The labour market situation in medium-sized urban centres of the Kujawsko-Pomorskie voivodeship and the problem of unemployment in the province

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Abstract

The aim of the paper is to analyse the spatial and spatio-temporal dependences in matters related to the situation in the labour market of the Kujawsko-Pomorskie voivodeship across municipalities in the period of 2004-2015. With reference to the guidelines of the 2020 development strategy for the province and the 2020+ modernisation plan, the analysis may constitute the basis for verifying whether, in the presence of a dependence, investing (e.g. through a growing number of enterprises) in the development of individual medium-sized urban centres with a high level of unemployment such as Włocławek, Grudziądz and Inowrocław can significantly improve the situation in the whole province. The assessment of the situation in the labour market for each of the municipalities is made with the use of two characteristics: the share of registered unemployed persons in the number of the working age population and the number of business entities per 10 000 working age population. The spatial and spatio-temporal tendencies and dependences are in turn investigated using the conception of spatial trends and spatial autocorrelation. The empirical analyses have been supplemented by simulations of the labour market situation in the province resulting from situation improvement in selected urban centres.

Keywords: *labour market, medium-sized urban centres, spatial and spatio-temporal dependence*
JEL Classification: C10, E24, R58

1 Introduction

With regard to labour market conditions, as stated by the data from the Central Statistical Office, the Kujawsko-Pomorskie voivodeship for many years has been located at the bottom of the Polish provinces rankings. The development of individual territorial units within provinces contributes to jobs creation, and thus, to a reduction of the unemployment rate. According to the 2020 development strategy for the Kujawsko-Pomorskie voivodeship and the 2020+ modernisation plan, an improvement in the labour market situation of the province should be the result of investments in the development of the medium-sized urban centres such as Włocławek, Inowrocław and Grudziądz, where the level of unemployment is high. The desire to verify the correctness of this supposition constitutes the main motivation for

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conducting this research. The mentioned assumption is also the main research hypothesis of the study.

The labour market is a heterogeneous category in different aspects of the analysis (Szulc, 2011; Vega and Elhorst, 2014; Nosek and Netrdova, 2014; Pillet et al. 2014; Semerikova, 2015; Blinova et al. 2016). In particular, in addition to variability in time, the labour market situation is characterised by spatial differentiation occurring at different levels of data aggregation. Simultaneously, certain regularities, tendencies and dependences in this area can be observed.

The primary aim of the paper is to analyse the spatial and spatio-temporal dependences in matters concerning the situation in the labour market of the Kujawsko-Pomorskie voivodeship across municipalities in the period of 2004-2015. It is the basis to verify that, with the existing dependencies, investments (e.g. through a growing number of enterprises) in the development of individual medium-sized urban centres of the province can significantly improve the labour market situation in the whole province. The labour market situation in each of the municipalities has been assessed on the basis of variables which, on the one hand, represent an unexploited labour supply in the form of the number of the unemployed, and, on the other, the demand for labour which generates enterprises operating in the market.

2 Subject and the scope of the investigation

The study concerns the labour market situation in the Kujawsko-Pomorskie voivodeship across municipalities in the period of 2004-2015. The following indicators have been analysed: the share of registered unemployed persons in the number of the working age population (Y) and the number of business entities per 10 000 working age population (X). It was considered that these variables are the most important determinants of the market situation. The data availability at a fixed level of the spatial aggregation (NUTS-5 classification) is also of significance. The adopted level of spatial aggregation and time range of the research allowed to observe the spatial and temporal tendencies and regularities in shaping of the analysed variables, which requires a large number of observations.

The spatial and spatio-temporal tendencies and dependences in the behaviour of the analysed variables were in turn investigated using the conception of the spatial trend and spatial autocorrelation. Additionally, spatial autoregressive models were estimated and verified. The findings in this range were used for the specification of the econometric model for the pooled spatial and temporal data. The empirical analyses have been supplemented by simulations of the labour market situation in the province assuming an improvement of the

situation in the selected urban centres. For this purpose the abovementioned model was used. The said model contained the spatio-temporal trend and spatially lagged variables.

