Global Journal of Business, Economics and Management

Volume 05, Issue 2, (2015) 53-62

http://sproc.org/ojs/index.php/gjbem

Regional disparities in labour productivity in Poland: a spatial statistics approach

Agata Sielska, Mathematics Application in Agricultural Economics Department, Institute of Agricultural and Food Economics, National Research Institute, Germany.

Aleksandra Pawłowska*, Mathematics Application in Agricultural Economics Department, Institute of Agricultural and Food Economics, National Research Institute, Germany.

Suggested Citation:

Sielska, A., & Pawłowska, A. (2015). Regional disparities in labour productivity in Poland: a spatial statistics approach. *Global Journal of Business, Economics and Management*, *5*(2), 53-62.

Received 28 September, 2015; revised 08 October, 2015; accepted 10 November, 2015.

Selection and peer review under responsibility of Prof. Dr. Andreea Iluzia IACOB, Bucharest Academy of Economic Studies, Romania

Abstract

An economic growth is considered in the agricultural economics as a central issue, most generally understood as long-term process of increasing agricultural production. Especially in neoclassical theory, the economic growth is determined mainly by a labour productivity. Hence, level and rate of change of the labour productivity are significant, particularly in the context of state activities for rural development. Our research objective was to examine spatial diversity of the labour productivity in Poland. The following partial objectives were also defined: measurement of strength and direction of inter-territorial dependencies and identification of clusters with high (or low) labour productivity level. Moreover, we assessed the labour productivity in the context of regional subsidies. Defining the labour productivity as gross value added divided by number of agricultural workers, we used Moran's I and Geary's C for identifying the spatial association. The calculations were made for 66 subregions at NUTS3 level, on the basis of information from the Local Data Bank base created by the Central Statistical Office of Poland. As the preliminary results indicated, the level of labour productivity differed by region. This included cluster with relatively low labour productivity in the Southeast and cluster with relatively high labour productivity in the North. Our findings may support decision-makers in evaluation of the instruments implemented by EU and national institutions for rural development and contribute to better understanding of agricultural policy effects.

Keywords: agricultural economics, labour productivity, gross value added, spatial autocorrelation

*ADDRESS FOR CORRESPONDENCE: **Aleksandra Pawłowska,** Mathematics Application in Agricultural Economics Department, Institute of Agricultural and Food Economics, National Research Institute, Germany.
E-mail address: aleksandra.pawlowska@ierigz.waw.pl

1. Introduction

Regional disparities in labour productivity in Poland: a spatial statistics approach Support under CAP (Common Agricultural Policy) and measures developed in order to improve the situation of agricultural sector and to increase its competitiveness play a significant role in Polish agriculture. Since Poland became a member of the EU in 2004, the amount of support exceeded 100 billion polish zloty. Its influence, among others on the efficiency of the production and overall operating of farms, is the subject of wide discussion (Kulawik, 2014; Lenkiewicz, Rokicki, & Wieliczko, 2014).

Achievement of agricultural policy objectives is closely linked with the issue of increased agricultural production. Sources of this growth have undergone a significant evolution from a situation in which growth resulted mainly from increased acreage (at the beginning of the twentieth century) to the state in which the productivity of land plays a key role (Ruttan, 2002). However, due to the limited acreage, more and more emphasis is placed on other factors of production. Accurate identification of factors affecting the growth processes is important from the agricultural policy point of view, particularly given the increasing demand for food.

The aim of the study is to analyse differences in the labour productivity in Polish agriculture. The authors' attention is focused on labour, both because of its high use in Polish agricultural sector (Michałek, Grotkiewicz & Peszek, 2009), and because of its role in the creation of wages and income (Rembisz & Florianczyk, 2015). Productivity can also be considered as one of the measures of competitiveness (Latruffe, 2010). We focus on the spatial perspective, due to the fact that agriculture relies heavily on the local conditions and has potential impact on local economic and social processes.

