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**WIESŁAWA LIZIŃSKA, MARIOLA GRZYBOWSKA-BRZEZIŃSKA,
MAŁGORZATA GRZYWIŃSKA-RĄPCA¹**

University of Warmia and Mazury in Olsztyn, Poland

**DETERMINANTS OF CHANGES IN AGRICULTURAL LAND
PRICES AT REGIONAL LEVEL IN POLAND**

Key words: agricultural land market, agricultural land prices, territorial concentration, Agricultural Property Stock of the State Treasury (APSST), private land trade

ABSTRACT. The aim of the research was to identify factors determining changes in land prices and to indicate clusters of Polish voivodeships distinguished according to the adopted variables. Because of the specific features of the agricultural land market in Poland, the performed analyses accounted for the distinction in prices of agricultural land from the Agricultural Property Stock of the State Treasury and from private land trade. In view of the formal and legal regulations implemented in Poland, and the way changes in land prices are recorded, the analysis concerned the time period of 2013-2020, divided into two sub-periods: 2013-2016, and 2017-2020. One of the most significant considerations was the fact that there were two submarkets on the Polish agricultural land market, such as the farmland in private turnover and the farmland from the Agricultural Property Stock of the State Treasury. The highest differentiation of land prices between the voivodeships was due to the average monthly disposal income *per capita* from a family farm relative to the average monthly income *per capita* from being self-employed, and the total acreage of farmland sold from the State Treasury Stock.

¹ Corresponding author: malgo@uwm.edu.pl

INTRODUCTION

From the point of view of the possibility of shaping the farms development potential, the land price is an important factor: determining changes in the area structure as a result of market transactions, an element underlying the profitability of investments in agriculture, the basis for allocating funds to any activity on a farm from external sources of financing, and the principal and most durable component of the assets owned by a farmer's family [Klank 2008]. The value of farmland provides very important information, required by both public institutions and private entities that have ownership rights to agricultural properties [Budzyński 2012].

One of the most significant processes affecting the situation on the agricultural land market in Poland in recent years is the country's integration with the European Union. Consequences can be observed in the successively modified legal regulations connected with agricultural land trade, demand for land and land prices, which are additionally stimulated by instruments of the Common Agricultural Policy [Lizińska et al. 2018].

Many authors [Barnard et al. 1997, Duvivier et al. 2005, Foryś, Putek-Szeląg 2008, Swinnen et al. 2013, Zawalińska et al. 2013, Kocur-Bera, Dudzińska 2014, Majchrzak 2015] have studied the effect of an agricultural policy (subsidies to farmland and agricultural production) on the value of land. Institutional factors have also been taken into consideration (transaction costs, availability of bank loans, etc.).

Differences in agricultural land prices can be noted both internationally and between regions. As pointed by Krzysztof Firliej and Sebastian Kubala [2018] there is evident regional variation in farmland prices in all EU member states. On the one hand, the accession of a country to the European Union creates opportunities for farms to achieve incomes, but on the other hand it intensifies transaction activity on the agricultural property markets and becomes a pro-growth stimulus for agricultural land prices. These consequences were seen in Poland as well. The cited author have noticed that prices of farmland are sensitive to cyclical fluctuations. The level of agricultural land prices is also significantly influenced by the amounts of awarded benefits and the volume of gross domestic product *per capita*.

Having analyzed the variation of land prices in the European Union countries, Robert Pietrzykowski [2014] concluded that there in all the analyzed EU countries (except the UK) there was the same, positive relationship between the country's economic development (measured with the GDP *per capita*) and the average price of agricultural land.

The regional differentiation of agricultural land prices has been analyzed by Małgorzata Kołodziejczak [2015]. Within the countries she studied there were regional differences in prices of agricultural land (for example, in Germany there are differences between the east and the west of the country). However, the slow convergence of agricultural land prices up to the level of the prices in western parts of Germany was observed. In Poland,

differences in agricultural land prices between regions were smaller. The farmland prices in Poland tended to be distinctly lower than in Germany, although in some Polish regions they exceeded the prices paid in some German regions (Brandenburg and Thuringia). The gradual levelling of the land prices in Poland and Germany could be a consequence of several factors: the Polish agriculture now being under the umbrella of the Common Agricultural Policy and other support programs, improved productivity of Polish farms, possibilities of using farmland for other purposes, and the expected lifting of barriers in agricultural land trade. Some influence on land prices may have been exerted by economic crises and instability of financial markets, which incline investors to diversify investment portfolios and to allocate some of the funds to tangible assets (e.g. through the purchase of agricultural land).

Differences can also be observed in the dynamics of price growth, as land in Western Europe is gaining value more slowly than in Central or Eastern Europe. This can be explained by specific legal regulations in each country and transaction costs, discouraging swift market transactions. Higher costs in Western Europe, including taxes levied on land sale transactions and land registration, help conserve the status quo, while lower fees in new EU member states may be conducive to land sale contracts, which by some is perceived as being speculative [Ciaian et al. 2012].

The research results achieved by Pia Nilsson and Sara Johansson [2013] demonstrated the regionally diverse and simultaneously significant effects of certain agricultural and non-agricultural factors on agricultural land prices. It was shown that non-agricultural factors were more important in the regions where farmland prices were high, whereas the decoupled Single Farm Payment implemented as a means to support farmers' incomes was most influential in the regions where land prices were low.

The presence of many stimuli strongly connected with the value of agricultural land makes the relevant research very complicated. Difficulties arising from the multitude of determinants of land price can lead to a dubious choice of a universal criterion that might identify the dependence of land price on a specific variable. However, certain factors can be distinguished as having a comparable degree of influence on most of agricultural land markets, in addition to ones that cause regional variations among these markets [Firlej, Kubala 2018].

In the case of Polish agriculture, characterized by a diversified interregional structure of farms, land prices and its supply may significantly affect the possibilities of its improvement. Certainly, there are limited opportunities for improvement, e.g. area structure in the case of a limited supply of agricultural land on the market, especially when it is mainly related to the actual resources. However, a barrier to improving the area structure may also be the high price of land, applicable legal regulations, or strong competition on the market – not only resulting from the willingness of those interested to allocate it for agricultural purposes.

Considering the complexity of factors that determine prices of land, as well as their varied influence implicated in the regional approach, the aim of this study was to determine differences in land prices at the regional level and their changes over time and diagnosing existing clusters distinguished according to the assumed variables. The implementation of the goal was based on the answers to the following research questions:

1. What factors determined the prices of agricultural land in Poland at the regional level?
2. Does the significance of the determinants of agricultural land prices selected for the analysis change over time?
3. Are there any similarities and interregional differences in agricultural land prices in Poland and in determinants influencing them?

Because of the specific features of the agricultural land market in Poland, the performed analyses accounted for the distinction in prices of agricultural land from the Agricultural Property Stock of the State Treasury (APSST) and from private land trade.

MATERIAL AND METHODS OF STUDY

The implementation of the goal and the formulation of answers to research questions required, first of all, the collection of data on the prices of agricultural land, in private and state trade. This study employed data on the acreage and prices of farmland from the APSST and from the trade of privately owned land. The next stage of the analyzes was to determine the time scope of the analysis. In view of the formal and legal regulations implemented in Poland, and the way changes in land prices are recorded, the analysis concerned the time period of 2013-2020, divided into two sub-periods: 2013-2016, and 2017-2020. Thus, the data were obtained from the reports issued by the Agricultural Property Agency on the management of the APSST. Such reports were issued annually for the minister responsible for agriculture, rural development and agricultural markets. The information on farmland prices in 2017-2020 originated from reports of the National Support Centre for Agriculture. The research reported in this article also took into account the prices of farmland sold and bought in private trade, which were collated by the Poland Statistics (formerly, Central Statistical Office – GUS). These data originated from the 16 Polish voivodeships, and covered the years 2013-2020.

Based on the literature on the subject and taking into account the criterion of the availability of data necessary for the analysis, a selection was made of variables characterizing not only the agricultural land market in Poland (land prices and area of sold land), but also variables characterizing the economic situation of farms, also in relation to other units. The analysis took into account the variable characterizing the development situation in voivodeships, too, illustrated in the form of capital expenditures.

The study was composed of statistical analyses of the following data:

- selling prices of agricultural land from the APSST (PLN/ha),
- selling prices of agricultural land per 1 ha in private trade (PLN/ha),
- total acreage of the land sold from the APSST (ha),
- capital expenditure *per capita* (PLN),
- average monthly disposable income *per capita* from a farm households relative to the average monthly income *per capita* from self-employment (%),
- average monthly disposable income *per capita* from a farm households (PLN).

Considering the determinants of agricultural land prices identified in relevant references, the analysis included such diagnostic characteristics as investment inputs, average monthly disposable income *per capita* from being self-employed to the average monthly disposable income *per capita* from a family agricultural farm.