The study verifies the hypothesis of an importance of job creation in certain medium-sized urban centres for the improvement of labour market situation in the whole region. In particular, an attempt was made to determine the extent of spatial influences of stimulation of labour demand in the selected spatial units. The question is whether a growing number of enterprises in selected centres will reduce unemployment in the whole region or in the neighbouring areas only.

3 Data

The data used in the analysis is retrieved from database of the Central Statistical Office (GUS) (https://bdl.stat.gov.pl/BDL/dane). The information regarding variable Y (the share of registered unemployed persons in the working age population) were drawn directly from the database, while the values of variable X (the number of entities per 10 000 working age population) were obtained through our own calculations.

Figure 1 shows the spatial differentiation of variable Y in the two extreme years of analysis, i.e. in the years 2004 and 2015. In Figure 2 the trend surfaces of the considered variable for the respective years are shown. It may be noted that in both years the central part of the province is characterised by a low level of unemployment compared to the remaining part of the region. A higher unemployment rate than that in the center of the region was noted, among others, in medium-sized urban centres, to which particular attention was paid in the investigation, i.e. in Grudziądz, Inowrocław and Włocławek.

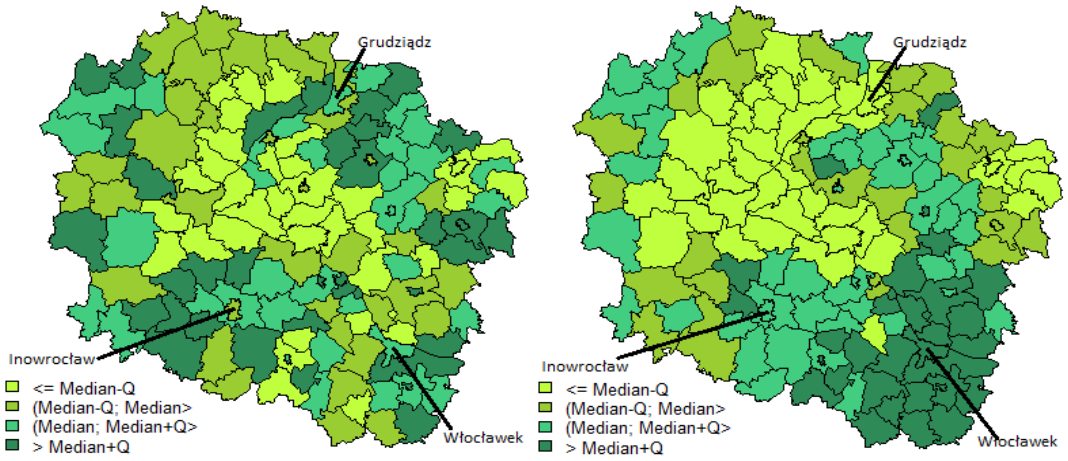


Fig. 1. Unemployment across the municipalities in the years 2004 and 2015.