2. Labour productivity as the basis of agricultural growth

According to the identities (1) and (2) labour productivity is related to the ratio of acreage and labour input and to the land productivity (Rembisz, Floriańczyk, 2015):

$$Y = L \cdot \frac{A}{L} \cdot \frac{Y}{A} \tag{1}$$

$$\frac{Y}{L} = \frac{A}{L} \cdot \frac{Y}{A} \tag{2}$$

where: Y - production; L - labour input; *A* - area of land.

As the cited authors noted, the increase in production is the most dynamic, when both acreage of arable land per employee and the land productivity rise. Since the possibilities of the former one are limited, there is a growing emphasis on the increased productivity of land and concentration (Rembisz & Floriańczyk, 2015). Ruttan (2002) has already pointed on the evolution of these sources of growth in agriculture. Currently, a faster growth in labour productivity than in land productivity can be noted in European agriculture (Rembisz & Floriańczyk, 2015). Christiaensen, Demery, Kuhl (2011) indicate that in years 1960-2003 GDP growth in agriculture, in contrast to non-agricultural activities, was primarily driven by an increase in labour productivity. Dorward (2013) draws attention to the significance of labour productivity in agricultural growth, especially to its role in increasing or maintaining the availability of food products. Increase of the food supply contributes to the decline in relative prices of food, which is strengthened by the increase in salaries – which in turn results from the higher productivity. Along with the increasing productivity, the possibilities of changes in manufacturing techniques are developed, and as a consequence a migration of workforce to other sectors takes place.

Despite its importance, productivity growth alone is not enough to make a positive impact on the economy and induce structural changes. Appropriate functioning of markets, which enable producers to monetize the benefits obtained from increased production and specialization is also essential (Chapoto et al., 2012). This is particularly important due to the increase in real income, which contributes towards the rise in consumer demand for non-food goods (Dorward, 2013). It also allows once again to have a positive effect on the organization of production in agriculture, as in the long term it leads to consolidation processes, which mean the more efficient use of factors of production (Badia-Miró, Pinilla & Willebald, 2015).

In Lewis' models, agriculture was considered as an economic sector characterized by low productivity and stagnant character. In this context, the expansion of the second sector drains labour resources from agriculture. That process, together with artificially low wages in agriculture is considered as a contribution of agricultural sector to overall economic growth (Rembisz & Floriańczyk, 2015).

Agricultural producer raises labour productivity, providing that this action gives her an opportunity to improve the value of her objective function. In this paper farm is considered as a producer in the microeconomic sense, i.e. the entity managing manufacturing processes and seeking to maximize profits or income:

$$I = Y \cdot p - (C \cdot \rho + L \cdot \omega) \rightarrow \max \tag{3}$$

where: I - agricultural producer's income; *p* - price obtained, *C* - the capital input; ρ - capital remuneration; ω - labour remuneration. It is often argued that agricultural producer's decisions, especially these made on family farms, are multi-criteria and should be modelled (Hayashi, 1998; 2000). However, income maximization can be considered both as a goal in itself, and also as a means to achieve other purposes (e.g. consumption of non-food products).

According to the equilibrium theory, the individual producer has no effect on prices neither of factors of production nor products. Due to that fact, the value of her objective function may be improved by increasing the productivity and efficiency of factors of production (Rembisz & Bezat-Jarzębowska, 2013):

$$\frac{\partial Y \uparrow p}{\partial L \downarrow} \Rightarrow I \uparrow \tag{4}$$

where: $\uparrow$ – growth; $\downarrow$ – decrease.

According to economic theory, in that situation, wages (ω) continue to go up, because factors of production are paid according to their productivity (Willis & Wróblewski, 2007; Patra & Nayak, 2012).

