*
SA	0.38*
W	0.21*

* statistically significant

Source: own elaboration in ArcMap.

Table 3. Diagnostic statistics for GWR and global models

	GWR model	**Global model**
Akaike Information Criterion	157.36	243.31
Adjusted R^2	0.70	0.51
Residual Sum of Squares	17.29	39.70

Table 4. Regression coefficients in GWR and global models

Variable	**GWR model**			**Global model**
	Minimum	**Median**	**Maximum**	
Constant	-9.59	6.42	18.91	4.31*
E_i	-1.66	-0.38	0.16	-0.49*
I_i	-0.43	-0.10	0.31	-0.11*
D_i	-1.27	0.14	1.49	0.16*
LB_i	-2.62	-1.26	0.24	-1.12*
SA_i	-1.17	0.54	2.46	0.58*

* Statistically significant

Figure 1. The share of unemployment in the working age population by gender (in%)

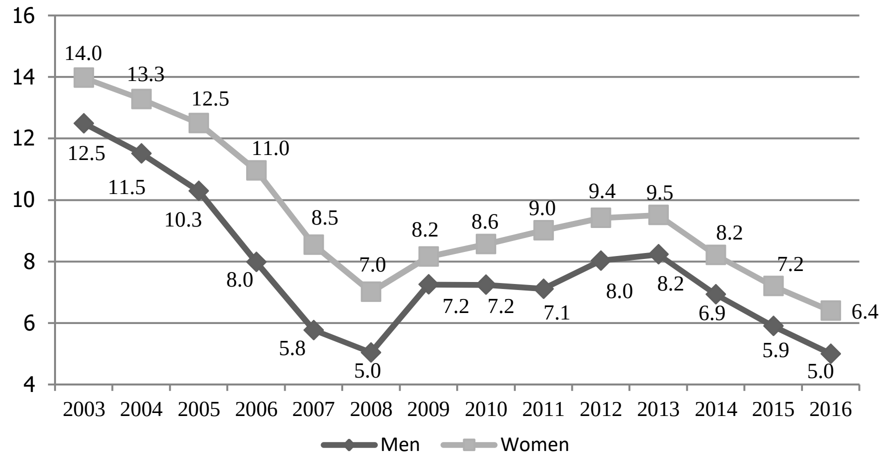
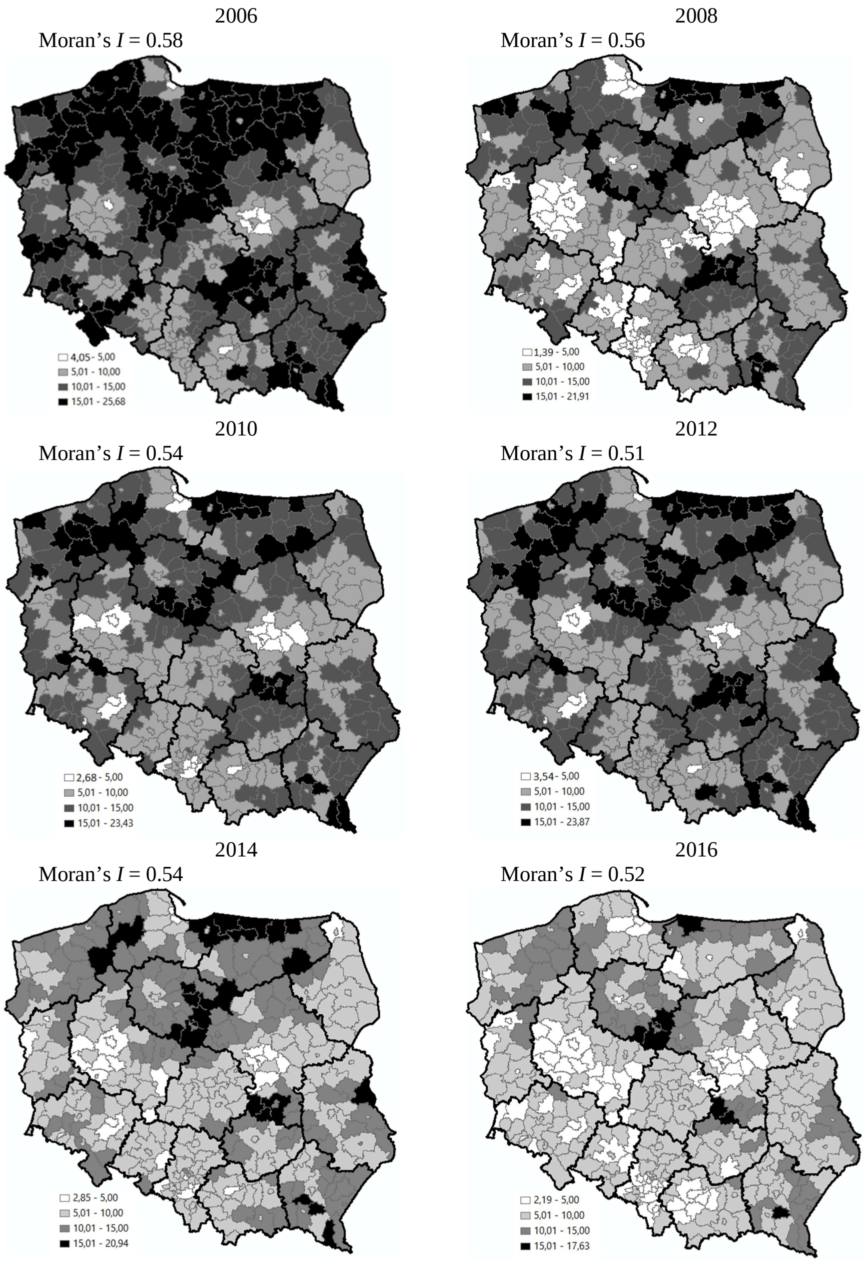
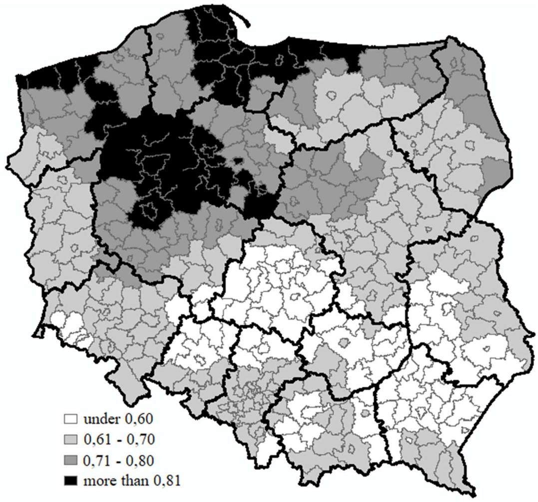


