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Regional approach to the effects of the production of agricultural holdings with respect to the CAP policy

Synopsis. The productivity is a key issue in economics as it is one of the factors affecting the economic prosperity. An analysis of the agricultural production has a special place in economics of agriculture due to its high dependency on many factors. Therefore, many authors try to define what and to what extent affects the production in agricultural holdings. In their paper, the authors wanted to show that apart from basic production inputs, we also observe an impact of various types of payments on the production. These payments are used in agricultural holdings to cover costs related to the agricultural production, e.g. purchase of fertilisers and plant protection products. In the longer term, such activity may have negative consequences, namely it may result in the stagnation of the development of a holding. This is related to providing the holding with additional funds which protect it against bankruptcy and consequently delay making a decision on reorganising the holding. The paper also attempts to approach the analysed issue in spatial terms, because, as many authors notice, changes in the production and the system of payments are strongly diversified regionally. The studies used the spatial econometrics the SAR model. Based on the above model, an econometric production model, extended by various types of payments, has been proposed.

Key words: direct payments, production, spatial analysis

Introduction

A basic instrument in support of agriculture, after Poland's accession to the EU are direct payments which are one of the Common Agricultural Policy instruments. The system of direct payments consists in granting financial support in an amount proportional to the area of agricultural land, regardless of the type of pursued agricultural activity. The system of payments includes single area payment (JPO – SAP) and complementary national direct payment (UPO – CNDP). Besides, Polish agriculture was supported by other operational activities, namely SAPARD (in the years 2002-2004), RDP and SOP Agriculture (in the years 2004-2006) and RDP (in the years 2007-2010). Most of the funds allocated to holdings are characterised by the strong spatial diversification which is related to the size of the area of agricultural land [Głębocki 2014]. In the year 2015 it is planned to change the method of granting direct payments, therefore an important aspect is to focus on examining a relation between direct payments and factors affecting the development of agricultural holdings. The relation of direct payments and virtually of their impact on the production has been analysed by many authors. Sadowski and Antczak [2012] claim that a positive impact of payments on the production growth is basically inconsistent both with the

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original function of using direct payments and with additional, environmental objectives set within the framework of the Luxembourg reform [Sadowski and Antczak 2012]. In his paper, Sadowski proved that the production growth had resulted from the use of direct payments for funding current production expenses, e.g. purchase of mineral fertilisers. However, many authors think that the introduction of direct payments results, in the longer term, in a negative impact on the productivity in agriculture. This is related to providing the holding with additional funds which protect it against bankruptcy, and consequently delay making a decision on reorganising the holding [Rude 2007]. As it results from analyses carried out by other authors, in Poland there are important socio-economic differences between the economy and agriculture as well as disproportions caused by different environmental conditions and different organisation of agricultural holdings at the regional level [Krasowicz and Kopiński 2006]. As noticed by Czubak [Czubak et al. 2011], payments are strongly diversified regionally, which is also a result of different agrarian structures specific to the individual regions of Poland.

The issue of connecting the productivity and direct payments is a problem which has already been dealt with by many foreign authors. In their studies, the authors found both a negative and a positive impact of payments on the productivity. In one of the papers on the productivity, Lee, who conducted studies in Korea [Lee 1996] as well as Beanson and Weinstein, who conducted studies in Japan [Beanson and Weinstein 1996] stated that payments had a negative impact on the production growth. When conducting studies on the production effectiveness in Sweden, Bergstrom concluded that payments had a positive impact on the production growth [Bergstrom 2000]. However, when it comes to the issue of direct payments in agriculture and their inclusion in the production function, such analyses were carried out by Rizov [Rizov et al. 2013]. When analysing the impact of grants received under the CAP, Rizov studied the productivity of commercial holdings in the EU. The data used in that study concerned the countries belonging to the EU-15 of the years 1990/1996-2008 and came from FADN. That paper used the nonparametric regression function, which allowed to increase a possibility of getting more coherent estimates of the production function parameters. Rizov et al. conducted regional analyses on the macro level as they also wanted to state whether there were any differences in the productivity between the states of Northern and Southern Europe. The analyses carried out confirmed the impact of grants on the production for all EU-15 states. The authors also found that payments had rather a negative impact on the agricultural production. A certain reservation regarding the conducted studies applies to the study sample used (EU-15), namely, the study used the states whose economies were more developed and thus, the market imperfections were less visible.