3. Labour productivity and political rent

Increasing agricultural productivity is significant from the policy-makers' point of view due to its multidimensional impact on the economy (Dorward, 2013). Productivity growth, as noted above, occurs when it contributes to the increase of value of producer's objective function. Support under the CAP plays a significant role in the creation of income, which may be referred to as "political rent" and which may prove substitutive or complementary to the improvement of production-process organization (reflected by the increase in efficiency or productivity) (Bezat-Jarzębowska, Rembisz & Sielska, 2014). Agricultural policy instruments used to improve the production processes may also result in income effects, providing the producer possibility to finance investments that she could otherwise finance from savings. As a consequence the ratio

of capital to labour increases or a new production technology is developed. It allows producing the same quantity of product with less labour input or obtaining higher production at constant input. Thus the labour productivity increases. This in turn translates into increase in income and improvement of manufacturer's situation (Bezat-Jarzębowska, Rembisz & Sielska, 2012):

$$S_{t-1} + T \Rightarrow IV_t \Rightarrow \frac{C}{L} \uparrow \Rightarrow \frac{Y}{L} \uparrow \Rightarrow I \uparrow \tag{5}$$

where: S - agricultural producer's savings; *T* – support (political rent); IV - investments.

Factors which are supposed to contribute to the increase in productivity include RDP (Rural Development Programme) measures, which objective is to increase the GVA (Gross Value Added). Restructuring and modernization processes enabled by investments play an important role. This measure involving support of investments was developed in order to redirect production, change its scale or lead to an improved production technology (i.e. investments in renewable energy sources, investments aimed at improving energy or water efficiency in the manufacturing process). Actions which may result in an increase in GVA are also important, even if they are not taken directly by the farm. We may mention, for example, investments in sales structure, and its modernization. RDP emphasizes the farmers' participation in the creation of value added and increasing their participation in final prices of products.

The effects of the Polish RDP 2014-2020 are to be evaluated, among others, on the basis of the GVA per labour unit criterion. Therefore this criterion will be also used in this study.

4. Methodology

In order to investigate the regional differentiation of labour productivity in Poland, we used methods of spatial statistics. They provide a simple yet effective tool for testing the presence of spatial autocorrelation, which allows to assess whether the value of the variable in a given location is determined by values in other locations (Kopczewska, 2007; Suchecki 2010). We took into account relations at both the global and local level.

Global autocorrelation indices are measures of overall similarity of regions. They allow identifying spatial autocorrelation between the values of the variable in the whole analyzed area. The advantage of such indices is their syntheticity. It should be noted, however, that they are averaged measures, so their value depends on the division into subregions. Global autocorrelation can be measured with Moran's I and Geary's C statistics (Kopczewska, 2007). Moran's *I* statistic is given by:

$$I = \frac{1}{\sum_{j=1}^{n}\sum_{j=1}^{n} w_{ij}} \cdot \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{6}$$

where: x_i – value of the variable in the *i*-th region, n – number of regions, w_{ij} – elements of the spatial weight matrix $\boldsymbol{W}$, row standardized to 1. As Suchecki (2010) points out, if the matrix of weights is properly constructed, "this statistic is a weighted correlation coefficient, used to detect deviations in a random distribution of variable X in terms of space. It is used to determine whether neighbouring areas are more similar to each other (in the sense of the value of the variable X), than would result from the stochastic nature of the phenomenon" . Although the absolute value of Moran's *I* statistic may be higher than 1, it can be interpreted similarly to the value of the correlation coefficient. Similarly, Geary's *C* global statistic is given by:

$$C = \frac{n-1}{2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \cdot \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - x_j)^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (7)$$

Values of this statistic belong to the interval [0,2]. Values in the upper half of the interval indicate the negative autocorrelation (differences between surveyed regions), while those in the bottom half indicate positive autocorrelation (similarity). As Griffith points out, Geary's *C* statistic is strongly influenced by both the outliers and the skewness of a distribution of the number of neighbouring regions (Griffith, 2003). In addition, there is a negative relationship between Geary's *C* and Moran's *I,* defined by the formula:

$$\boldsymbol{C = \frac{1}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \cdot \sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} \cdot \sum_{j=1}^{n} w_{ij} - \frac{n-1}{n} \cdot I} \quad (8)$$

Significance tests carried out for both of these statistics assume the same null hypothesis, i.e. the randomness of the studied phenomenon in the area and the lack of autocorrelation. When the null hypothesis is rejected, it is accepted that the values of the variable in one region are determined by the values in other regions and the type of this relation is assessed. If areas with similar values of a given variable are neighbours, there is a positive spatial autocorrelation, whereas in the opposite situation, when the areas characterized by low values are combined with areas in which the values are high, there is a negative autocorrelation.

