SPATIAL ANALYSIS OF AGRICULTURAL LAND PRICES BY REGIONS IN POLAND
Mariola Chrzanowska¹, Dr.oec.,
¹Warsaw University of Life Sciences

Abstract. The modern spatial structure of agriculture results from numerous important socio-economic changes which occurred throughout history. Therefore, it is difficult to determine precisely what are the causes of an increase or decrease in prices. The aim of this study is to analyse the spatial relationship among prices of agricultural land on the voivodeship level in years 2004-2014. The paper also presents the dynamics of change of average land price in this period.

Before the accession to the European Union, the price of farmland in Poland was moderately increasing. Poland’s accession to the European Union in 2004 caused a significant increase in the price of farmland in Poland. It increased fivefold over the analysed period. In the fourth quarter of 2004 the average price of farmland was PLN 6,810 per hectare, while in the first quarter of 2015 it was PLN 36,203. The average prices of farmland were also significantly diversified regionally. Analysing the local spatial relationships (with the local Moran’s statistic), it can be noticed that from 2009 the farmland prices in Kujawsko-Pomorskie and Wielkopolskie voivodeships were significantly higher than in neighbouring regions. In years 2005-2008 and 2011-2014 the only voivodeship characterised by statistically significant local Moran’s statistic value was Podkarpackie. In its surrounding regions (Malopolskie, Swietokrzyskie and Lubelskie) farmland prices were similar. Analysing the farmland prices, it can be noticed that in Podkarpackie voivodeship they were the lowest in Poland.

Key words: agricultural land price, spatial correlation, Moran’s statistic.

JEL code: Q14, C19

Introduction
Agricultural land is often considered by economists * (Physiocracy was an economic theory which appreciated the importance of agriculture and farmland for economic development (Gudowski, 2007, p. 146).) to be an important production resource for agricultural production. In this context, land is one of the three primary factors of production (apart from labour and capital goods). It is also the reason for numerous changes in agriculture and agricultural processes. The importance of farmland has been changing significantly throughout history, depending on the importance of agriculture for national economy. When a substantial proportion of people were employed in agriculture, agricultural production became a dominant part of domestic product. Then, the land was the most important factor of production. Being the land owner not only determined social status but it also gave political rights (Wilkin, 2014).

Farmland market condition depends on a range of economic, political and demographic factors. Supply and demand for farmland are determined by the pace of changes in the farmland market (Masniak, 2007). The price of farmland should be influenced by the location, economic and political factors (Van Dijk, 2003).

Before the accession to the European Union, the prices of farmland in Poland were moderately increasing. Typical market participants underestimated effects of the accession. The majority of Polish farmers were sceptical about the European Union. They were afraid of economic effects of the accession, particularly the bankruptcy of underfinanced farms or massive land repurchase by European farmers.

Poland’s accession to the European Union in 2004 caused a significant rise in farmland prices in Poland. New laws and regulations and an increase in transfers for agriculture led to the changes of farmland prices and higher demand for farmland (Forys, Putek-Szelag, 2008). The price of farmland increased fivefold over the analysed period. In the fourth quarter of 2004 the average farmland price was PLN 6,810 per hectare as compared to PLN 36,203 in the first quarter of 2015. Therefore, having realised that the price of 1 hectare was significantly lower than in the “old” European Union countries, potential investors were right to predict fast profits. The dynamics of prices is presented in Figure 1 and Table 1. As one can notice, the biggest change in farmland prices, period by period, was recorded in 2007, 2012 and 2014. The lowest increase in farmland prices, whereas, was recorded in 2010. A huge rise in the prices can be explained by the interest of non-
farmers in land investment. Low deposit interest rates make potential investors more interested in looking for different investments. People who want to buy farmland in order to re-sell or lease it (due to changes in regulations on selling agriculture land to foreigners, May 2016) at profiteering prices may also be interested in land purchase.

### Dynamics in farmland prices in the period 2004-2015

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Fixed Base Index (Previous Year=100%)</td>
<td>122%</td>
<td>115%</td>
<td>131%</td>
<td>122%</td>
<td>105%</td>
<td>113%</td>
<td>127%</td>
<td>103%</td>
<td>127%</td>
<td>106%</td>
<td></td>
</tr>
<tr>
<td>Fixed Base Index (Year 2004=100%)</td>
<td>122%</td>
<td>141%</td>
<td>185%</td>
<td>227%</td>
<td>254%</td>
<td>267%</td>
<td>303%</td>
<td>386%</td>
<td>396%</td>
<td>503%</td>
<td>532%</td>
</tr>
</tbody>
</table>

*Source: author’s calculations*

![Average farmland prices (PLN/hectare) based on data provided by the Central Statistical Office of Poland (Polish: GUS) in the period 2004-2015](image)

**Fig. 1. Average farmland prices (PLN/hectare) based on data provided by the Central Statistical Office of Poland (Polish: GUS) in the period 2004-2015**

The average farmland prices are significantly diversified by regions. Figure 2 shows average farmland prices in the first quarter of 2015. The highest price was recorded in Kujawsko-Pomorskie region, as opposed to the lowest price in Podkarpackie. The analysis of farmland prices shows that the lowest prices tend to be located in the South-East of Poland (Swietokrzyskie, Podkarpackie and Lubelskie) and in the North-West of Poland (Zachodnio-Pomorskie and Lubuskie).