Figure 2. The share of unemployed women in the working age population in Polish districts



Source: own work in ArcMap.

Figure 3. Local adjusted R^2 in the GWR model

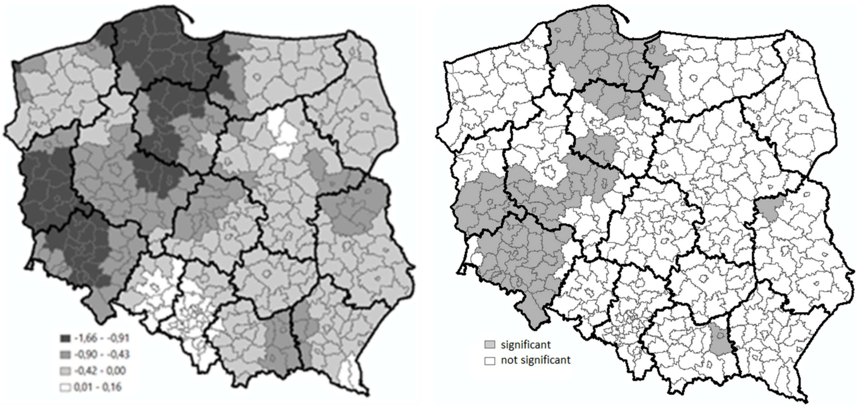


Source: own elaboration in ArcMap.

Figure 4. Values of coefficients and t-statistics in the GWR model

Coefficients t-statistics

E_i - the number of economic entities per 10.000 people

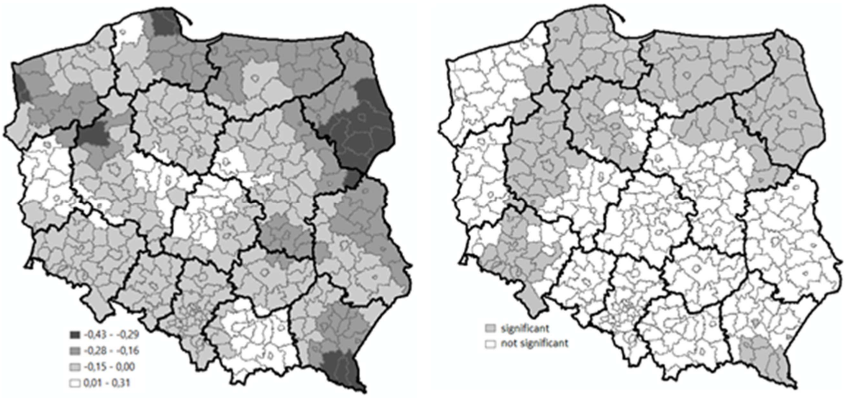


Source: own elaboration in ArcMap.

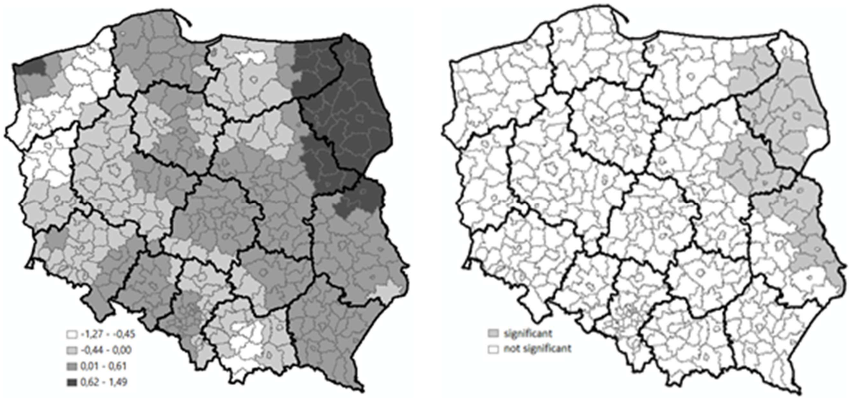
Figure 4. Continued

Coefficients t-statistics

I_i - the capital investments in enterprises per capita in PLN



D_i - the number of divorces per 1.000 people



LB_i - the number of live births per 10.000 people

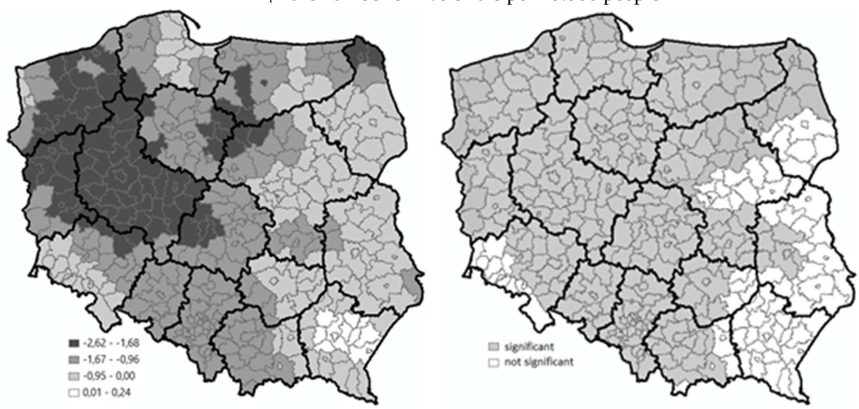
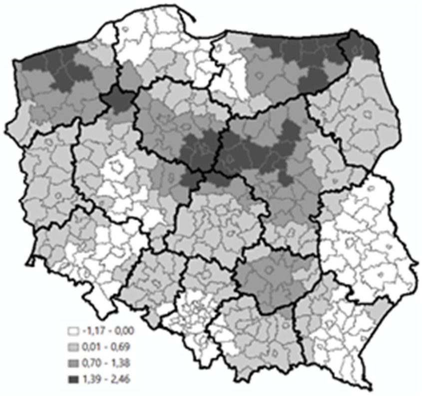


Figure 4. Continued

Coefficients | t-statistics

SA$_i$ - the budgetary expenditure of municipalities and towns with district rights on social assistance per capita in PLN



Source: own elaboration in ArcMap.