The classification of voivodeships according to the selected diagnostic characteristics was based on cluster analysis algorithms. These algorithms include many methods representing hierarchical or non-hierarchical approaches as well as the fuzzy cluster analysis [Roszko-Wójtowicz 2014, Sobolewski, Sokołowski 2017, Ertunç et al. 2021]. The most common hierarchical methods involve agglomerative techniques, which take advantage of a variety of ways to determine distances (linkages) between clusters [Migdał-Najman, Najman 2013, Szopik-Depczyńska et al. 2020]. The following are distinguished: single, complete and average linkages as well as the centroid approach. The Ward's method was employed to achieve a preliminary estimate of the number of clusters. The Ward's method differs from the other approaches mentioned above because it uses an ANOVA approach for estimation of distances between clusters, and strives towards the minimization of the sum of squared deviations within clusters. The ESS (error sum of squares) is a measure of variation within a cluster. In our study, the Ward's method served to determine the number of clusters in a *k*-means analysis. The principal concept of the *k*-means method is such allocation of taxonomic units onto *k*-groups that minimizes the variation within the clusters obtained while maximizing the variation between these clusters. It needs to be noted that because of a potentially great number of possible divisions of objects, it is impossible to determine the optimal division using criteria based on a matrix of distances [Pietrzykowski, Kobus 2008, Grzywińska-Rapca, Markowski 2017]. Hence, the division of a set of objects often relies on the assumption of a known preliminary number of classes. Thus, the *k*-means method requires that an arbitrary decision be made at the onset of the procedure about the number of clusters into which the input set of objects should be divided [Walesiak, Gatnar 2009]. The use of *k*-means analysis to group voivodeships according to the variables adopted for analysis is supported by the fact that this method does not require meeting the assumptions of linearity and normality [Stanisz 2006]. The data on the basis of which the *k*-means analysis was carried out are representative (without the presence of outliers) and do not show strong correlation, thanks to which a set of clusters was created.

RESULTS

VARIABLES CHARACTERIZING THE AGRICULTURAL LAND MARKET

Prices of land are highly varied, depending on the usefulness of land plots, quality of soil and natural fertility, location, natural environment condition, etc. Regardless of the spatial differentiation, prices also undergo temporal variation [Maśniak 2013]. Renata Marks-Bielska and Arkadiusz Bieniek [2018] emphasize that the market prices of agricultural real properties in recent years have been influenced by the limited supply of farmland and external factors arising from Polish agriculture operating within the EU economy.

Basic descriptive statistics were determined for the variables taken for our analysis, characterizing the agricultural land market in the selected time periods and divided into the voivodeships (Table 1). The analysis of the observed changes in land prices showed that the cause of the highest differentiation between the voivodeships in 2013-2016 was the ratio of the average monthly disposable income *per capita* from a privately owned farm relative to the average monthly income *per capita* from being self-employed, and the area of farmland sold from the State Treasury Stock (Table 1). This is implicated by the determined coefficients of variation, which were 93.47% and 86.80% for the two mentioned variables respectively. The determined coefficients (asymmetry and kurtosis) for the variables submitted to the analysis show the highest asymmetry of the distribution of the values of the analyzed objects (voivodeships), and the presence of outliers in the case of one variable: capital expenditures *per capita* ($A_{D2013-2016} = 1.53$, $K_{D2013-2016} = 3.73$).

Also, distributions of the variables, that is the average disposable income *per capita* from being self-employed relative to the average disposable income from a private farm in agriculture, and the average disposable income from a private farm in 2013-2016, were characterized by high values of the kurtosis coefficient, which means that values of these variables showed less concentration than with the normal distribution.

Distributions of the values of concentration coefficients (variation and asymmetry) for all the variables tested in 2017-2020 were similar to the ones obtained in 2013-2016. The median of price values indicates a growth in land prices relative to such prices in 2013-2016 by 13.03% for the land from the APSST, and by 24.9% per 1 ha of the agricultural land traded privately. The median for the selling prices of agricultural land from the State Treasury Stock in 2017-2020 was 159.75.

Numerous authors have emphasized that the economic size (economic power) of farms, that is the level of earned incomes [Mikołajczyk 2008, Sobczyński 2009, Gołębiowska 2010, Grzelak 2013] is a significant determinant of the capital expenditures, financed mainly from own capital. This situation can affect considerably the level of all prices, including the prices of agricultural land. As indicated by the research of other authors

Table 1. Descriptive statistics of the distribution of average values of the analyzed variables

Item	Average values of variables* in period 2013-2016					
	A [PLN/ha]	B [PLN/ha]	C [ha]	D [PLN]	E [%]	F [PLN]
Average	26,845.70	31,514.13	5,578.22	5,989.72	57.85	55.30
Median	24,284.25	31,702.59	3,435.88	5,741.75	32.81	47.06
Min.	15,657.00	20,238.35	397.25	3,984.25	2.65	3.72
Max.	37,186.50	47,149.58	15,255.25	10,156.25	205.63	184.97
Standard deviation	7,905.64	8,080.19	4,841.71	1,452.99	54.07	46.64
Coefficient of variance [%]	29.45	25.64	86.80	24.26	93.47	84.33
Asymmetry coefficient	0.12	0.69	0.72	1.53	1.55	1.49
Kurtosis	-1.72	-0.12	-0.85	3.73	2.49	2.89
	2017-2020					
Average	30,343.55	39,359.66	211.73	6,976.63	55.81	67.77
Median	32,752.63	38,426.25	159.75	6,493.67	39.29	49.40
Min.	18,461.00	26,533.50	53.50	4,489.33	3.75	4.76
Max.	46,459.50	60,873.25	509.75	12,293.33	260.23	286.02
Standard deviation	8,544.52	9,638.21	137.88	1,905.76	65.25	71.16
Coefficient of variance [%]	28.16	24.49	65.12	27.32	116.92	105.00
Asymmetry coefficient	0.16	0.83	1.03	1.65	2.27	2.06
Kurtosis	-0.83	0.39	0.00	3.37	6.22	5.44

* A – selling prices of agricultural land from the APSST [PLN/ha], B – selling prices of agricultural land per 1 ha in private trade [PLN/ha], C – total acreage of the land sold from the APSST [ha], D – capital expenditure *per capita* [PLN], E – average monthly disposable income *per capita* from a farm households relative to the average monthly income *per capita* from self-employment [%], F – average monthly disposable income *per capita* from a farm households [PLN]

Source: own analysis

[Guan et al. 2022], whereas land rights are an important element determining the level of welfare of farmers. The results showed that the confirmation of farmland rights could improve the welfare of farmers. The value of the welfare of farmers who had been transferred out was higher than that of farmers who had been transferred in. Kamal Vatta and coauthors [2022] also point to the importance of factors related to the challenges of the COVID-19 situation. The research showed that farmers may need some financial support to counter the effect of rising costs of farming. There is a need to enhance the resilience of various input and output markets in agriculture in the future. Valerii Havrysh and coauthors

[2022] instead, they note that the need to mitigate climate change has become increasingly significant in recent times, which drives an increase in renewable electricity generation. It may also affect farmers who can develop renewable energy and increase their profitability by allocating agricultural land to PV power plants.

CLUSTERING OF AGRICULTURAL LAND PRICES IN POLAND

Based on the values of variables obtained in this study (Table 1), and using the *k*-means procedure, clusters for the two time periods, 2013-2016 and 2017-2020, were determined. The mean values of the variables for every cluster are presented in Table 2. In 2013-2016, the highest average prices of the land sold from the APSST were recorded in the cluster composed of the Kujawsko-Pomorskie, Opolskie and Wielkopolskie voivodeships. In 2017-2020, the highest average prices of the land sold from the State Treasury Stock were noted in a two-element cluster, comprising the Kujawsko-Pomorskie and Wielkopolskie voivodeships. The highest average value of this variable in 2017-2020 was observed in the cluster consisting of the voivodeships: Lubelskie, Łódzkie, Mazowieckie, Podlaskie, Śląskie and Świętokrzyskie. This cluster was also distinguished by the lowest average area of all the land sold from the APSST (164.71 ha).

The visualization of the spatial distribution of the clusters of Polish voivodeships is shown in Figure 1. A comparison of elements of the clusters in the two time periods indicates persistent variation in the mean values of the variables taken for our study. An analysis of the location of the cluster elements (voivodeships) leads to the conclusion that the lowest average prices for the land sold from the State Treasury Stock and in private trade are in the voivodeships situated in Poland's eastern part. In 2013-2016, the cluster with the lowest average prices for the land sold from the State Treasury Stock and privately, following the clustering procedure, comprised such voivodeships as Podlaskie, Lubelskie, Podkarpackie, Lubuskie and Świętokrzyskie.

These administrative units are characterized by low economic development and their contribution to Poland's gross domestic product (according to the 2016 current prices) ranged from 2.2% (Podlaskie) to 3.8% (Lubelskie). These are also the voivodeships with the lowest level of capital expenditure. The fourth cluster, with the lowest average prices of the land sold from the APSST and in private turnover, contained yet another voivodeship, namely Małopolskie (8.0% share in the country's GDP in 2016 according to the then current prices). The voivodeships creating the mentioned clusters were also characterized by a large total acreage of the land sold from the State Treasury Stock, which may have had some impact on the relatively lower prices of agricultural land in these regions.

The highest average prices (nearly double the ones in the first cluster) for the land sold from the State Treasury Stock and privately in 2013-2016 were observed in

Table 2. Average values of variables for clusters

Time range	Clusters of land prices**	Elements of clusters	Average values of variables for clusters*					
			A	B	C	D	E	F
2013-2016	HL	Kujawsko-Pomorskie, Opolskie, Wielkopolskie	36,559.00	45,074.32	6,661.58	6,129.50	56.99	52.97
	M	Łódzkie, Mazowieckie, Śląskie	34,357.42	31,833.32	1,348.58	7,632.17	28.51	37.34
	L	Dolnośląskie, Pomorskie, Warmińsko-Mazurskie, Zachodniopomorskie	25,664.06	31,027.83	11,730.06	6,231.19	38.84	39.18
	LL	Lubelskie, Lubuskie, Małopolskie, Podkarpackie, Podlaskie, Świętokrzyskie	19,020.96	24,898.65	3,050.13	4,937.63	85.62	76.19
2017-2020	HL	Kujawsko-Pomorskie, Wielkopolskie	44,640.88	58,390.25	201.13	6,650.33	80.36	104.70
	M	Dolnośląskie, Opolskie, Pomorskie, Warmińsko-Mazurskie	35,518.81	42,551.63	225.44	7,713.50	33.84	42.46
	L	Lubuskie, Małopolskie, Podkarpackie, Zachodniopomorskie	31,042.31	29,621.75	273.88	6,263.58	11.46	15.09
	LL	Lubelskie, Łódzkie, Mazowieckie, Podlaskie, Śląskie, Świętokrzyskie	21,661.75	37,380.08	164.71	7,069.50	91.83	107.44

* A – selling prices of agricultural land from the APSST [PLN/ha], B – selling prices of agricultural land per 1 ha in private trade [PLN/ha], C – total acreage of the land sold from the APSST [ha], D – capital expenditure *per capita* [PLN], E – average monthly disposable income *per capita* from a farm households relative to the average monthly income *per capita* from self-employment [%], F – average monthly disposable income *per capita* from a farm households [PLN]

** HL – the highest, M – medium, L – low, LL – the lowest

Source: own analysis

Polish farming is diverse in terms of the area structure and environmental conditions for agricultural production. This diversity translates into differences in the prices for agricultural land purchased from both private owners and the State Treasury Stock. A characteristic feature is the difference in prices obtained by the agency that manages state-owned land (lower prices) and by individual farmers [Marks-Bielska, Lizińska 2015].

In Poland, despite the growing tendency of land prices present in all Polish voivodeships, certain significant differences are discernible between the country's regions. According to Konrad Żelazowski [2014], the regional variation of land prices can be explained by the resources and economic foundations of the markets operating in every voivodeship. Out of a broad array of determinants of agricultural land prices, the variables that let us explain the regional differences in land prices were the factors that characterized the level of good agricultural practice and profitability of farmland as well as the factors that defined the volume of investments made on farms and, indirectly, the economic situation in agriculture.

Areas where land prices are the lowest are characterized mostly by the difficult economic situation and high unemployment. On the other hand, the voivodeships with the highest land prices comprise areas with the best farming culture, high quality of farmland and the highest share of farms able to compete on national and international markets. The supply of agricultural land in these areas is relatively low. Unregulated legal relations or claims of former owners are an obstacle to land trade. Differences in prices of agricultural land are also influenced by the regionally diversified supply of state-owned agricultural land.

CONCLUSIONS

The perusal of the literature suggested that prices of agricultural land were shaped by a series of factors contained in different categories. Obviously, one of the most significant considerations was the fact that there were two submarkets on the Polish agricultural land market, such as the farmland in private turnover and the farmland from the APSST. The agricultural land market in Poland has been shaped in connection with the structure of farms in Poland, first developed in the post-war years, and then during the political and economic transformation period followed by Poland's accession to the EU, as well as the legal regulations governing the agricultural land trade being amended accordingly.

Based on the research, the following conclusions were drawn:

1. Regions characterized by lower prices of land were at the same time regions included in the group with a lower level of economic development. The development situation in the region may, in turn, determine the propensity of agricultural land owners, on the one hand, to look for alternative sources of income, to reorient the profile of the farm, or to a more radical solution in the form of selling the land. One of the measures of situation considered in the article was the ratio of the average monthly

disposable income per capita from a family farm in relation to the average monthly income per capita from self-employment. The results of the research confirmed that the greatest differences in land prices between voivodeships resulted from the above-mentioned factors relationship.

2. The significance of factors determining the prices of agricultural land change over time, but these changes still cause interregional price differences to persist.
3. A comparison of the voivodeships assigned to the identified clusters in the two time ranges according to the average values of the variables taken for analysis suggests the persistent spatial differentiation thereof. The lowest average prices of the land sold from the State Treasury Stock and in private trade in 2013-2016 were determined in the voivodeships situated in Eastern Poland, characterized by the low level of economic development and the lowest capital expenditure. The highest farmland prices were recorded in the voivodeships where the gross domestic product *per capita* was above Poland's average (ca 110%). Differences between the Polish voivodeships in terms of the analyzed variables continued to exist in 2017-2020. Based on the performed analyses and results of the analysis of variance for the distinguished clusters ($p < 0.001$), it can be concluded that the differentiation of the clusters is mostly discriminated by the prices of agricultural land sold from the APSSST and in private trade.
4. Thus, the hypothesis assuming the existence of interregional differences in the formation of agricultural land prices was confirmed. However, despite the changes in time differences, they still occur.

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DETERMINANTY ZMIAN CEN GRUNTÓW ROLNYCH W POLSCE NA POZIOMIE REGIONALNYM

Słowa kluczowe: rynek gruntów rolnych, ceny gruntów rolnych, koncentracja terytorialna, Zasób Własności Rolnej Skarbu Państwa (ZWRSP), prywatny obrót ziemią

ABSTRAKT. Celem badań była identyfikacja czynników determinujących zmiany cen ziemi oraz wskazanie skupień województw wyróżnionych według przyjętych zmiennych. Ze względu na specyfikę rynku gruntów rolnych w Polsce, w analizach uwzględniono różnicowanie cen gruntów rolnych z Zasobu Własności Rolnej Skarbu Państwa (ZWRSP) oraz z obrotu gruntami prywatnymi. Ze względu na obowiązujące w Polsce regulacje formalno-prawne oraz sposób rejestrowania zmian cen gruntów, analiza dotyczyła okresu 2013-2020, podzielonego na dwa podokresy: 2013-2016 i 2017-2020. Jednym z najistotniejszych czynników było to, że na polskim rynku gruntów rolnych istniały dwa podryniki, czyli grunty rolne w obrocie prywatnym oraz grunty rolne z ZWRSP. Największe różnicowanie cen gruntów między województwami wynikało z przeciętnego miesięcznego dochodu do dyspozycji na 1 mieszkańca z rodzinnego gospodarstwa rolnego w stosunku do przeciętnego miesięcznego dochodu na 1 mieszkańca z pracy na własny rachunek oraz łącznej powierzchni gruntów rolnych sprzedawanych z ZWRSP.

AUTHORS

WIESŁAWA LIZIŃSKA, DR HAB. PROF. UWM

ORCID: 000-0002-6957-2846

University of Warmia and Mazury in Olsztyn

Faculty of Economic Science

Department of Economic Policy

e-mail: wieslawa.lizinska@uwm.edu.pl

MARIOLA GRZYBOWSKA-BRZEZIŃSKA, DR HAB. PROF. UWM

ORCID: 0000-0002-6571-1140

University of Warmia and Mazury in Olsztyn

Faculty of Economic Science

Department of Market and Consumption

e-mail: margrzyb@uwm.edu.pl

MAŁGORZATA GRZYWIŃSKA-RĄPCA, DR HAB. PROF. UWM

ORCID: 0000-0003-2088-2795

University of Warmia and Mazury in Olsztyn

Faculty of Economic Science

Department of Market and Consumption

e-mail: malgo@uwm.edu.pl

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