The evaluation of farmland prices in specific regions does not seem to be evenly distributed. The data presented in Table 2 show that the highest (relatively) rise in prices was recorded in Lubuskie, Warminsko-Mazurskie, Opolskie and Dolnoslaskie regions. The lowest increase in farmland prices, whereas, was evidenced for Slaskie and Malopolskie regions. Based on the above-mentioned findings, it can be noticed that the highest rate was recorded in regions with the highest average farm size. In other words, farmland concentration may affect the price of land. The regions with relatively lowest rise in average farmland prices are characterised by fragmentation of farmlands*. However, this correlation does not seem to be strong. The correlation coefficient is in this case 0.71. To conclude, a clear tendency to regional diversification of intensity and changes in the market prices of farmland is visible.

Figure 3 illustrates farmland prices in 2004-2014. It can be noticed that the year 2004 is characterised by low diversification of farmland prices by regions. In the subsequent years increasing diversification of farmland prices is visible. Over the analysed period, the lowest prices were reported for Lubuskie (2000, 2007 and 2004), Podkarpackie (2005-2006, 2011-2014) and Swietokrzyskie (2009-2010) regions. The highest (average) price was reported in Slaskie (2004), Wielkopolskie (2005-2006, 2009-2013) and Kujawsko-Pomorskie (2007-2008 and 2014).

*Modern spatial structure of agriculture results from numerous important socio-economic changes which occurred throughout history, including the Partitions of Poland or the Centrally Planned Economy (Grabowski T., 2012).*
Fig. 2. **Average farmland prices (PLN/hectare) in the first quarter of 2015**

Table 2

<table>
<thead>
<tr>
<th>Region</th>
<th>Average farmland size in 2014</th>
<th>Rise in farmland prices over 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dolnoslaskie</td>
<td>16.22</td>
<td>619%</td>
</tr>
<tr>
<td>Kujawsko-pomorskie</td>
<td>15.30</td>
<td>578%</td>
</tr>
<tr>
<td>Lubelskie</td>
<td>7.54</td>
<td>469%</td>
</tr>
<tr>
<td>Lubuskie</td>
<td>20.92</td>
<td>634%</td>
</tr>
<tr>
<td>Lodzkie</td>
<td>7.61</td>
<td>463%</td>
</tr>
<tr>
<td>Malopolskie</td>
<td>3.95</td>
<td>347%</td>
</tr>
<tr>
<td>Mazowieckie</td>
<td>8.55</td>
<td>414%</td>
</tr>
<tr>
<td>Opolskie</td>
<td>18.22</td>
<td>655%</td>
</tr>
<tr>
<td>Podkarpackie</td>
<td>4.63</td>
<td>397%</td>
</tr>
<tr>
<td>Podlaskie</td>
<td>12.24</td>
<td>459%</td>
</tr>
<tr>
<td>Pomorskie</td>
<td>19.00</td>
<td>469%</td>
</tr>
<tr>
<td>Slaskie</td>
<td>7.37</td>
<td>356%</td>
</tr>
<tr>
<td>Swietokrzyskie</td>
<td>5.57</td>
<td>412%</td>
</tr>
<tr>
<td>Warminski-mazurskie</td>
<td>22.92</td>
<td>605%</td>
</tr>
<tr>
<td>Wielkopolskie</td>
<td>13.51</td>
<td>503%</td>
</tr>
<tr>
<td>Zachodniopomorskie</td>
<td>30.29</td>
<td>512%</td>
</tr>
</tbody>
</table>

Source: author’s calculations based on data provided by the Agency for Restructuring and Modernisation of Agriculture and the Central Statistical Office of Poland
Goal and research methods

The aim of this study is to analyse the spatial interrelationships between regions. For this purpose, the nearest neighbourhood method was adopted as the criterion. The structure of the relationship based on the common boundary criterion is presented in Figure 4. Based on this type of relationship between regions, weighted matrix $W$ was calculated for spatial autocorrelation. The phenomenon of spatial autocorrelation is based on the values attributed to spatial objects. Spatial autocorrelation is a measure that looks at the relationship between close spatial units and describes the degree to which one object is similar to other nearby objects. Positive spatial autocorrelation occurs when similar values cluster together in a map. Research on spatial autocorrelation will be carried out using the Moran's and Gear's...
statistics. These measures are discussed briefly by Schabenberger and Gotway (2005).