On the basis of the analyses carried out by other national and foreign authors, the authors decided to conduct similar studies for Poland based on the Economic Accounts for Agriculture (EAA) at the NUTS 2 level. Due to earlier studies, which determined the regional diversification of payments and the production value, the spatial effect has been included in the production function. The objective of the paper was to determine the impact of payments on the production value, with consideration given to the spatial nature of this relation.

Data and methods

In this paper, we used the data derived from the Regional Accounts for Agriculture (RAA) which are drawn up on a basis of a methodology of the Economic Accounts For Agriculture (EAA). The first account is drawn up at the NUTS 1 level, the other at the NUTS 0 level. In Poland, the EAA have been drawn up at the Institute of Agricultural and Food Economics National Research Institute, since 1998 at the national level (EAA) and since 2009 – at the regional level (RAA), both in cooperation with the Department of Agriculture of the Central Statistical Office. The EAA is an instrument used in agricultural statistics by Eurostat for the purposes of the European Union. They are used to calculate the volume and value of the agricultural production in the European Community countries. The EAA are drawn up for the entire agricultural sector and are the satellite accounts to the National Accounts (NA). The EAA and RAA are the accounts of macroeconomic nature taking into consideration the volume and value of the production of holdings in a given year. The EAA are drawn up on an accrual basis, i.e. at the moment of the existence of an economic event, when the economic value of the product is being created rather than at the moment when payment is actually made (cash basis). The method for preparing the EAA has been developed and standardised by Eurostat. The identical system of calculating the EAA in all Member States allows to compare the production and economic results as well as to monitor agricultural income in the EU. Simultaneously, the accounts provide the information necessary when determining the major priorities or making decisions within the framework of the Common Agricultural Policy (CAP). A legal basis for the Economic Accounts for Agriculture is the the EC Regulation 138/2004 of the European Parliament and of the Council of the European Union of 5 December 2003 *on the economic accounts for agriculture in the Community*, which is an essential document obliging the EU countries to develop the EAA and simultaneously specifying the scope and method of the accounts. The rules for calculating the EAA have been included in the "Manual On The Economic Accounts For Agriculture And Forestry Eaa/Eaf 97 (Rev. 1.1)" as amended (Commission Regulation (EC) No 306/2005 of 24 February 2005, Commission Regulation (EC) No 909/2006 of 20 June 2006, Commission Regulation (EC) No 212/2008 of 7 March 2008).

An analysis to study the impact of payments on the production value used the results of the Regional Economic Accounts for Agriculture (RAA) for the years 2005-2008 which are drawn up in the fashion of the Economic Accounts for Agriculture (NUTS 0 level). Chart 1 shows the changes in the production value in the years 2005-2008. As it may be noticed, two voivodeships (Mazowieckie and Wielkopolskie) in the analysed period were clearly different from others, in terms of that feature.

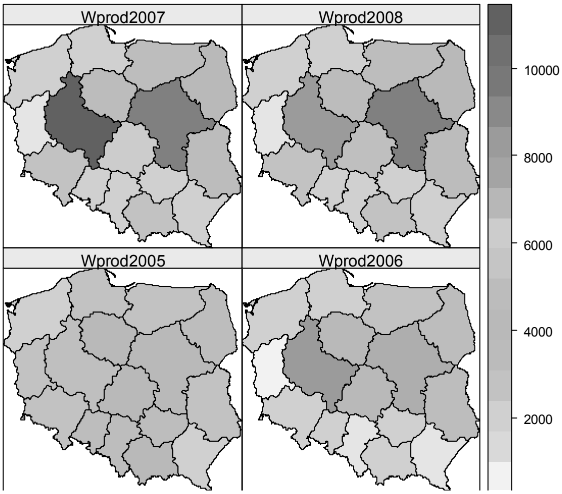

Fig. 1. Production value in thous. zl of individual holdings in the individual voivodeships for the years 2005 – 2008

Source: own calculations, based on the Regional Economic Accounts for Agriculture (RAA).

Chart 2 shows the average amounts of three types of payments by voivodeships. As we may notice, the spatial layout of granted payments is similar to that presented for the production value in Fig. 1

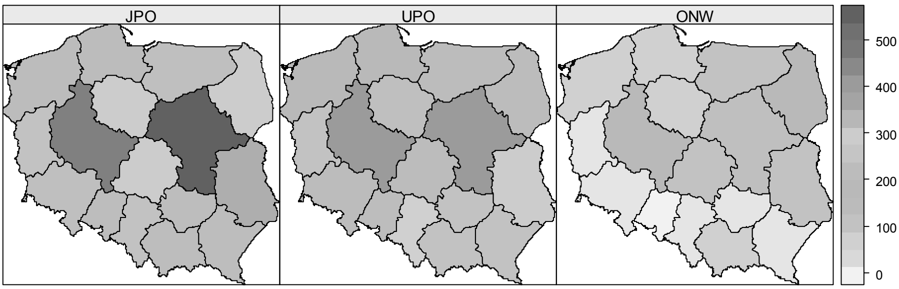

Fig. 2. Average amounts of three types of payments (JPO – single area payment, UPO – complementary national direct payment, ONW – payments to less-favoured areas) by voivodeships in thous. zl.

Source: own elaboration based on the EAA data from the years 2005 – 2008.

The production potential of agriculture is formed by resources of basic production factors i.e.: land, capital and labour. The resources of these factors are significantly diversified regionally. In order to remove the impact related to changes in prices, the fixed prices of 2005 have been adopted. All variables in the analysis are considered in value terms.

In the conducted studies, the effect of agricultural activity – the value of production of plant and animal goods – has been adopted as a dependent variable (Wprod). Independent variables were production inputs, in which indirect consumption has been included (NAK1). In the RAA accounts, this component covers materials inputs in agriculture, including: seed material; energy and fuel; fertilisers and plant protection products;

veterinary services; purchased and self-manufactured feed; as well as the maintenance of machinery, buildings and equipment. As another component complementing material inputs and reflecting the capital input, the costs of depreciation of buildings and structures and machinery used in the agricultural production process (NAK2) have been included. On the other hand, as the labour component, the number of persons employed in agriculture expressed in thousand AWU (NAK3) has been included. For the purposes of the study on indirect consumption, the following have been additionally singled out within the inputs: fertilisers (NAK4); inputs for purchase of plant protection products (NAK5). As the land factor, the value of agricultural land has been introduced (NAK6). We have to add that the above structure of the groups of inputs reflects the technology of the agricultural production. In addition, the values of single area payments (JPO), of complementary national direct payments (UPO), of payments to less-favoured areas (ONW) and of other payments (InneDop) have been included. The value of other payments consisted of: payments to loans, to biological progress, to plant protection, to organic farming, to support for agri-environmental projects, to support for semi-subsistence farms, return of excise duty included in the price of oil used for the agricultural production, payments of compensation for renouncing the milk quotas, payments to seed material as well as historic payments not related to the current production: complementary payment to the hop production area and separate payment to fruit and vegetables (payment to tomatoes). Due to the key importance of cereal crops in Poland and the existence of the regional diversification at the production level, the amount of complementary payments has been divided into complementary payments to the production of cereals (ZbozaDop) and complementary payments related to the production of other plants (UPOb). In order to eliminate the collinearity in the analysed regression model, indirect consumption has been decreased by inputs for fertilisers and plant protection products (the variable obtained in this way has been designated in short as NAK1a).

As a result, the following production model has been considered:

$$Wprod = \beta_0 NAK1^{\beta_1} \cdot NAK2^{\beta_2} \cdot NAK3^{\beta_3} \cdot NAK4^{\beta_4} \cdot NAK5^{\beta_5} \cdot NAK6^{\beta_6} \cdot JPO^{\beta_7} \cdot UPO^{\beta_8} \cdot ONW^{\beta_9} \cdot InneDOP^{\beta_{10}} + \varepsilon \quad (1)$$

An analysis of the data for the above model may be found in the paper by Buks and Pietrzykowski [Buks and Pietrzykowski 2014]. The extension of the conducted studies consisted in including the spatial effects in the analyses carried out.

The classic production model consists of three elements: capital, land and labour. Thus, we may write it down using the following formula:

$$y = f(x_1, x_2, \dots, x_p) = \beta_0 \prod_{i=1}^{p} x_i^{\beta_i} + \varepsilon \quad (2)$$

where $x_1, x_2, \dots, x_p \geq 0$ and correspond to individual production inputs and β are the regression coefficients. In the previous paper, the authors extended the above model by various types of payments [Buks and Pietrzykowski 2014]. The model written using formula 1 does not include spatial autocorrelation. In the spatial analyses, we may consider spatial autoregressive models (SAR), spatial error models (SEM, SMA, SEC) and spatial cross-regressive models (SCM). In the study the SAR model (Spatial Autoregressive

Model) describing spatial autocorrelations has been selected [Arbia 2006], which in the matrix form may be written down using the following formula:

$$\mathbf{y} = \rho\mathbf{W}\mathbf{y} + \mathbf{X}\beta + \varepsilon \tag{3}$$

where **y** – vector dependent variables, **X** – matrix of independent variables, β **-** vector of regression coefficients**,** ε **-** vectors of independent identically normal distributed random errors N(**0,** σ^2**I)**, ρ - autoregression parameter, **W –** matrix of spatial weights.

In standard terms the SAR spatial model may be presented by means of the following formula:

$$y_i = \rho\left(\sum_{j=1}^{N} w_{ij} y_i\right) + \sum_{i=1}^{k} x_{ij}\beta_i + \varepsilon_i \tag{4}$$

where: w_{ij} is elements of this weight matrix **W.**

The study used the first-order binary weight matrix **W**[3]. The application of this type of matrix in the SAR model results in the appearance of the so-called global autocorrelation dependency of observations in a given location with respect to the other locations of the analysed phenomenon [LeSage 1999]. The global autocorrelation dependencies may be presented by means of the following formula:

$$(\boldsymbol{I} - \rho\boldsymbol{W})^{-1} = \boldsymbol{I} + \rho\boldsymbol{W} + \rho^2\boldsymbol{W}^2 + \rho^3\boldsymbol{W}^3 + \cdots \tag{5}$$

Formula 5 describes the extension of the matrix $(\boldsymbol{I} - \rho\boldsymbol{W})^{-1}$, which is to illustrate a change in the random factor appearing in one location and then this extension is transferred to other areas of the impact of the analysed feature.

In the conducted studies, for the purpose of including the spatial relations, the following autoregressive model has been proposed to describe the dependency of the production value on inputs and various payments:

$$\ln(y_i) = \rho\left(\sum_{j=1}^{N} w_{ij} y_i\right) + \ln(\beta_0) + \sum_{i=1}^{k} \ln(x_{ij})\beta_i + \varepsilon_i \tag{6}$$

where y_i – production value, x – inputs (values: labour, capital and land). The proposed model determining the production value (formula 6) is the production model presented in a linear form.

The analysed function has been extended by payments, to obtain the following econometric model:

$$\ln(y_i) = \rho\left(\sum_{j=1}^{N} w_{ij} y_i\right) + \ln(\beta_0) + \sum_{i=1}^{p} \beta_i \ln(x_{ij}) + \sum_{j=(p+1)}^{k} \beta_j \ln(d_j) + \varepsilon \tag{7}$$

where x_i correspond to production inputs, whereas d_j correspond to various types of payments. The final form of the proposed model is presented using formula 8:

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[3] The weight matrix in binary style, units for neighbouring voivodeships, otherwise zero.

$$\ln(y_i) = \rho\left(\sum_{j=1}^{N} w_{ij} y_i\right) + \ln(\beta_0) + \sum_{i=1}^{p} \beta_i \ln(x_i) + \ln(D_i) + \varepsilon \quad (8)$$

$$D_i = \exp\left(\sum_{j=(p+1)}^{k} \beta_j x_j\right) \quad (9)$$

Due to a failure to meet the assumptions for the classic least-squares method (OLS), the maximum likelihood method has been used to estimate the parameters of that model. All calculations have been made using the R-CRAN programme [R: A language… 2009].

Results

As a result of the analyses carried out, two econometric models were considered. In the first model, various production inputs were considered and also various types of payments were added (Model A, presented by means of formula 8 – table 1). In the other model (Model B –table 2), only payments themselves were included, to be treated as funds which are not a regular input but an input which provides additional cash flow. Table 3 (Model C) included the results obtained for the model without the spatial effects. When comparing the considered models for the purpose of determining the quality of obtained fits, the adjusted coefficient of determination has been used (D_{adj}). For model C, which did not include the spatial effects, the value $D_{adj} = 0{,}9746$ has been obtained, whereas for model A, which included the spatial effects, i.e. interdependencies among neighbours the value was $D_{adj} = 0{,}9981$. In model A, the production value was significantly affected by the value of the land, amount of fertilisers applied, direct consumption (excluding the input for fertilisers and plant protection products) and all payments received by farmers and taken into account in the analyses carried out. The calculations for model B were made in order to determine the relation between the production and payments, except for other explanatory features. Model B has obtained the lowest coefficient $D_{adj} = 0{,}9128$, but this is natural due to the fact that other variables were not included in it. It should be noted, however, that the removal of typical inputs from the production model, and leaving payments only did not result in a great change in the value of the coefficient (decline in value by 0.06). Therefore, we may conclude that payments have a large impact on the obtained production value, because 91% of the production variability are explained by the variability of features which describe payments (while only 9% remain unexplained or reserved for other features which may be included in the study).

The analyses carried out allowed to assess more precisely a relation between the production value and payments received in agriculture. In model C, no relation for all types of payments with the production value has been shown. It seems that the relation described by means of this model may prove a positive trend in the evolution of the CAP (in accordance with the assumptions, the impact of payments on the production is gradually decreasing). In model A, however it has been confirmed that payments have the greater impact on the production value in the ranking of analysed variables. The obtained effect may be explained by the regional diversification at the level of voivodeships, i.e. in the model, which did not include spatial dependencies, the impact of payment has been simply decreased (masked as a result of having not included spatial correlations). Moreover, the analysis showed a negative relation between the production and complementary payments (UPOb, ZbozaDop) and other payments, which would confirm a thesis that obtaining this type of payments by farmers results in weakening of activities for the development of holdings. Therefore, it should be stressed that thanks to the inclusion of the spatial effects, the impact of location on the production has been found, through the diversification of the use of payments in the individual voivodeships.

Table 1. Values of regression coefficients of the spatial econometric production model according to formula 8

Variables	Estimate coefficients	Standard errors	t value	p – value
(Intercept)	4,3298	0,8333	5,1961	2,04E-07
NAK6	0,2012	0,0678	2,9685	0,002992
NAK1a	0,1588	0,0617	2,5735	0,010068
NAK4	0,3875	0,0783	4,9507	7,40E-07
JPO	0,0103	0,0016	6,6470	2,99E-11
UPOb	-0,0151	0,0019	-8,0395	8,88E-16
ONW	0,0054	0,0005	10,7573	< 2,2e-16
InneDop	-0,0030	0,0005	-6,0820	1,19E-09
ZbozaDop	-0,0061	0,0013	-4,7630	1,91E-06

Source: own calculations based on the Regional Economic Accounts for Agriculture (RAA).

Table 2. Values of regression coefficients of the spatial econometric production model including the impact of payments only

Variables	Estimate coefficients	Standard errors	t value	p – value
(Intercept)	14,3805	0,1115	129,0228	< 2,2E-16
JPO	0,0219	0,0062	3,5016	0,0005
UPOb	-0,0223	0,0053	-4,1753	2,98E-05
ONW	0,0077	0,0025	3,1068	0,0019
InneDop	-0,0065	0,0023	-2,7693	0,0056
ZbozaDop	0,0095	0,0032	3,9604	7,48E-05

Source: own calculations, based on the Regional Economic Accounts for Agriculture (RAA)

Table 3. Values of regression coefficients of the econometric production model without the spatial effects.

Variables	Estimate coefficients	Standard errors	t value	p – value
(Intercept)	2,0806	0,8615	2,415	0,0190
NAK6	0,1885	0,0508	3,714	0,0005
NAK4	0,1891	0,0585	3,233	0,0021
NAK5	-0,1597	0,0844	-1,891	0,06371
NAK1a	0,6487	0,0580	11,181	6,85E-16
JPO	-0,0020	0,0009	-2,210	0,0311
UPO	0,0009	0,0002	3,641	0,0005
InneDop	0,0011	0,0004	2,766	0,0077

Source: own calculations, based on the Regional Economic Accounts for Agriculture (RAA).

Figure 3 shows the spatial distribution of residuals for model A (including the spatial correlations). In the figure, the negative residuals (light grey voivodeships), positive residuals (dark grey voivodeships) and distant points, so-called "outliers" have been marked. The voivodeships marked black are the voivodeships for which the values of residuals were positive (outliers+), and those marked white mean negative residuals (outliers). Most voivodeships obtained the positive values of residuals which would mean that in these voivodeships the model underestimates the production value. Two voivodeships, namely the Opolskie voivodeship (positive value of residuals) and Lubuskie voivodeship (negative value of residuals) are different from the other

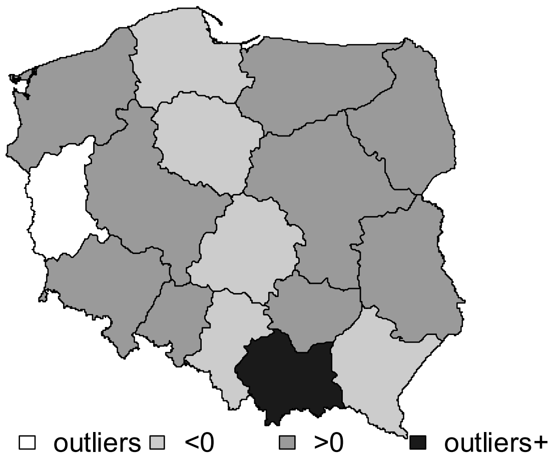

Fig. 3. Spatial distribution of residuals value for model A

Source: own elaboration based on the EAA data from the years 2005 – 2008

In the Pomorskie, Kujawsko-Pomorskie, Łódzkie, Śląskie and Podkarpackie voivodeships, the negative values of residuals were obtained. Therefore, it may be concluded that in those voivodeships the production value would be higher than that derived from the model estimated on a basis of obtained features (including payments). The greatest differences will be noticeable for the Lubuskie voivodeship. The econometric spatial model is the "better" model due to the criterion adopted (adjusted coefficient of determination). However, it should be stated that the difference is not very significant, but the inclusion of the spatial effects allowed to determine the impact of all payments on the production value, which was not achieved in the standard model.