Local autocorrelation statistics allow to describe the spatial distribution of analysed variables more precisely. In this 'individual' approach, spatial autocorrelation may be measured by Moran's I_i local statistics, defined as follows:

$$I_i = \frac{(x_i - \bar{x})\sum_{i=1}^{n} w_{ij}(x_j - \bar{x})}{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} \quad (9)$$

Standardized local Moran's *I* statistics, which have asymptotically normal distribution allowed us to verify the null hypothesis assuming the absence of clusters of similar values of the test variable in the vicinity of *i*-th location. Due to the issue of possible multiple comparisons during the testing procedure Sidak's correction for the level of significance was used in order to avoid a type *I* error:

$$\alpha^* = 1 - (1 - \alpha)^{1/n} \quad (10)$$

where: α – selected significance level equal 0.05, n – number of regions.

5. Data

In the study we used data from Local Data Bank of Polish Central Statistical Office (CSO) on the 66 subregions (NUTS3) and period 2005-2012. We focused on the Gross Value Added (GVA, in current prices) and employment in section A (further referred to as agriculture, but according to the PKD 2007 classification, section A includes agriculture, forestry, hunting and fishing), amount of payments under Polish 2007-2013 RDP (payments cumulated since the launch of the program) and Gross Domestic Product per capita. In the case of GVA we used the CSO definition according to which GVA is "a sum of gross value added of all institutional sectors or branches of

economic activity. It is calculated as the difference between output and intermediate consumption (production side) or as a sum of employees' compensation, depreciation of fixed assets, gross operating surplus / mixed income and other taxes less subsidies on production (income side)." It is worth mentioning that this is not the only approach used in order to evaluate Polish RDP. FADN GVA definition was also used to evaluate the effectiveness of selected measures (The mid-term evaluation, 2010).

Approach used in this study to describe productivity is similar to that proposed by Dorward (2013) and Czyżewski, Henisz-Matuszczak (2006).

6. Results

The value of the global Moran's *I* statistic indicates the presence of a positive spatial autocorrelation for labour productivity in agriculture in 2012. The variation in labour productivity is determined by the location approximately in 32.15%. Similarities between regions are confirmed by the value of Geary's *C* statistic equal to 0.4286. Significantly positive values of both global statistics indicate the existence of inter-spatial relationships for labour productivity. On the basis of Moran scatterplot we identified potentially influential observations, i.e. subregions characterized by a significantly higher level of labour productivity compared to neighbouring ones.

Four subregions are found to be outliers: olsztyński, pilski, miasto Szczecin and miasto Poznań. For two urban ones (miasto Szczecin and miasto Poznań) we found a negative spatial autocorrelation - the level of labour productivity in these subregions was significantly lower than in neighbouring ones. Subregions olsztyński and pilski are characterized by the positive spatial autocorrelation, which means that both in those subregions, as well as in the neighbouring ones, productivity is relatively high.

Local Moran's I_i statistics allow us to identify patterns of local relationships between studied subregions. Three spatial clusters characterized by significantly higher absolute values of local spatial autocorrelation statistics were found (Fig. 1). These are clusters of subregions with similar levels of labour productivity in agriculture. Moreover, the miasto Szczecin subregion was confirmed to be an outlier (the value of Moran I_i statistic for this subregion was equal to -2.54).

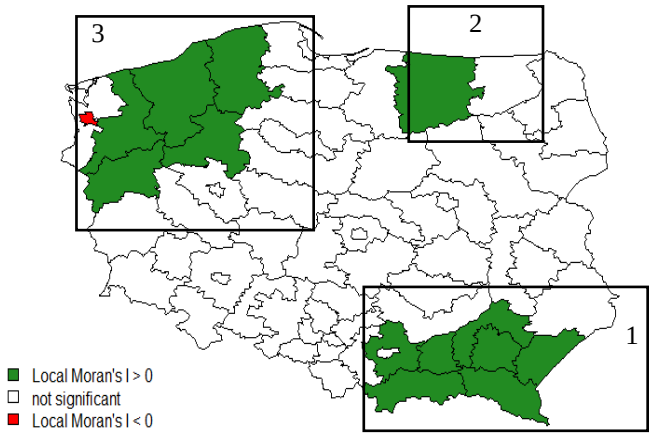

Figure 1. Labour productivity clusters in 2012.

The first cluster is located in the south-eastern Poland. It consists of subregions with relatively low labour productivity and high employment in agriculture. It is also characterized by a significant share of the rural population in total population, surplus of workforce, agrarian fragmentation and low marketability. Second cluster, located in the north of the country, consists of only one subregion – olsztyński. In contrast to the first one, the second cluster is

characterized by a relatively high level of labour productivity and low employment in agriculture. It is similar to the third cluster which is located in the north-western Poland.

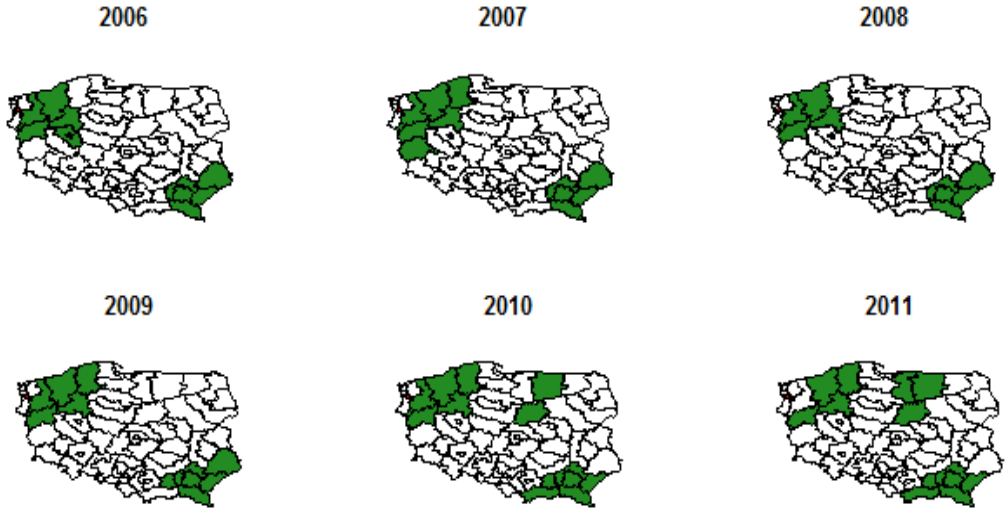

Figure 2. Evolution of clusters in years 2006-2011.

Clusters 1 and 3 are the strongest ones in dynamic terms (Fig. 2). Since 2006 we can observe differences in labour productivity between those two regions. The second cluster may be considered as relatively young - significantly positive spatial autocorrelation revealed in 2010.

Table 1. Selected characteristics of clusters

Cluster	The number of subregions in a cluster	Labour productivity in agriculture	The number of people employed in agriculture (% of employed in total)
1	7	5074.33	35%
2	1	41598.69	14%
3	5	40549.88	15%
Cluster	GVA in agriculture (% of total GVA)	GDP *per capita*	Support under RDP 2007-2013
1	3%	28340.86	484220219.43
2	6%	33780.00	876392305.00
3	7%	31107.40	708029963.60

We can notice significant differences in labour productivity between clusters (Tab.1). In northern clusters (the 2nd and the 3rd cluster), labour productivity was about eight times higher than in the southern cluster (the 1st cluster). This difference results from more than two times higher employment in agriculture (as % of total employment) combined with twice smaller GVA in agriculture (as % of total GVA) in the southern cluster compared to the northern one. Clusters are not differentiated by the GDP *per capita* - the level of wealth is similar in all clusters.

Interpretation of this results can prove interesting in the context of RDP support. It can be expected that the amount of the subsidies determines the level of labour productivity by contributing to better organization of production processes. However, the results show that the distribution of labour productivity in agriculture is different from the distribution of RDP support (Fig. 3).

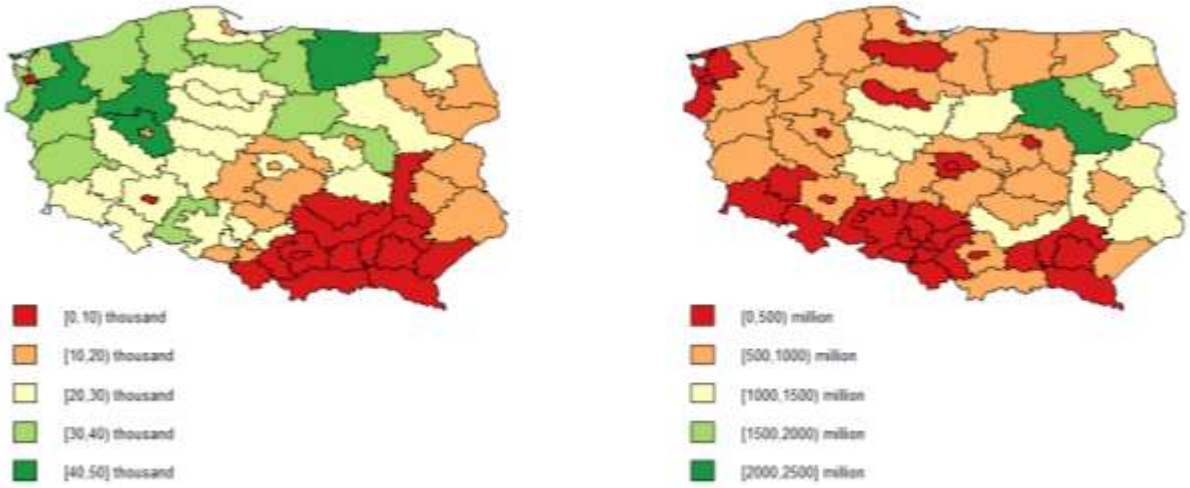

Figure 3. Distributions of labour productivity in agriculture (left) and RDP support (right).

The highest financial support was received by subregions which are characterized by low to moderate labour productivity. In the northern part of Poland, where the level of labour productivity was the highest, financial support obtained by the agricultural sector was relatively small. Moreover, there are no distinct similarities between the distribution of RDP payments and the distributions of labour productivity clusters in recent years presented in Fig. 2. Moreover, the average amount of support per labour productivity is five times higher for the first cluster than for the second and the third one (Tab.1). This suggests that the amount of financial support may correspond only to the GVA, not to the employment.

Certain regularities in the changes in labour productivity in clusters 1 and 3 can be observed as well (we omit cluster 2 due to its relatively late development). In the case of the cluster 3 productivity has been steadily rising, while for the cluster 1 after an initial growth of productivity there was a substantial drop (Fig. 4).

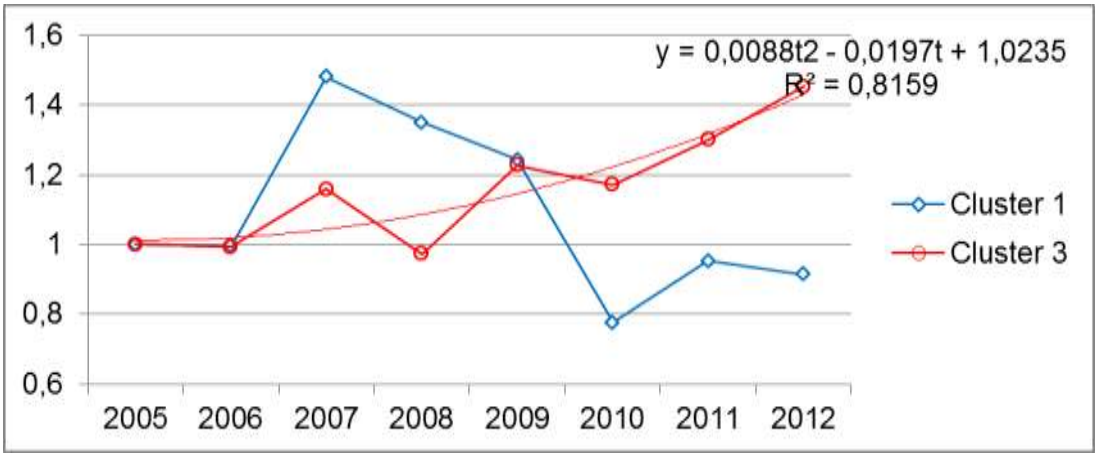

Figure 4. Labour productivity in 1st and 3rd cluster (2005=1).

7. Conclusions

In this paper we identified patterns of spatial relationships with respect to labour productivity in agriculture. Three spatial clusters were identified. Two of them have remained relatively stable throughout the considered period 2005-2012: low-productivity cluster located in the southern Poland and high-productivity cluster situated in the north of the country. Both clusters reacted to the support under the RDP in a different way.

High-productivity cluster, characterized by relatively higher concentration, lower share of agricultural population in total population, and receiving high support per one employee increased productivity in years 2005-2012. In the second half of the studied period, that growth was accompanied by the increase of employment in agriculture.

Labour productivity in the southern cluster began to fall after 2007. This trend can be attributed to a substantial increase in employment in agriculture. It seems that producers operating in this area used financial support in a less efficient manner compared to the north. In spite of the fact that the support per employee directed to that region was relatively higher than in the north, it did not cause the breakdown of the cluster or a clear change in its character.

The reasons for these trends in labour productivity may be associated with producers' investments that contribute to a better use of the available factors of production. Due to the lack of data we make no distinction between investments financed from RDP and those financed from producers' savings, but, as noted earlier, both of these sources are, to a certain extent substitutable to each other.

Since 2009 in the north of the country investments were higher than in the south both in absolute terms and relative ones, measured by the ratio of investments expenditure in agriculture to expenditures in whole economy. Differences in labour productivity can result from the significantly faster growth of the relative amount of investment in the north.

The conclusions are consistent with earlier studies that suggest that high support directed to the agricultural sector did not affect the regional differentiation (Lenkiewicz, Rokicki & Wieliczko, 2014; Kuszewski & Sielska, 2012). However, the positive aspect was, the fact that until 2012 the investments in agriculture in southern Poland grew faster than in the north. This may help to initiate a future positive trend in productivity.

References

Badia-Miró, M., Pinilla, V., & Willebald, H. (2015). *Natural Resources and Economic Growth: Learning from History*. New York: Routledge.

Bezat-Jarzębowska, A., Rembisz, W., & Sielska, A. (2012). *Wybór polityki i jej wpływ na decyzje producentów rolnych w ujęciu analitycznym z elementami weryfikacji empirycznej [The policy choice and its impact on agricultural producers' decisions from analytical perspective with elements of empirical verification*]. Warsaw: IAFE-NRI.

Bezat-Jarzębowska, A., Rembisz, W., & Sielska, A. (2014). Developing of modelling tool for policy and economic rent in agriculture. In C. Zopounidis, N. Kalogeras, K. Mattas, G. van Dijk, G. Baourakis (Eds.), *Agricultural Cooperative Management and Policy*. Switzerland: Springer International Publishing, 87-107.

Chapoto, A., Haggblade, S., Hichaambwa, M., Kabwe, S., Longabaugh, S., Sitko, N., & Tschirley, D. (2012). *Agricultural Transformation in Zambia: Alternative Institutional Models for Accelerating Agricultural Productivity Growth and Commercialization*. Lusaka: Indaba Agricultural Policy Research Institute (IAPRI), Working Paper 64.

Christiaensen, L., Demery, L., & Kuhl, J. (2011*).* The (evolving) role of agriculture in poverty reduction-An empirical perspective*. Journal of Development Economics*, *96*, 239-254.

Cliff, A.D., & Ord, J.K. (1973). Spatial Autocorrelation. London: Pion.