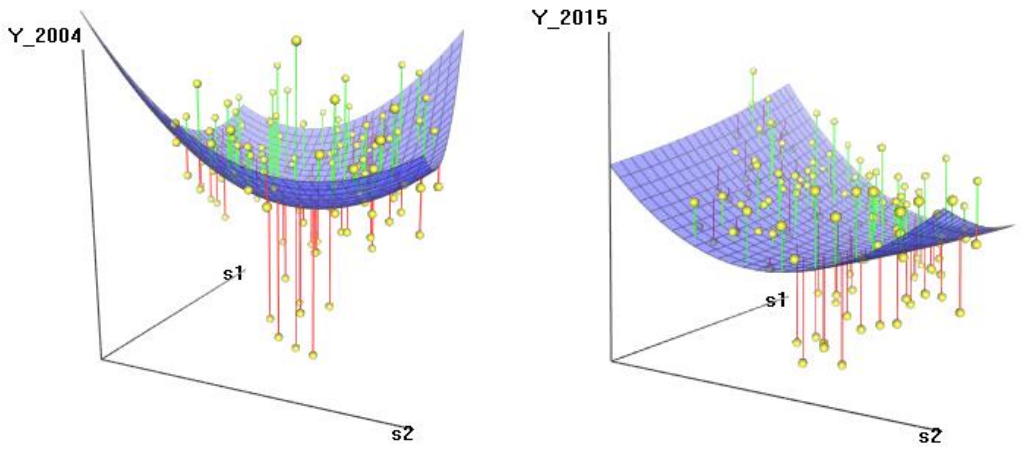
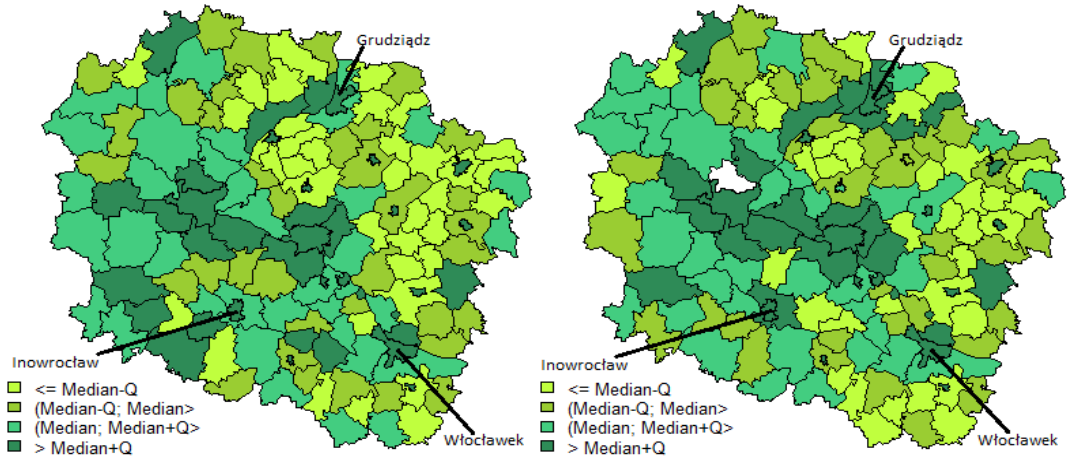


Fig. 2. Trend surfaces of unemployment across the municipalities in the years 2004 and 2015.



Note: The uncoloured municipality on the right map is the commune of Osielsko which constitutes the so-called outlier with a high value of the variable.

Fig. 3. The number of entities per 10 000 population at working age across the municipalities in the years 2004 and 2015.

In turn, Figure 3 shows spatial differentiation of variable X. In the case of the number of entities per 10 000 population at working age, the spatial distribution displays an opposite regularity as compared with the distribution of the variable characterising the level of unemployment. The municipalities located in the central part of the region are characterised by a relatively high level of variable X. This concerns both the first and the last year of the investigation. Furthermore, it should be emphasised that a relatively high number of enterprises in the central part of the province was observed also in urban municipalities, which are of particular interest to us, i.e. Grudziądz, Inwrocław and Włocławek. Figure 4 shows the trend surfaces observed in the formation of variable X in the extreme years of our analysis.

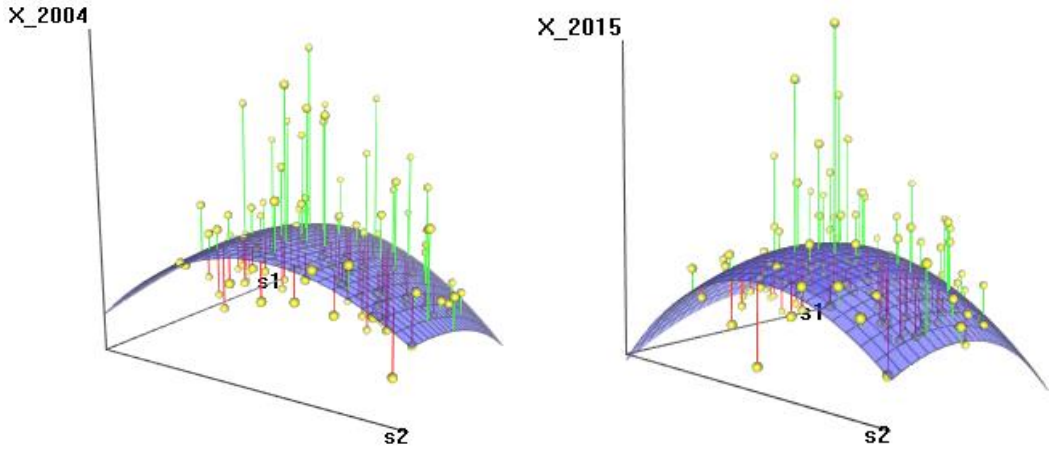


Fig. 4. Trend surfaces of the number of entities per 10 000 population at working age across the municipalities in the years 2004 and 2015.

Based on Figures 2 and 4 a presumption was formulated regarding the presence of the second-degree spatial trend for both the variables analysed, whereas the spatial directions of the increases and decreases in those variables are opposite.

4 Methodology

The primary tool of analysis conducted in the study is an econometric model specified for spatio-temporal stochastic process, i.e. a random function $Y(\mathbf{s},t)$, where non-random arguments are defined as $\mathbf{s}=[s_1,s_2]\in D\subset R^2$, $t\in T\subset R$ (Cressie, 1993; Schabenberger and Gotway, 2005). The two-dimensional argument **s** quantifies the locations of spatial units, and *t* indicates the time. Due to the discreet quantification of space and time in the analyses of economic phenomena the process $Y(\mathbf{s}_i,t)$ is considered, where $\mathbf{s}_i=[s_{i1},s_{i2}]$, i = 1, 2, …, N is the number of the spatial unit, t = 1, 2, ..., T $\subset$ C and C denotes the set of natural numbers.

The specification of the spatio-temporal model was made on the basis of the research of trend-autoregressive structures of the analysed spatial processes $Y(\mathbf{s}_i)$ and $X(\mathbf{s}_i)$, for each year of the period considered. For this purpose spatial trends were identified and spatial autocorrelation was tested. Moreover, the estimation and verification of the spatial autoregressive models was conducted. The models of spatial trend were used, whose general form can be written as follows (Cressie, 1993; Schabenberger and Gotway, 2005):

$$P(\mathbf{s}_i)=\sum_{k=0}^{p}\sum_{m=0}^{p}\theta_{km}s_{1i}^{\ k}s_{2i}^{\ m}, \tag{1}$$

where: $\mathbf{s}_i = [s_{1i}, s_{2i}]$ stands for location coordinates on the plane, i = 1,2, ..., N (indexes of spatial units), and p means the polynomial trend degree ($k + m \leq p$).

Respectively, the spatio-temporal trend model takes the form (Szulc, 2007):

$$P(\mathbf{s}_i, t) = \sum_{k=0}^{p} \sum_{m=0}^{p} \sum_{l=0}^{p} \theta_{mkl} s_{1i}^{k} s_{2i}^{m} t^{l}, \tag{2}$$

where: $\mathbf{s}_i$, i, p are as above, wherein $k + m + l \leq p$.

The spatial autocorrelation was tested using the test based on the Moran statistic (Moran's I) which can be expressed as follows (Schabenberger and Gotway, 2005):

$$I = \frac{N}{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij}} \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij} [z(\mathbf{s}_i) - \bar{z}][z(\mathbf{s}_j) - \bar{z}]}{\sum_{i=1}^{N} [z(\mathbf{s}_i) - \bar{z}]^2}, \tag{3}$$

where: $z(\mathbf{s}_i)$ denotes the observation of the phenomenon in the region i, $\bar{z}$ is the average value of the phenomenon, w_{ij} represents components of the appropriate connectivity matrix. In the study the matrix $\mathbf{W}$ of connections based on the common border criterion was used.

With the designations adopted above, the spatial autoregressive models (Arbia, 2006; LeSage and Pace, 2009) including spatial trends can be written in the following form (Szulc, 2011):

$$Z(\mathbf{s}_i) = \sum_{k=0}^{p} \sum_{m=0}^{p} \theta_{km} s_{1i}^{k} s_{2i}^{m} + \rho \mathbf{W} Z(\mathbf{s}_i) + \varepsilon(\mathbf{s}_i), \tag{4}$$

where: $\varepsilon(\mathbf{s}_i)$ is the spatial white noise.

In turn, the hypothesis of space-time model for the studied process $Y(\mathbf{s}_i)$ was as follows:

$$Y(\mathbf{s}_i, t) = \sum_{k=0}^{p} \sum_{m=0}^{p} \sum_{l=0}^{p} \theta_{mkl} s_{1i}^{k} s_{2i}^{m} t^{l} + \rho \mathbf{W}^{*} Y(\mathbf{s}_i, t) + \gamma X(\mathbf{s}_i, t) + \delta \mathbf{W}^{*} X(\mathbf{s}_i, t) + \varepsilon(\mathbf{s}_i, t), \tag{5}$$

where $\mathbf{W}^{*}$ denotes the block matrix of spatio-temporal connections which takes the form:

$$\mathbf{W}^{*} = \begin{bmatrix} \mathbf{W}_1 & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{W}_2 & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{W}_T \end{bmatrix},$$

wherein: $\mathbf{W}_1 = \mathbf{W}_2 = ... = \mathbf{W}_T$ represent standard spatial connectivity matrixes, such as in (4), the same for all years.

5 Specification of spatio-temporal econometric model – results of the empirical analysis

5.1 Analysis of the spatial trends and spatial autocorrelation

The analysis of the situation of the labour market in the municipalities of the Kujawsko-Pomorskie voivodeship started with identifying the spatial structure of both variables. For this purpose the spatial trend models were estimated and verified and next the spatial autocorrelation using Moran's *I* was tested. Table 1 reports the results of the investigation.

Year	Degree of spatial trend		R^2		Spatial autocorrelation		Morans's *I*	
	$Y(\mathbf{s}_i)$	$X(\mathbf{s}_i)$	$Y(\mathbf{s}_i)$	$X(\mathbf{s}_i)$	$Y(\mathbf{s}_i)$	$X(\mathbf{s}_i)$	$Y(\mathbf{s}_i)$	$X(\mathbf{s}_i)$
2004	2	2	0.1494	0.0996	+	-	0.3746	0.0295
2005	2	2	0.1612	0,1016	+	-	0.3600	0.0337
2006	2	2	0.1580	0.1004	+	-	0.3807	0.0222
2007	2	2	0.2856	0.1021	+	-	0.4050	0.0339
2008	2	2	0.2736	0.1107	+	-	0.4363	0.0429
2009	2	2	0.2600	0.1343	+	-	0.3951	0.0585
2010	2	2	0.2891	0.1336	+	+	0.4488	0.0842
2011	2	2	0.2839	0.1397	+	+	0.4973	0.0979
2012	3	2	0.3400	0.1386	+	+	0.4722	0.1127
2013	3	2	0.3220	0.1469	+	+	0.4420	0.1320
2014	3	2	0.4309	0.1529	+	+	0.4339	0.1434
2015	2	2	0.4611	0.1504	+	+	0.4404	0.1480

Table 1. Spatial structure of the processes: $Y(\mathbf{s}_i)$ – share of the registered unemployed persons in the working age population and $X(\mathbf{s}_i)$ – entities per 10 000 working age population. *Note*: Symbol "+" means that spatial autocorrelation occurs (at the level of significance of at least 0.05), symbol "-" means that spatial autocorrelation does not occur.

The presence of spatial tendencies in each year of the investigation for both analysed variables has been identified. The considered variables dependence on their values reported in neighbouring municipalities was observed in each year for variable Y and from 2010 for variable X. Next, on the basis of the pooled time series and spatial data, the analysis of spatio-temporal trend was conducted for each variable. In the case of unemployment the presence of second-degree spatio-temporal trend was observed (with regard to both the spatial and

temporal component). At the same time, the variable concerning the number of business entities did not show a significant tendency over time.