Moran’s indicator can be interpreted as correlation coefficient. The value of Moran’s statistic generally falls into the interval [-1, 1] and can be classified as:
- $I = 0$ - no autocorrelation;
- $I < 0$ - negative autocorrelation (objects are different);
- $I > 0$ - positive autocorrelation (objects are similar to each other).

The Global Moran’s statistic is described by the formula (1):

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

$w_{ij}$ – weight of the connections between units $i$ and $j$ (first order matrix standardised according to rows);

$x_i$ $x_j$ – value of the variables in spatial units $i$ and $j$ (first order matrix standardised according to rows);

$\bar{x}$ - arithmetic mean value of the analysed variable for all spatial units.

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

$$ I_i = \frac{(x_i - \bar{x})^T \sum w_{ij} (x_j - \bar{x})}{\sum (x_i - \bar{x})^2} $$

(2)

Description as previously.

**Research results**

Global Moran’s statistic was calculated in order to determine the impact of neighbouring regions on the farmland prices in a specific region in 2004-2014. As presented in Figure 5, the Moran scatter plot allows the division of objects on spatial regimes: High-High, Low-Low, Low-High, High-Low. Local Moran’s statistic values are presented in Figure 6. The following clusters of regions can be found: regions characterised by low (statistically significant) local Moran’s statistic value and surrounded by regions with a low value of local Moran’s statistic (Low-Low; areas filled with grid pattern); as well as regions characterised by high (statistically significant) local Moran’s statistic value and surrounded by regions with a high value of local Moran’s statistic (High-High; areas filled with diagonal lines). Random farmland prices in specific regions are represented by values near 0 (in white).

In 2004, spatial correlations between the prices of farmland in specific regions did not occur. There were no statistically significant values of local Moran’s statistic. In 2005, there were usually two regions Podkarpackie and Kujawsko-Pomorskie, characterised by statistically significant Moran’s statistic value. Podkarpackie region is surrounded by the regions with similar farmland prices (Malopolskie, Swietokrzyskie – statistically significant). In 2006, statistically significant Moran’s statistic value appeared in eight regions, four of which were Podkarpackie region.

and Lubelskie). Farmland prices in Kujawsko-Pomorskie were significantly higher than in neighbouring regions. The same situation was reported to have happened in 2005-2007. In 2008, the only significant spatial correlation was recorded again in Kujawsko-Pomorskie region. Statistically significant spatial correlations did not occur in other regions. In 2009-2014, a cluster of two regions, Wielkopolskie and Kujawsko-Pomorskie with similar (high) values appeared on the map. During this period of time Podkarpackie (and Swietokrzyskie in 2009-2010) are characterised by low value of local Moran's statistic.

Source: author’s calculations

Fig. 5. Moran scatter plots for land prices in the individual voivodeship
Conclusions

Farmland market in Poland is characterised by a significant diversity, in terms of space and time. In 2004-2013, the lowest relative rise in prices (three times) was evidenced in Malopolskie region, whereas the highest (6.5 times) in Opolskie region. The analysis of data presented in Figure 3 reveals that farmland prices have a clear general tendency to rise. The aim of the study was to determine spatial correlation between the prices of farmland in specific regions in Poland in 2004-2014. By means of spatial statistics, statistically significant spatial correlations were proved. Global Moran’s statistic value calculated for each year was not statistically significant. These findings are proved by the analysis of the Moran scatter plot data (Figure 5). For each year, the distribution of spots (regions) seems to be quite regular, which means that spatial autocorrelation does not appear. Additionally, the

Source: author’s calculations

Fig. 6. Location of statistically significant Moran's values for farmland prices by regions
analysis of data in scatter plots proves low linear regression (2004-2014). The analysis of local correlations shows that in two regions (Wielkopolskie and Kujawsko-Pomorskie) the prices of farmland are definitely higher than the prices in neighbouring regions. This situation did not occur until 2009. Before that time only Kujawsko-Pomorskie (2005-2008) was characterised by high negative Moran’s spatial statistic. Podkarpackie is the only region close to which neighbouring areas are characterised by similar farmland prices. It can be noticed that this region offers the lowest farmland prices in the country (Figure 3).

The results are consistent with the research of other authors (e.g. Pietrzykowski, 2011).

Although the trend towards an increase in farmland prices is clear, it should be noticed that average farmland prices per hectare are not influenced by the prices in neighbouring regions. General economic situation or changes in laws and regulations might be the reasons behind the increase in prices.

Bibliography: