Discrimination against women in the local labour markets of Eastern Poland

Monika Bolińska

Department of Economics and Innovation of the Jagiellonian University, Krakow, Poland
ORCID: 0000-0003-0361-7148

Paweł Dykas

Department of Mathematical Economics of the Jagiellonian University, Krakow, Poland
ORCID: 0000-0002-3317-941X

Rafał Wisła

Department of Economics and Innovation of the Jagiellonian University, Krakow, Poland
ORCID: 0000-0002-7895-6243

This study discusses the effect of spatial factors, understood as distances between counties (Pl. 'powiat'), on the increase in unemployment rates in Eastern Poland, and also aims to determine the effect of business cycles on unemployment by gender. The research project was based on the methods of spatial econometrics used to analyse panel data collected in the period 2010-2020 in 101 counties in Eastern Poland (NUTS 4). The study led to the conclusion that women needed a longer time to get a job than men in the phase of economic expansion. In times of rising unemployment in the local labour markets of Eastern Poland, women left the workforce at a greater rate than men, and when unemployment in those markets fell, women remained out of work for a longer time.

1. Introduction

The labour market represents one of the principal fields of research in economics. Research into the processes in the labour market covers the analyses of unemployment on both a regional and local scale. The labour market is also strongly correlated with the product market: a rapid increase in unemployment is observed during a recession, and a fall in unemployment during economic expansion. Numerous

studies demonstrate that major determinants of employment and unemployment include fluctuations in output (Kwiatkowski, 2011). An analysis of interactions between the labour market and product market leads to the conclusion that the demand for the workforce is determined principally by the situation in the product market. This correlation was observed by Keynes, who identified causes of unemployment not in the labour market as such, but in the product market. The theory proposed by Keynes assumes a relationship between the demand for labour and production, leading to the conclusion that the demand for labour can be considered as a function of the global demand for production (Rogut, 2008). Applying a Keynesian approach to growth models, adopted e.g. in the Harrod-Domar model, the conclusion may be drawn that the demand for labour is an increasing function of the product and a decreasing function of labour productivity. Consequently, an increase in production results in a reduction in the unemployment rate. However, Okun's law states that changes in the demand for labour and in the unemployment rate are smaller than those in production and occur with a time lag. The time lag in changes in the labour market in response to the business cycle in the product market varies, taking into consideration both the spatial characteristics of the labour market and the unemployment structure.

The principal aim of this study was to determine the strength and direction of the effect of business cycle fluctuations in the product market on the level of unemployment by gender in the counties of Eastern Poland, bearing in mind the spatial factors.

The analyses conducted in this paper were based on panel data collected in 101 counties of Eastern Poland in 2010-2020. The following sections of this paper discuss the county labour markets in Eastern Poland, using the methods of descriptive statistics to present major macroeconomic variables that characterise the conditions prevailing in those local labour markets and their spatial variation. They also describe the theoretical framework used to create a model explaining the increase in unemployment rates as a function of the production growth rate, and of the variation in registered unemployment rate in prior periods. The methods of spatial econometrics were used to test the theoretical model.

2. Review of the literature

Feminist economic researchers continually propose and develop new theories indicating that gender has a fundamental importance for economic development, but one must also remember that the theory and methods used to prevent discrimination solve the problem only in part, and should see the ultimate goal as the complete eradication of gender discrimination. The significant variable of gender is frequently ignored in economic analyses. Discrimination against women in the labour market has complex origins and is determined by economic, social, cultural and political

conditions, resulting in considerable differences between women and men in such aspects as remuneration, terms of employment or even status in the workplace. İlkkaracan (2012, pp. 3-6) argued that Turkey demonstrates the largest gap in employment of women and men, and emphasised the problem of patriarchy and capitalist growth strictly connected with gender. Comparative analyses concerning member countries of the Organisation for Economic Cooperation and Development have led to the conclusion that the disproportion in the unemployment rate by gender is significantly higher in the Mediterranean countries than in the remaining OECD countries (Azmat et al., 2006, pp. 2-5). The authors also observed that the disproportion grew in the last decade of the 20th century, even though women were increasingly interested in retaining their jobs at that time. The study demonstrates that the problem of discrimination against women in the labour market does not affect all countries. When analysing the disproportion in the labour market, certain factors have to be considered that determine the higher unemployment rate among women than among men. The principal reason for the unemployment rate among women being higher than among men in some member states of the European Union in the early 21st century was the absence of an effective pro-family policy: mothers had to leave the workforce following childbirth and encountered problems in returning to work. Research into this topic was conducted by e.g. Bičáková (2016, pp. 8-13) who analysed data from 21 member states of the European Union in the early 2000s, concluding that in 13 of the economies analysed, women took maternity leaves of varying duration to return to the labour market afterwards, whereas in the remaining eight economies a large proportion of women who were employed before pregnancy did not return to the labour market after giving birth. In Poland, which has been undergoing an economic transformation initiated in the 1990s, women frequently take steps to counteract discrimination in the labour market without assistance, e.g. by registering as sole traders, adapting to new terms of employment (part-time jobs, variable hours of work, telework and recently also remote work), but these options are available only to a narrow segment of society, principally to those who live in big cities. The economic transformation process, involving the transfer of labour from the public to the private sector, was not always beneficial to women who were affected by unemployment to a larger extent.

Haponiuk (2014) and Kalinowska-Nawrotek (2004, pp. 237-238) demonstrated that discrimination against women in Poland could only be reduced by changes to the state's social and economic policies, enabling women to balance their family lives and occupational careers, and promoting the development of small and medium-sized enterprises. The unemployment rate among women is also materially affected by their education level, as stated by Kucharski and Rutkowska (2021, pp. 54-58): women with a higher level of education are less affected by the risk of exclusion from the labour market than those with a lower level. Eastern Poland, frequently referred to as Poland "B" or "C", is a region affected by long-term problems caused

by unemployment that reaches record levels not only on a national but also on an EU scale. The macroregion strongly responds to business cycle fluctuations. The problem of labour supply became particularly severe in this area of Poland after the global financial crisis; the regional labour market is strongly correlated with the dynamics of economic growth (Cicha-Nazarczuk and Nazarczuk, 2014, pp. 163-167).

Research into gender inequality in the labour market of Eastern Poland was conducted by e.g. Leśniak-Moczuk (2018) who observed that women encountered extreme difficulties in seeking work in the Warmińsko-Mazurskie province. Women play a greater role in economic modernization than men: the proportion of women working in the service sector is greater than that of men in Eastern Poland (Leśniak-Moczuk, 2018). However, Poland is affected by the problem of gender pay gap, and women have been paid less for decades (Ulman, 2011, pp. 65-72). The changes in unemployment by region are affected by a number of factors, such as economic, social and cultural conditions, but also the geographic location is indicated as one of the most important determinants of those changes. The interrelations between regions can be identified using suitable models developed in spatial econometrics. Studies analysing the effect of spatial interactions on unemployment rates in Poland were conducted, among others, by Pietrzak (2013, pp. 2-28), Ciżkowicz et al., (2015), Pietrzak and Balcerzak (2016, pp. 303-308), Antczak et al., (2018, pp. 25-43), and Ciołek (2021, pp. 523-538), who applied methods of spatial econometrics such as the Spatial Durbin Model (SDM), the Spatial-Auto-Regressive model (SAR), and the Spatial Error Model (SEM) to identify trends in the labour market using various weight matrices. All these researchers are unanimous in pointing out that the omission of spatial relationships is a serious mistake, in particular, because changes in the labour market of a region affect labour markets in the adjacent regions.

Hence, the authors of this study made an assessment of the variation in the unemployment rate using models developed in spatial econometrics. The study aimed to test the following hypotheses.

H1: Space, understood as actual distances between counties, has a (statistically) significant effect on the variation in unemployment in the local labour markets of Eastern Poland.

H2: The elasticity of unemployment increases in relation to sold production of industry in the category of unemployed women is smaller than in the category of unemployed men. Women in the local labour markets are less pro-cyclical, i.e. during a stage of economic expansion or recovery they need a longer time to get a job than men.
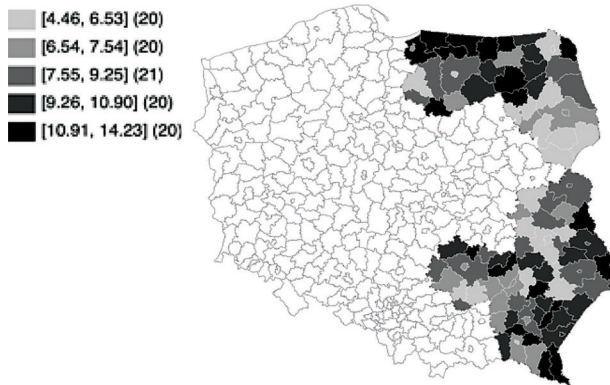
H3: When unemployment rates tend to fall in the counties of Eastern Poland, women find a job at a lower rate than men, and if unemployment rates rise, women lose jobs at a higher rate than men. This hypothesis implies the discrimination against women in the local labour markets of Eastern Poland.

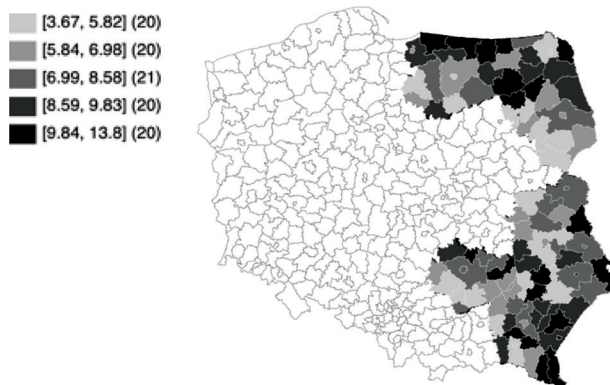## 3. Situation in local labour markets in Eastern Poland

Eastern Poland is defined as a macroregion including 101 counties in five voivodeships (regions): Warmińsko-Mazurskie, Podlaskie, Lubelskie, Świętokrzyskie and Podkarpackie. It occupies about 30% of Poland's territory, inhabited by 20% of the national population as of 2021. The macroregion of Eastern Poland marks the eastern border of Poland, the European Union and the Schengen Area, and borders on the Russian Federation, Belarus, Lithuania, Ukraine and Slovakia. In 2004, at the time of Poland's accession to the European Union, this part of the country was the least developed region in the Union. The labour market, next to the markets of money, capital, product, and land, plays a very important role in an economy; and though unemployment directly affects individuals, it poses a problem to society as a whole. The economic transformation initiated in Poland in the 1990s involved material changes that also affected the labour market. In 2004, the average registered unemployment rate in Poland reached 19%, falling to 6.2% in 2020. Considering all the voivodeships in Poland, the highest unemployment rate was observed both in 2004 (29.2%) and in 2020 (10.10%) in the Warmińsko-Mazurskie voivodeship, an area affected by structural unemployment since the winding-up of state agricultural farms.

The maps show the average unemployment rates in 2010-2020 in the counties o f Eastern Poland in total, and the percentages of unemployed men and women in the working-age populations of men and women (Map 1). The map showing the total unemployment rates in the counties of Eastern Poland (a) reveals that only four metropolitan counties (urban territorial units excluding rural areas) qualify into the quintile group characterised by the lowest values, namely Olsztyn (4.5%), Suwałki (5.63%), Krosno (5.76%) and Lublin (6.34%). The lowest value was shown in the Suwałki county (4.46%) in the Podlaskie voivodeship, containing a Special Economic Zone. The group characterised by the lowest value included six other counties from that voivodeship, next to the town of Suwałki and Suwałki county. The group also contained six counties each from the Lubelskie voivodeship, and two counties from the Podkarpackie, Świętokrzyskie and Warmińsko-Mazurskie voivodeships. The highest values of unemployment rates were observed in two counties from the Podkarpackie voivodeship: Lesko (14.7%) where agriculture and tourism are the most important industries, and Brzozów (14.22%) with the economy based on tourism. In addition to these two counties, the group with the highest unemployment rates included four other counties from the same voivodeship, and eight counties from the Warmińsko-Mazurskie voivodeship forming the largest set in the group. This group also included two counties each from the Lubelskie, Podlaskie and Świętokrzyskie voivodeships.
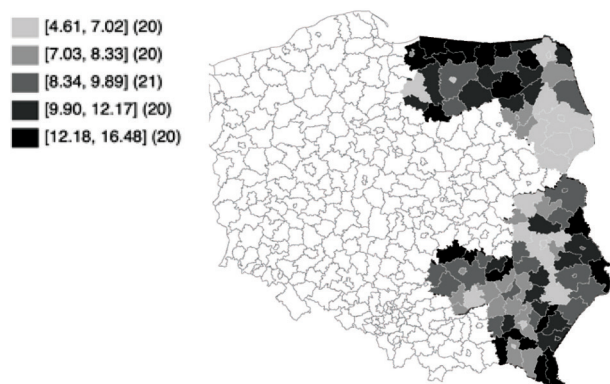
The second map (b) shows the percentage of unemployed in the working-age male population; an analysis of the map reveals that only three metropolitan - counties, namely Olsztyn (4.42%), Suwałki (5.15%) and Krosno (5.24%), qualified

M. Bolińska, P. Dykas, R. Wisła

[4.46, 6.53] (20)
[6.54, 7.54] (20)
[7.55, 9.25] (21)
[9.26, 10.90] (20)
[10.91, 14.23] (20)

a) total

[3.67, 5.82] (20)
[5.84, 6.98] (20)
[6.99, 8.58] (21)
[8.59, 9.83] (20)
[9.84, 13.8] (20)

b) among men

[4.61, 7.02] (20)
[7.03, 8.33] (20)
[8.34, 9.89] (21)
[9.90, 12.17] (20)
[12.18, 16.48] (20)

c) among women

Map 1. Spatial variation in total average registered unemployment rates and spatial variation in the average percentages of unemployed in the working-age male and female populations (in %, the period 2010-2020)

Source: own study based on https://bdl.stat.gov.pl/BDL/start (access: 20.01.2022).

for the group with the lowest values of the variable discussed. The group consists of six counties from the Podlaskie voivodeship, four counties each from the Lubelskie and Podkarpackie voivodeships, and three counties each from the Świętokrzyskie and Warmińsko-Mazurskie voivodeships. The highest values of the variable were noted in seven counties from the Podkarpackie voivodeship, including Przemyśl (10.03%), and five counties from the Warmińsko-Mazurskie voivodeship. The group also included three counties each from the Lubelskie and Podlaskie voivodeships, and two counties from the Świętokrzyskie voivodeship. The highest values of the percentage of unemployed in the male population were recorded in the Bartoszyce county (Warmińsko-Mazurskie voivodeship); the adverse situation in that county was caused, among others, by the limited activity of local employers, who failed to use the opportunities offered by the Bartoszyce section of the Warmińsko-Mazurskie Special Economic Zone, and by a border checkpoint with the Russian Federation. The second lowest value was recorded in Lesko county (13.8 %) in the Podkarpackie voivodeship.

An analysis of the map (c) showing the percentage of unemployed in the working-age female population led to the conclusion that as many as six of the 14 metropolitan counties were classified into the group with the lowest values of this variable, namely Olsztyn (4.61%), Suwałki (6.15%), Białystok (6.21%), Krosno (6.30%), Lublin (6.33%) and Rzeszów (7.02%). This quintile group includes six counties from the Lubelskie voivodeship, two from the Podkarpackie voivodeship, nine from the Podlaskie voivodeship and two from the Warmińsko-Mazurskie voivodeship. The group of counties with the highest values does not include any county from the Podlaskie voivodeship, but includes two counties from the Lubelskie, six counties from the Podkarpackie, three from the Świętokrzyskie and nine from the Warmińsko-Mazurskie voivodeships. The highest values of the variable discussed were observed in the counties of: Bartoszyce (15.45%, Warmińsko-Mazurskie), Braniewo (16.03%, Warmińsko-Mazurskie) and Brzozów (16.48%, Podkarpackie).

Analysing Map 2 of similarity in total registered unemployment rates and in the percentages of unemployed in the working-age male and female populations, it can be observed that the counties of Eastern Poland classified according to those indicators show differences that emerged in the Polish economy during its transformation initiated in the 1990s. The differences are very distinct in the Podkarpackie voivodeship, which includes counties with economies based on agriculture and tourism, naturally affected by high unemployment levels, and also post-industrial counties such as Dębica, Mielec, Stalowa Wola, Tarnobrzeg, which also experienced the problem of high unemployment rates since the termination of the development project of the Central Industrial Region. Special Economic Zones were established there to solve the problem, beginning with the Mielec Special Economic Zone launched in 1994. The operation areas of Special Economic Zones attract investors by offering preferential tax treatment, aimed at reducing unemployment levels in those areas. The Podkarpackie voivodeship also includes counties with a developed

1 (47)
2 (33)
3 (21)

a) total

1 (40)
2 (37)
3 (24)

b) among men

1 (42)
2 (35)
3 (24)
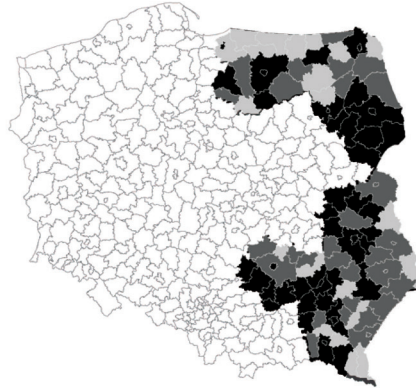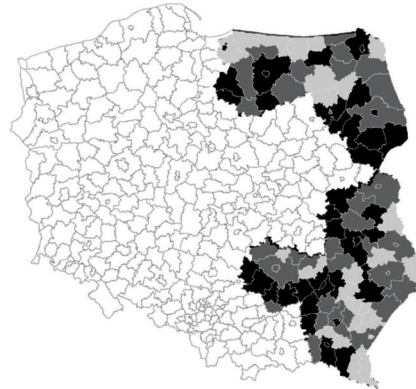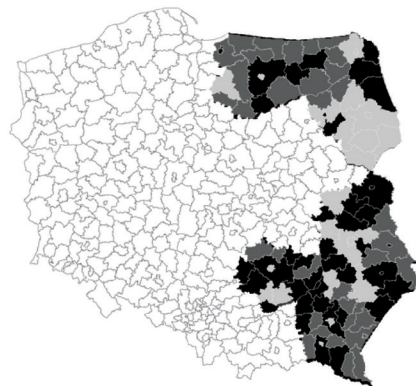
c) among women

Map 2. Similarity clusters of county groups in total unemployment rates, and similarity clusters of county groups in the percentages of unemployed in the working-age male and female populations

Source: own study based on https://bdl.stat.gov.pl/BDL/start (access: 20.01.2022).

service sector, such as the town of Rzeszów, Rzeszów county as its natural satellite, or Krosno and Dębica characterized by low values (considering the overall picture of the voivodeship) of the analysed variables. When discussing the unemployment rates or percentages of unemployed in the working-age populations, the situation in the Lubelskie voivodeship must be explained, where a severe problem is posed by hidden unemployment in agriculture and the employment of people active in low--productivity farming. As a result, the counties of this voivodeship do not demonstrate the high values of the variables under discussion, but unemployment remains a real problem.

One of the clusters of similarity includes the northern counties of the Warmińsko-Mazurskie voivodeship and south-eastern counties of the Podkarpackie voivodeship, selected counties of the eastern section of the Lubelskie voivodeship, and counties located in the north-western section of the Podlaskie voivodeship; the high unemployment level in those counties is partly caused by a mismatch of demand and supply in the labour market. This cluster contains the smallest number of elements. Another (largest) cluster includes counties where the problem of unemployment is less severe: the capital towns of counties (Kielce, Olsztyn, Rzeszów) and metropolitan counties (Elbląg, Krosno), as well as the counties hosting Special Economic Zones in which the problem of unemployment is reduced (Puławy, Dębica, Łuków, Iława). The third cluster includes the remaining counties characterised by average unemployment levels and average percentages of unemployed in the male and female working-age populations.

Map 3 shows the average values of sold production of industry in the counties of Eastern Poland excluding including? four counties (Lubartów, Łęczna, Kolno, Wysokie Mazowieckie), in which the value of this variable equals zero due to the absence of the corresponding data provided by Statistics Poland. The highest values of this macroeconomic variable are observed in Ostróda county (PLN 62879.84) in the Warmińsko-Mazurskie voivodeship, traditionally a typical agricultural county with enterprises engaged in wood and food processing. The second-largest value of sold production of industry was recorded in Mielec county (PLN 54558.55) in the Podkarpackie voivodeship, with a Special Economic Zone called Euro-Park Mielec, successfully operating and dynamically growing since 1994. Polish Aviation Works is one of the major enterprises located in the Zone. The group with the largest values of sold production of industry includes seven counties from the Świętokrzyskie voivodeship, six from the Podkarpackie voivodeship, three each from the Podlaskie and Warmińsko-Mazurskie voivodeships, and two from the Lubelskie voivodeship. Only eight out of the fourteen metropolitan counties qualified for the group demonstrating top and high values of the variable. The lowest values of sold production of industry were recorded in the county of Sejny (PLN 294.76) in the Podlaskie voivodeship, which borders on Belarus and Lithuania, with its the population employed mainly in the agricultural sector.
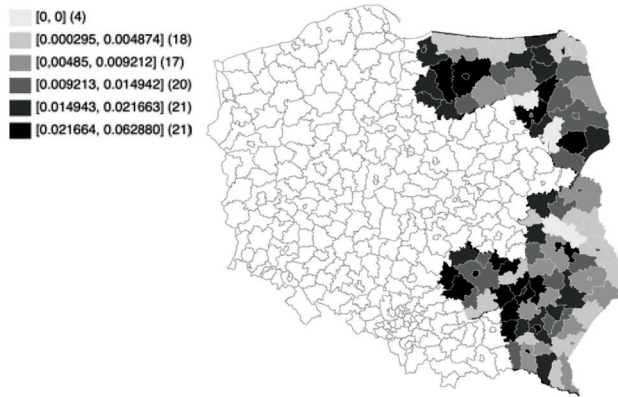
Map 3. Spatial variation of average sold production of industry per capita (in PLN million, 2010--2020, fixed prices of 2020)

Source: own study based on https://bdl.stat.gov.pl/BDL/start (access: 20.01.2022).

Second place in the classification determined by the analysed macroeconomic variable is occupied by the county of Włodawa (PLN 746.21) in the Lubelskie voivodeship, borders on Ukraine and Belarus and contains, among others, the Polesie National Park, the Polesie Landscape Park, the Sobibór Landscape Park and the Western Polesie Biosphere Reserve, making it a naturally valuable, but also a typical tourist area. The group of counties with the lowest values includes five counties from the Lubelskie voivodeship, four each from the Podkarpackie and Warmińsko-Mazurskie voivodeships, three from the Świętokrzyskie voivodeship and two from the Podlaskie voivodeship.
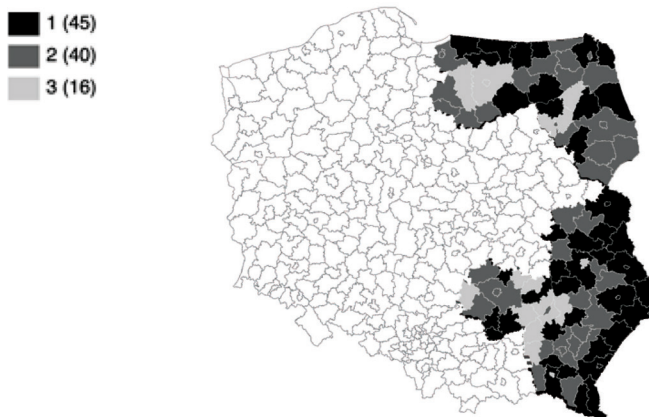
Map 4. A similarity cluster of county groups regarding sold production of industry per capita

Source: own study based on https://bdl.stat.gov.pl/BDL/start (access: 20.01.2022).

In developed countries, the share of industry in creating GNP is falling while that of the service sector is growing, but changes taking place in the structure of industry still affect developments in the economy as a whole (Sadowski, 2006, p. 24). The largest cluster depicted on the map includes counties located in the eastern sections of Podkarpackie and Lubelskie voivodeships, such as Lesko, Lubaczów, Hrubieszów, Włodawa and Tomaszów, being typical agricultural and tourist areas with low values of sold production of industry per capita. The cluster also includes northern counties of the Podlaskie (Sejny, Sokółka) and Warmińsko-Mazurskie (Braniewo, Bartoszyce, Kętrzyn) voivodeships; the enterprises established in these counties predominantly take conservative measures aimed to survive rather than develop business, and the high unemployment rates characteristic of those counties reflect the considerable percentages of people who are long-term unemployed due to labour mismatch or to their passive attitudes.

The second cluster (containing the smallest number of units) mostly includes counties where the Central Industrial Region used to operate (Lublin, Starachowice, Mielec, Dębica, Tarnobrzeg, Stalowa Wola). Investment in the area was focused on large industrial centres. The factories that were established or refurbished as part of the development project of the Central Industrial Region continue to operate, and operations of those large enterprises provide local small businesses with growth opportunities. The third cluster principally includes those counties in which sold production of industry reaches values that can be described as average, bearing in mind the conditions prevailing in the macroregion.

4. Methodology

4.1. Determinants of the increase in unemployment rates in Eastern Poland

Regarding the approach taken in this study, the relation between spatial interactions in individual groups of unemployed persons and changes in production and unemployment rates is described using a simple theoretical model. The following definition of the unemployment rate was adopted to identify the principal determinants of increase in that rate:

$$u_{it} = \frac{U_{it}}{U_{it} + L_{it}} = 1 - \frac{L_{it}}{N_{it}}, \qquad (1)$$

where U_{it}, L_{it} and N_{it} represent (respectively) the number of unemployed, the number of employed and labour supply in ith region in year t. The relation described by equation (1), proceeding to increments, was used to identify the relation between the current increase in unemployment and its rate from the prior period and the production growth rate. For this purpose, the relation expressed by (1) can be differentiated with respect to time as follows:

$$\dot{u}_{it} = \frac{L_{it}\dot{N}_{it} - N_{it}\dot{L}_{it}}{N_{it}^2} = \frac{L_{it}}{N_{it}}\left(\frac{\dot{N}_{it}}{N_{it}} - \frac{\dot{L}_{it}}{L_{it}}\right).$$

Referring to the definition of unemployment rate (1), the above relation can be expressed as:

$$\dot{u}_{it} = \left(1 - u_{it}\right)\left(\frac{\dot{N}_{it}}{N_{it}} - \frac{\dot{L}_{it}}{L_{it}}\right). \tag{2}$$

Production is one of the major factors determining the number of employed persons in an economy, hence equation (2) implies the following relation:

$$\dot{u}_{it} = \left(1 - u_{it}\right)\left(\frac{\dot{N}_{it}}{N_{it}} - f(g)\right), \tag{3}$$

assuming about function f that $df/dg > 0$. In other words, equation (3) shows that the rate of increase in the number of employed persons is an increasing function of the production growth rate.

The above discussion led to the conclusion that an increase in unemployment is a decreasing function of the production growth rate, and if the growth rate of labour supply is greater (smaller) than the growth rate of the number of workers, the increase in unemployment is a decreasing (increasing) function of the unemployment rate.

In terms of relation (3), an increase in current unemployment in the categories of unemployed in discrete time can be expressed by the following equation:

$$\Delta u_{it}^j = \alpha_0 - \alpha_1 u_{it-1}^j + \alpha_2 d_{\Delta u} u_{it-1}^j - \alpha_3 lnPS_{it}, \tag{4}$$

where u_{it}^j is the unemployment rate when $j = 0$, and in the case of $j = 1$ ($j = 2$) is the percentage of (respectively) unemployed men (women) in the working-age population in i^{th} county ($i = 1,2,3, \ldots, 101$) in year t ($t = 2010, 2011, 2012, \ldots, 2020$), whilst $d_{\Delta u}$ is a dummy variable that equals 1, if the unemployment rate in i^{th} region in year t rises, and otherwise is 0. Considering the definition of variable $d_{\Delta u}$, it can be analytically expressed as:

$$d_{\Delta u} = \begin{cases} 1, & \text{if } u_{it}^j > u_{it-1}^j \\ 0, & \text{if } u_{it}^j \le u_{it-1}^j \end{cases}.$$

Variable $d_{\Delta u}$ in equation (4) is a switching variable that adjusts the effect of unemployment from the preceding period on its current increase, depending on whether a rise in unemployment was recorded or not; $lnPS_{it}$ is a natural logarithm of sold production of industry in i^{th} region in year t.

Equation (4) was estimated in the first stage using the ordinary least squares (OLS) method for panel data on the counties of Eastern Poland in 2010-2020. Subsequently, equation (4) was expanded by individual effects (fixed effects) per county. The main limitation of classical panel models, although they assume the

heterogeneity of fixed effects in regions, lies in their failure to consider spatial locations and the way of interaction between adjacent regions. This limitation is overcome in spatial panel models that expand the classical ones by introducing in equation (4) a matrix that defines the mutual locations of the objects analysed. The matrix, known as a spatial weight matrix, determines the structure of the neighbourhood of the analysed area and the force of potential interactions of its neighbours, providing tools for estimating the effect of neighbouring regions on the processes analysed, taking place in local labour markets in Eastern Poland (Kula and Wójcik, 2017).

Analytical equation (4), expanded by spatial panel methods, can be expressed by the formula (on the structures of general formulae of spatial panel models: see e.g. Ciołek & Brodzicki, 2017; Le Gallo & Pirotte, 2017):

$$\Delta u_{it}^{j} = \alpha + \rho \sum_{l=1}^{101} w_{il} \Delta u_{it}^{j} + \sum_{k=0}^{3} x_{ikt}^{j} \alpha_k + \sum_{k=0}^{3} \sum_{l=1}^{101} w_{il} x_{lkt}^{j} \theta_k + \mu_i + \gamma_t + \upsilon_{it}, \tag{5}$$

where x_{ikt}^{j} for $k = 1,2,3$ represents the corresponding endogenous variables from equation (4) for individual categories of unemployed persons in i^{th} region in year t, and the random component is decomposed as follows:

$$\upsilon_{it} = \lambda \sum_{j=1}^{n} w_{ij} \upsilon_{it} + \epsilon_{it}, \tag{6}$$

where γ_t represents constant temporal effects, and w_{ij} – components of a spatial weight matrix W defined in advance.

Equation (5) contains parameters characteristic of spatial panel methods, where ρ is the spatial auto-regression coefficient. If coefficient ρ assumes a statistically significant non-zero value in a correctly defined model, it confirms strategic spatial interactions occurring between the analysed regions (Karska & Torój, 2018). The existence of spatial relationships means that the response variable in i^{th} region is determined not only by the value of the explanatory variables in that region, but also by changes in the value of the response variable from neighbouring regions; λ is the spatial correlation coefficient of the random component. It is included in the model specification to verify that the model meets the condition of random error; the coefficient itself defines the extent to which shocks occurring in neighbouring regions are transmitted to i^{th} region (Folfas, 2017). The autocorrelation of model random components discussed here may be caused by unobserved factors that are spatially correlated with each other. Thus, θ_k represents the components of vector $\boldsymbol{\theta}$, corresponding to estimates of parameters at spatial lags of independent variables. In other words, components θ_k represent estimates of parameters for independent variables in neighbouring regions (see Pastor, 2018). They indicate whether the values of independent variables in neighbouring regions have an effect on the response variable in the region analysed.

Generally, all parameters of equation (5) are not estimated at a time, and this study considers the following types of spatial econometrics methods:

- $\rho = 0$ and $\theta = 0$; a model with spatial autocorrelation of errors (Spatial Error Model – SEM); a characteristic parameter for model λ.
- $\theta = 0$; Spatial Autoregressive and Spatially Autocorrelated Model (SARAR or Spatial Autoregressive Combined – SAC); characteristic parameters for the model ρ and λ.
- $\lambda = 0$; Spatial Durbin Model – SDM; characteristic parameters for the model θ and ρ.

The SEM is used to analyse spatial interactions considering random errors of the response variable while the SAC – random errors and spatial lags of the response variable. The SDM includes, next to the spatial interactions of the response variable, spatial lags of independent variables.

Usually, the maximum likelihood method or the generalised method of moments is used to estimate the structural parameters of the above models (see Anselin et al., 2008; Olejnik & Olejnik, 2020: 37-66). In addition, all the models listed above are expanded by spatial fixed effects.

The common characteristic of all spatial panel methods is their use of a spatial weight matrix. In this study, a single, common and time-invariant matrix W was chosen, characteristic of all spatial effects described by the parameters, i.e. λ, ρ and θ.

Weight matrix $W = \left[w_{ij} \right]_{nxn}$ was based on actual distances (represented by a Euclidean metric) between the analysed regions. Matrix W was a symmetric square matrix with dimensions 101×101 which assumed only non-negative values. Components w_{ij} in the matrix defined as above, referring to various combinations of region pairs, assumed non-negative values representing distances between the geometric centres of those regions; the distances between the regions were determined using the geographic coordinates of their centres of gravity.

4.2. Empirical test results

The statistical analyses of spatial variation in the increases in unemployment rates per individual categories of unemployed persons were based on the panel data on 101 counties of Eastern Poland, from the period 2010-2020.

The estimation results of equations (4) and (5) described in the preceding section are contained in Tables 1 to 4; the data presented in the tables show strong spatial interactions between increases in the registered unemployment rates in the counties of Eastern Poland. The coefficient describing spatial interactions between current increases in unemployment rates (ρ) proved to be statistically significant (see the SDM and SAC). This confirms that a distinct shift-share effect occurs in the counties of Eastern Poland – a change in sold production of industry and/or unemployment rates in prior periods in one county causes a shift of an increase in unemployment rates to other counties. In other words, changes in the current increase in unemployment rates

in a county depend on increases in unemployment rates in its neighbouring counties. The directions of changes in that shift for unemployed persons in total, unemployed men and unemployed women are consistent in their sign, but the relatively lowest effect of the parameter discussed is observed in the category of unemployed women.

The inclusion of the values of the response variable characterised by a spatial lag in the SAC model, had a positive effect on the increase in the value of parameter λ in the category of unemployed persons in total and unemployed men, and thus did not affect its significance level. In the category of unemployed women, the values of parameter λ in the SAC model dropped; the lower values of that parameter for the category of unemployed women (compared to unemployed persons in total and unemployed men) may indicate that the current increase in unemployment in the group of women disclosed a weaker response to random errors in neighbouring counties in Eastern Poland. However, considering the above observation, it can be assumed that an increase in unemployment in a county is affected by random errors from neighbouring counties in each of the discussed categories of unemployed persons. The significance of parameters ρ and λ confirms that the use of spatial econometrics methods is purposeful in the analyses of the current increase in unemployment rates in Eastern Poland.

Table 1

OLS estimations for equations (4) and (5) in individual categories of unemployed persons in the counties of Eastern Poland in 2010-2020

		OLS with fixed effects		
		All	Men	Women
Main	$\Delta\ln\left(PS_{IT}\right)$	-0.0028* (0.0013)	-0.0034* (0.0014)	-0.0023* (0.0014)
	$d_{\Delta u}u_{it-1}$	0.0147*** (0.0003)	0.0157*** (0.0004)	0.0147*** (0.0004)
	u_{it-1}	-0.0682*** (0.0040)	-0.0693*** (0.0045)	-0.0631*** (0.0040)
	Constant	-0.0025*** (0.0004)	-0.0030*** (0.0004)	-0.0023*** (0.0004)
R^2		0.6415 0.6405	0.6465 0.6455	0.5927 0.5916
ll (null)		3681.336	3609.197	3647.678
ll (model)		4251.213	4186.809	4146.625
AIC		-8494.425	-8365.617	-8285.251
BIC		-8474.373	-8345.565	-8265.199

Notes: Significance levels: ***$p < 0.01$, **$p < 0.05$, p* < 0.1, standard errors (SEs) in parentheses, p-values for tests in square parentheses [p-value].

Source: authors' calculations.

Table 2

SEM estimations for equations (4) and (5) in individual categories of unemployed persons
in the counties of Eastern Poland in 2010-2020

SEM with spatial fixed effects				
		All	**Men**	**Women**
Main	$\Delta\ln\left(PS_{IT}\right)$	**-0.0022**** (0.0011)	**-0.0029*** (0.0012)	**-0.0022*** (0.0014)
	$d_{\Delta u}u_{it-1}$	**0.0085***** (0.0006)	**0.0087***** (0.0005)	**0.0096***** (0.0006)
	u_{it-1}	**-0.0841***** (0.0088)	**-0.1039***** (0.0083)	**-0.0836***** (0.0104)
	λ	**0.8664***** (0.0282)	**0.8869***** (0.0249)	**0.8331***** (0.0339)
R^2	Within	0.6179	0.5874	0.5793
	Between	0.3533	0.2560	0.3565
	Overall or adjusted	0.5587	0.5214	0.5247
ll (model)		4487.475	4458.282	4334.613
AIC		-8964.95	-8906.523	-8659.225
BIC		-8939.885	-8881.458	-8634.16

Notes: Significance levels: ***p < 0.01, **p < 0.05, p* < 0.1, standard errors (SEs) in parentheses.
Source: authors' calculations.

Table 3

SAC (SARAR) estimations for equations (4) and (5) in individual categories of unemployed persons
in the counties of Eastern Poland in 2010-2020

SAC (SARAR) with spatial fixed effects				
		All	**Men**	**Women**
Main	$\Delta\ln\left(PS_{IT}\right)$	**-0.0021**** (0.0011)	**-0.0028*** (0.0011)	**-0.0011*** (0.0016)
	$d_{\Delta u}u_{it-1}$	**0.0079***** (0.0006)	**0.0083***** (0.0005)	**0.0096***** (0.0008)
	u_{it-1}	**-0.0850***** (0.0089)	**-0.1065***** (0.0082)	**-0.0521***** (0.0079)
ρ		**-1.6680***** (0.1616)	**-1.4107***** (0.2046)	**-0.4899***** (0.0671)
λ		**0.9723***** (0.0065)	**0.9705***** (0.0075)	**0.1361*** (0.2314)
R^2	Within	0.3527	0.3862	0.6709
	Between	0.3918	0.2454	0.3720
	Overall or adjusted	0.2855	0.2905	0.6577
ll (model)		4516.093	4472.739	4334.752
AIC		-9020.185	-8933.478	-8657.504
BIC		-8990.107	-8903.4	-8627.426

Notes: Significance levels: ***p < 0.01, **p < 0.05, p* < 0.1, standard errors (SEs) in parentheses.
Source: authors' calculations.

Table 4

SDM estimations for equations (4)- and (5) in individual categories of unemployed persons in the counties of Eastern Poland in 2010-2020

		SDM with spatial fixed effects		
		All	Men	Women
Main	$\Delta\ln\left(PS_{it}\right)$	-0.0021* (0.0012)	-0.0028* (0.0012)	-0.0021* (0.0014)
	$d_{\Delta u}u_{it-1}$	0.0082*** (0.0006)	0.0086*** (0.0005)	0.0093*** (0.0006)
	u_{it-1}	-0.0878*** (0.0090)	-0.1090*** (0.0084)	-0.0885*** (0.0110)
θ_k	$\Delta\ln\left(PS_{it}\right)$	0.0053 (0.0044)	0.0073 (0.0046)	0.0080* (0.0047)
	$d_{\Delta u}u_{it-1}$	-0.0023* (0.0010)	-0.0036*** (0.0008)	-0.0020* (0.0012)
	u_{it-1}	0.0546*** (0.0091)	0.0823*** (0.0095)	0.0503*** (0.0106)
ρ		0.6810*** (0.0443)	0.7290*** (0.0340)	0.6203*** (0.0516)
	Within	0.7369	0.7422	0.6851
	Between	0.3444	0.2510	0.3476
	Overall or adjusted	0.7061	0.6995	0.6498

Notes: Significance levels: ***p < 0.01, **p < 0.05, p* < 0.1, standard errors (SEs) in parentheses. Source: authors' calculations.

In the case of parameters θ_k, the spatial effects of sold production of industry in the categories of unemployed persons in total and unemployed men have no statistical significance. However, parameters θ_k proved to be statistically significant for all the discussed categories of unemployed persons in the case of unemployment from the preceding period, both at an increasing and a decreasing trend in unemployment. This led to a general conclusion that the current increase in unemployment in a county is affected by changes in independent variables from neighbouring regions, excluding sold production of industry for unemployed persons in total and unemployed men.

Tables 1 to 4 present the results of the estimation of equations (4) and (5). From the results of the estimations presented in these tables and from the theoretical considerations, one can draw the following conclusions. The estimated parameters, representing elasticities of the current increase in unemployment rates relative to sold production of industry, proved to be statistically significant in all considered methods. They suggest that changes in sold production of the industry have a stronger effect on an increase in unemployment in the group of men than in the group of

women. Thus, it can be concluded that in the counties of Eastern Poland men showed a stronger response to the business cycle in the product market than women. If the unemployment rate in the earlier periods reflected a decreasing trend, the category of unemployed men was characterised by greater decreases in current unemployment than the category of unemployed women, as confirmed by the higher (absolute) values of parameters at variable u_{it-1}^{j} for unemployed men. However, when unemployment in the previous periods showed an increasing trend, the recorded increase in unemployment among women was higher, compared both to the category of unemployed men and unemployed persons in total.

Summary and recommendations

The local labour markets in Eastern Poland display significant variation, both spatially and divided by gender. In the analysed macroregion there are regions with both high and low unemployment rates. Those with a low level of average unemployment include, among others, metropolitan counties and their immediate surroundings – satellite counties. In these regions, after the economic transformation in the 1990s, the service sector has significantly developed, which is the main driving force of economic development in Poland. The highest unemployment rates in all the groups were recorded in counties with an agricultural structure. When analysing the sold production of industry per capita in this part of the country, it should be noted that the lowest values of this variable were recorded mainly in border counties and those with an agritourism structure. On the other hand, the highest values of sold industrial production were recorded mainly in the areas where the Central Industrial Region operated, and in later years Special Economic Zones were established there.

The estimated structural parameters of spatial econometrics models confirm the hypothesis proposing that spatial factors have a significant effect on unemployment in the region. The empirical tests performed also confirm the hypotheses suggesting discrimination of women in local labour markets of Eastern Poland. This is demonstrated by lower elasticities of unemployment among women relative to sold production of industry; consequently, women need a longer time than men to get a job under conditions of economic expansion in the product market. However, when unemployment in Eastern Poland rises, women leave the workforce at a higher rate than men, and when unemployment falls, women get jobs at a lower rate than men.

In addition, with unemployment rates not increasing, each subsequent percentage point of unemployment rates in the previous year translated into a decrease in unemployment, depending on the model used, by less than 10% for the SEM, SAC and SDM models and by about 15% in the case of the OLS method. In conditions of growing unemployment, each subsequent percentage point of the unemployment rate, depending on the estimation method, translated into an increase in this variable by about 10%. An active labour market policy should be defined in local (county) labour markets. The study shows that the elasticity of unemployment relative to sold

production varies significantly depending on gender. A precise definition of the groups that are most susceptible to changes in production, and coordination of active labour market policies at the regional level may materially influence the effectiveness of measures taken to counteract unemployment.

References

Anselin, L., Le Gallo, J., & Jayet, H. (2008). Spatial panel econometrics. In *The Econometrics of Panel Data* (pp. 625–660). Springer.

Antczak, E., Gałecka-Burdziak, E., & Pater, R. (2018). Unemployment and vacancy flows in spatial labour market matching at the regional level. The case of a transition country. *Journal of Applied Economics*, 21(1), 25–43.

Azmat, G., Güell, M., & Manning, A. (2006). Gender gaps in unemployment rates in OECD countries. *Journal of Labor Economics*, 24(1), 1–37.

Bičáková, A. (2016). Gender unemployment gaps in the EU: Blame the family. *IZA Journal of European Labor Studies*, 5(1), 1–31.

Cicha-Nazarczuk, M., & Nazarczuk, J. (2014). Dekompozycja zmian w stopie bezrobocia w woje-wództwach Polski wschodniej. *Studia Ekonomiczne*, 196, 158–169.

Ciołek, D. (2021). Changes in the labour market during the COVID-19 pandemic and their spatial interactions–evidence from monthly data for Polish LAU. *Geographia Polonica*, 94(4), 523–538.

Ciołek, D., & Brodzicki, T. (2017). Spatial dependence structure of total factor productivity in Polish local administrative districts. *Acta Universitatis Lodziensis. Folia Oeconomica*, 3(329), 73–92.

Ciżkowicz, P., Ciżkowicz-Pękala, M., Pękala, P., & Rzońca, A. (2015). The Effects of Polish Special Economic Zones on Employment and Investment: Spatial Panel Modelling Perspective.

Folfas, P. (2017). Regiony USA i UE-28 – PKB per capita, procesy zbieżności i zależności przestrzenne. *Studia Oeconomica Posnaniensia*, 5(1), 75–85.

Haponiuk, M. (2014). Sytuacja kobiet na rynku pracy w Polsce, W: M. Kiełkowska (red.), *Rynek pracy wobec zmian demograficznych* (pp. 38-51). Instytut Obywatelski.

İlkkaracan, İ. (2012). Why so few women in the labor market in Turkey? *Feminist Economics*, 18(1), 1–37.

Kalinowska-Nawrotek, B. (2004). Formy dyskryminacji kobiet na polskim rynku pracy. *Ruch Prawniczy, Ekonomiczny i Socjologiczny*, 2, 231–245.

Karska, M., & Torój, A. (2018). Strategiczne interakcje przestrzenne między decyzjami wydatkowymi gmin w Polsce w latach 2008–2014. *Collegium of Economic Analysis Annals*, 53, 29–46.

Kucharski, L., & Rutkowska, A. (2021). Sytuacja kobiet na rynku pracy w Polsce w porównaniu z sytuacją mężczyzn. *Wiadomości Statystyczne*, 66(08), 46–67.

Kula, G., & Wójcik, P. T. (2017). Lokalne determinanty starzenia się populacji w Polsce. *Acta Universitatis Lodziensis. Folia Oeconomica*, 3(329), 93–110.

Kwiatkowski E., (2011). Kryzys globalny a rynek pracy w Polsce i innych krajach Grupy Wyszehradzkiej. *Ekonomista*, 1, 37–54.

Le Gallo, J., & Pirotte, A. (2017). Models for spatial panels. In: The Econometrics of Multi-dimensional Panels (pp. 263–289). Springer, Cham.

*Econometrics*Leśniak-Moczuk, K. (2018). Aktywność kobiet na tle mężczyzn w sferze zawodowej w Polsce wschodniej. *Czasopismo Naukowe Instytutu Studiów Kobiecych*, 1(4), 112–136.

Olejnik, A., & Olejnik, J. (2020). Metody stochastyczne w ekonometrii przestrzennej – nowoczesna analiza asymptotyczna. Łódź: Wydawnictwo UŁ.

Pastor, K. (2018). Determinanty absorpcji środków z perspektywy finansowej 2007–2013 na poziomie powiatów. *Catallaxy*, 3(1), 27–39.

Pietrzak, M. B. (2013). *Interpretation of structural parameters for models with spatial autoregression*, No. 32, Institute of Economic Research Working Papers, 2–28.

Pietrzak, M. B., & Balcerzak, A. P. (2016). A spatial SAR model in evaluating the influence of entrepreneurship and investments on unemployment in Poland, Chapter 48 in Proceedings of the International Scientific Conference Quantitative Methods in Economics Multiple Criteria Decision Making XVIII, 2016, vol. 1, pp. 303–308.

Rogut, A. (2008). *Determinanty popytu na pracę w Polsce w okresie transformacji*. Wydawnictwo Uniwersytetu Łódzkiego.

Sadowski, Z. (2006). Akcesja do Unii Europejskiej a kierunki rozwoju Polski. In: *Gospodarcze skutki Akcesji Polski do Unii Europejskiej. Wyd. Nauk. Uniwersytetu Opolskiego*.

Ulman, P. (2011). Rozkłady płac w Polsce ze względu na płeć i zajmowane stanowisko: analiza porównawcza. *Zeszyty Naukowe*, 847, 61–74.