Czyżewski, A., & Henisz-Matuszczak, A. (2006). *Rolnictwo Unii Europejskiej i Polski. Studium porównawcze struktur wytwórczych i regulatorów rynków rolnych [A comparative study of the production structures and regulators of agricultural markets. Agriculture in the European Union and in Poland]*. Poznań: Wydawnictwo Akademii Ekonomicznej w Poznaniu.

Dorward, A. (2013). Agricultural labour productivity, food prices and sustainable development impacts and indicators. *Food Policy*, *39,* 40-50.

Griffith, D.A. (2003). *Spatial Autocorrelation and Spatial Filtering. Gaining Understanding Through Theory and Scientific Visualization*. New York: Springer-Verlag Berlin Heidelberg GmbH, 8-10.

Hayashi, K. (1998). Multicriteria aid for agricultural decisions using preference relations: Methodology and application. *Agricultural Systems*, *58*(4), 483-503.

Hayashi, K. (2000). Multicriteria analysis for agricultural resource management: A critical survey and future perspectives. *European Journal of Operational Research*, *122*(2), 486-500.

Kopczewska, K. (2007). *Ekonometria i statystyka przestrzenna z wykorzystaniem programu R CRAN [Spatial econometrics and statistics with applications in R]*. Warsaw: CeDeWu, 72-99.

Kulawik, J. (Eds.) (2014). *Dopłaty bezpośrednie I dotacje budżetowe a finanse oraz funkcjonowanie gospodarstw I przedsiębiorstw rolniczych [Direct payments and budget allocations and finance and operating of agricultural holdings and agricultural enterprises]*. Warsaw: IAFE-NRI.

Kuszewski, T., & Sielska, A. (2012). Efektywność sektora rolnego w województwach przed i po akcesji Polski do Unii Europejskiej [The efficiency of the agricultural sector in the provinces before and after the Polish accession to the European Union]. Gospodarka narodowa, *3*, 19-42.

Latruffe, L. (2010). Competitiveness, Productivity and Efficiency in the Agricultural and Agri-Food Sectors, OECD Food. *Agriculture and Fisheries Papers*, No. 30, OECD Publishing, http://dx.doi.org/10.1787/5km91nkdt6d6-en.

Lenkiewicz, S., Rokicki, B., & Wieliczko, B. (2014). *"Budżet rolny" a konkurencyjność polskiego rolnictwa ["Agricultural budget" and competitiveness of polish agriculture]*. Warsaw: IAFE-NRI.

Michałek, R., Grotkiewicz, K., & Peszek, A. (2009). Wydajność ziemi i pracy w wybranych krajach Unii Europejskiej [Land and labour productivity in selected European Union countries]. *Inżynieria Rolnicza*, 1(110)/2009, 199-205.

Ocena Śródokresowa Programu Rozwoju Obszarów Wiejskich na lata 2007-2013. Raport końcowy [The mid-term evaluation of the Rural Development Programme for 2007-2013.Final Report]. (2010). Volume I, Warsaw.

Patra, S., & Nayak, S. R. (2012). A Theoretical Study on the Relationship between Wages and Labour Productivity in Industries. *International Journal of Economic Research*, http://ijeronline.com, V3i3, p. 157-163.

Rembisz, W., & Floriańczyk, Z. (2015). Models of growth in Agriculture sector with empirical evidence for EU. LAP LAMBERT Academic Publishing, Saarbrűcken.

Rembisz, W., & Bezat-Jarzębowska, A. (2013). *Ekonomiczny mechanizm kształtowania dochodów producentów rolnych*. Warsaw: IAFE-NRI.

Ruttan, V.W. (2002). Productivity Growth in World Agriculture: Sources and Constraints. *Journal of Economic Perspectives*, *16*(4), 161-184.

Suchecki, B. (Eds.) (2010). *Ekonometria przestrzenna. Metody i modele analizy danych przestrzennych [Spatial econometrics. Methods and models of analysis of spatial data]*. Warsaw: C.H. Beck.

Willis, J.L., & Wroblewski, J. (2007). What happened to the gains from strong productivity growth?. *Economic Review*, *92*, 5-23.