Summary

The results obtained allowed to confirm the opinions of other authors pointing to the impact of payments on the production value. The use of spatial analyses showed that the impact of payments was diversified regionally. The study showed the production value model which also included the land factor and other total inputs included in indirect consumption. The greatest impact on the production value was found for inputs aggregated in indirect consumption, namely, an increase of those inputs by one percentage point would result in the production growth by 38.75%, on average. In the model with the spatial effects, it was possible to state the impact of all types of payments on the production value (it was impossible to achieve that in model C without the spatial effects). Both models show minor changes in the production value with an increase in payments by one percentage point. However, in the model including the spatial effects that impact would significantly higher. We should also note that in the model including the spatial effects, complementary payments (broken down in terms of payments to the production of cereals and other plants) as well as other aggregated payments affect the production value in a negative manner. The use of the SAR model allowed to state the impact of all payments on the production value. This analysis has confirmed the relation and diversification of payments and production in the space which the reference area of Poland at the NUTS-2 level was.

References

Anselin L., Florax R., Rey S. (red.) [2004]: Advanced in Spatial Econometrics. Methodology. Tools and applications. Springer-Verlag, Berlin

Arbia G. [2006]: Spatial Econometrics: Statistical Foundations and Applications to Regional Convergence, Springer-Verlang, Berlin.

Beason, R. Weinstein D. E. [1996]: Growth, Economies of Scale, and Targeting in Japan (1955-1990). The Review of Economics and Statistics, 78(2), May, 286–295.

Bergstrom, F. [2000]: Capital subsidies and the performance of firms, Small Business Economics, 14, 283-293.

Bivand R. S., Pebesma E., Gómez-Rubio V. [2013]: Applied Spatial Data Analysis with R, Springer 2nd edition, New York.

Buks J., Pietrzykowski R. [2014]: Efekty produkcji gospodarstw w Polsce w odniesieniu do WPR w latach 2005 – 2008, Zeszyty Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, (in print).

Czubak W., Jędrzejak P. [2011]: Wykorzystanie dopłat bezpośrednich w gospodarstwach rolnych, Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu, Tom XIII Zeszyt 2, Warszawa – Poznań – Wrocław.

Czubak W., Sadowski A., Poczta W. [2011]: Wpływ reformy systemu dopłat bezpośrednich na dochody polskich gospodarstw rolnych z pola obserwacji FADN [w:] Dopłaty bezpośrednie i dotacje budżetowe a finansowanie gospodarstw i przedsiębiorstw rolniczych, Raport PW nr 20, IERiGŻ-PIB, Warszawa.

Głębocki B. [2014]: Zróżnicowanie przestrzenne rolnictwa, Powszechny Spis Rolny 2010, Wydawnictwo GUS, Warszawa.

Krasowicz S., Kopiński J. [2006]: Wpływ warunków przyrodniczych i organizacyjno-ekonomicznych na regionalne zróżnicowanie rolnictwa w Polsce, Raporty PIB zeszyt 3, IUNG-PIB, Puławy.

Lee, J.-W. [1996]: Government Interventions and Productivity Growth, Journal of Economic Growth, 1, 391–414.

LeSage J.P. [1999]: The Theory and Practice of Spatial Econometrics, Department of Economics, University of Toledo. [Available at:] http://www.spatial-econometrics.com/html/sbook.pdf [accessed: November 2014]

Sadowski A., Antczak W. [2012]: Kierunki wykorzystania dopłat bezpośrednich przez rodzinne gospodarstwa rolne położone w wybranych województwach, Journal of Agribusiness and Rural Development, 4(26) 2012, 103-113 Poznań.

Rachunki Ekonomiczne dla Rolnictwa, Regionalne Rachunki Ekonomiczne dla Rolnictwa [2014]: Eurostat, Luksemburg. [Available at:] http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database [Access: November 2014].

Rizov M., Pokrivcak J., Ciaian P. [2013]: CAP Subsidies and Productivity of the EU Farms, Journal of Agricultural Economics, Vol. 64, No. 3.

Rude J. [2007]: Production effects of the European Union’s single farm payment, Canadian Agricultural Trade Policy Research Network (CATPRN) Working Paper 2007-6, September.

R: A language and environmental for statistical computing 2009, R Development Core Team, R Foundation for Statistical Computing, Vienna, Austria. [Available at:] http://www.R-project.org [Access: October 2014].