Based on the foregoing findings the estimation and verification of spatio-temporal SAR model was made where the level of unemployment in a given year in each of the municipalities of the province analysed is explained by the current level of unemployment in neighboring municipalities, the number of business entities in the municipality in a given year, and the number of entities in the neighboring municipalities in the same year.

Parameter	**Estimate of parameter**	**Standard error**	**Statistic z**	**p-value**
θ_{000}	1.00E+00	3.29E-01	3.0374	0.0024
θ_{100}	-8.39E-07	5.78E-07	-1.4526	0.1463
θ_{010}	-2.19E-06	7.90E-07	-2.7748	0.0055
θ_{200}	6.12E-13	4.42E-13	1.3829	0.1667
θ_{110}	3.47E-13	5.55E-13	0.6254	0.5317
θ_{020}	1.66E-12	5.52E-13	3.0060	0.0026
θ_{001}	-1.16E-02	1.35E-03	-8.5634	< 2.2E-16
θ_{002}	9.56E-04	1.23E-04	7.7413	9.77E-15
γ	-1.58E-05	1.96E-06	-8.0839	6.66E-16
δ	-3.27E-05	4.69E-06	-6.9785	2.98E-12
$\rho = 0.6574$				
Test LR: 505.3, p-value: < 2.22E-16				
Moran test: -1.2234, p-value: 0.1106				

Table 2. The results of the estimation and verification of SAR model with spatio-temporal trend.

In accordance with the above findings, the model contained an additional component, i.e. the spatio-temporal trend of degree 2. The model was estimated on the basis of data for the period from 2004 to 2012 in order to enable a simulation of changes in the level of unemployment on assumptive changes regarding the number of enterprises. Table 2 contains the results of the model estimation and verification.

5.2 Simulation of the level of unemployment in municipalities

Using the model described above, a simulation of the level of unemployment in municipalities of the Kujawsko-Pomorskie voivodeship was performed on the assumption that number of enterprises per 10 000 population at working age in individual medium-sized urban centres such as Grudziądz, Inowrocław and Włocławek increases (the assumed increase amounted to approximately 20%). Table 3 sets out the municipalities where a decrease of the level of unemployment was noted.

Among the municipalities, which showed a decrease in the unemployment as a result of an increase in the number of enterprises per 10 000 working age population are the three centres considered and their neighbouring municipalities.

Year	Municipalities: Urban – (1), Rural – (2), Urban-Rural (3)
2013	Inowrocław (1), Pakość (3), Inowrocław (2), Brześć Kujawski (3), Bobrowniki (2), Lubanie (2), Włocławek (2), Dobrzyń nad Wisłą (3), Fabianki (2), Włocławek (1), Grudziądz (2), Dragacz (2), Grudziądz (1), Rogóźno (2)
2014	Inowrocław (1), Pakość (3), Inowrocław (2), Brześć Kujawski (3), Bobrowniki (2), Lubanie (2), Włocławek (2), Dobrzyń nad Wisłą (3), Fabianki (2), Włocławek (1), Grudziądz (2), Dragacz (2), Grudziądz (1), Rogóźno (2)
2015	Inowrocław (1), Pakość (3), Inowrocław (2), Brześć Kujawski (3), Bobrowniki (2), Lubanie (2), Włocławek (2), Dobrzyń nad Wisłą (3), Fabianki (2), Włocławek (1), Grudziądz (2), Dragacz (2), Grudziądz (1), Rogóźno (2)

Table 3. List of the municipalities where a decrease in the unemployment rate was observed.

Conclusion

The analysis showed that with the existing spatial and spatio-temporal dependencies observable in the labour market in the Kujawsko-Pomorskie voivodeship across municipalities an improvement of the situation of this market may be expected as a result of an increase in the number of enterprises in medium-sized urban centres such as Grudziądz, Włocławek and Inowrocław. However, according to the results of the investigation, investments in new business entities in the indicated centres will improve the labour market situation only in the said centres and the neighbouring municipalities. The obtained results do not provide sufficient grounds to formulate a statement that the indicated actions will significantly improve the labour market situation in the entire province.

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