REGIONAL ASPECTS OF AGRICULTURAL INCOME LEVEL IN VOJVODINA PROVINCE IN FUNCTION OF BASIC PRODUCTION FACTORS

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Abstract

In the present research the analysis of the level of national income in agriculture was done for different districts and municipalities of the Province of Vojvodina.

The analysis of the achieved level of national income in agriculture in function of the most important factors was performed on the base of classical form the traditional non-linear regression model of Cobb-Douglas production function with labour and capital as predictors and on the extended form of Cobb-Douglas function which in addition includes the arable areas.

Key words: National income in agriculture, Cobb-Douglas production function, investments in agriculture, agricultural population

Introduction

During the 80s of XX century, European Union countries were closely focused on enhancing development of rural areas aiming to achieve a coherent economic development. The tendencies were to diminish the differences between the city and the country (urban vs. rural), as well as to replacing the activities in agriculture by activities related to agriculture, etc (Stojanović, 2006). European Union Countries have been actively engaged with fostering development of rural regions and establishing rural development policies, as well as deciding on and improving the list of rural development indicators (Bryden, 2003). Defining the basic indicators of rural development is one of the essential requirements for international comparison (Stojiljković, Bošković, 2008). International organizations, such as OECD, EU and others, make remarkable effort to establish the list of indicators of rural development.

The level of development of municipalities in Serbia was measured on the basis of several indicators. In this paper, the indicator for determining municipality development was the corrected national income per capita in 2005. The correction of the national income was provided by two-year average of the national income of agriculture from 2004 and 2005. Ranking of the municipalities was conducted according to the value of indexes of the national income per capita with the level of the Republic of Serbia taken as the basis for comparison (Municipalities in Serbia, 2006, 2007). On the basis of such ranking of Serbian municipalities – according to the above stated indicator – only one municipality in Vojvodina (the place of Zitište, rank 47) belongs to the group of underdeveloped municipalities. There is no Vojvodinian municipality belonging to the group of the most undeveloped municipalities. Regarding other municipalities, 8 municipalities from

Vojvodina are ranked in the top 20 Serbian municipalities. These are the following ones: Apatin (rank 13), Bačka Palanka (rank 16), Bela Crkva (rank 8), Beočin (rank 6), Vršac (rank 10), Kikinda (rank 15), Novi Sad – city (rank 7) and Senta (rank 19). The highest ranks are occupied by municipalities of the city of Belgrade**.** In 2005. total number of municipalities of Serbia was 162, while Vojvodina Province had 45 municipalities.

The above presented indicators of the level of development of Serbian municipalities suggest that Vojvodina, as one of the three regions in Serbia, belong to the group of developed regions. Serbia is divided into the following regions: Region 1 (the lowland region) includes the regions of Bačka, Srem, Banat and a part of Mačva; Region 2 covers the northern part of central Serbia (Šumadija, part of Mačva and Stig); Region 3 (the mountainous and highland region) includes the eastern, southern and western parts of Serbia (Bogdanov, 2007). Regarding the development of the Vojvodinian regions, it is pointed out in the literature that from the 90s the western part of the Province, i.e. Bačka and Srem, is generally speaking more developed compared to the eastern part, i.e. Banat (Bogdanov, 2007). This paper shall compare the level of development of these 3 regions – Bačka, Banat and Srem – at the level of the Autonomous Province. It would certainly be far more suitable for the analysis if the level of development could be measured at the level of settlements or municipalities or counties. However, the availability of the published statistical data is restricted and, therefore, these three regions are compared.

The aim of this paper is comparison of these Vojvodinian regions according to the share of rural population in the total population, the share of national income from agriculture in the total national income and according to estimated models of Cobb-Douglas production function.

Data and methods

The paper uses the data provided for municipalities and districts of Vojvodina on the national income from agriculture in 2005. The recorded data on investments in agriculture in 2004 in municipalities and districts of Vojvodina are to show whether there is an effect of the investments from the preceding year in terms of the achieved income level from agriculture in the following year. Furthermore, the study uses the data on active agricultural population, as well as the data on cultivable land, on arable land and gardens. Regression analysis is employed here in order to determine the behavior of dependent variable (national income from agriculture) in relation to the combinations of two independent variables (agricultural population and investments in agriculture, active agricultural population and investments in agriculture). The national income from agriculture and investments in agriculture are given in thousands of Serbian diner currency (RSD).

The research uses the model of multiple linear regression with two independent variables and the model of curvilinear regression of Cobb-Douglas function type with two independent variables. The general form of Cobb-Douglas function is the following: $Y = AL^{\alpha}K^{\beta}e^{\varepsilon}$, where Y is the dependent variable (production), L represents the labour input (the first independent variable), K represents the capital input (the second independent variable), and $\eta = e^{\varepsilon}$ is a random variable with log-normal distribution. The parameters α and β are indicators of elasticity of labour and capital (http://en.wikipedia.org/wiki/Cobb-Douglas). Since the results of χ^{2} test prove that the distribution of the dependent variable Y statistically has no significant deviation from log-normal distribution, the model of Cobb-Douglas function is by logarithmic transformation turned into multiple linear regression with two independent variables in which the random errors have normal distribution: $\ln Y = \ln A + \alpha \ln L + \beta \ln K + \varepsilon$.

The adequacy of the model is determined by application of residual tests: Lagrange Multiplier Test (LM) which examines the presence of serial residual correlation, ARCH LM, and White Test for determining conditional heteroskedasticity of residuals (Gujarati, 1995). The calculations were conducted by applying **STATISTICA 8.0** and Eviews 3.1 programmes (Asteriou, 2007).

Research results

According to OECD criterion, the regions are divided into three types: predominantly rural regions if more than 50% of population live in rural communities; intermediate (or mixed) if 15-50% of population live in rural communities; and predominantly urban regions if less than 15% of population live in rural communities (Bryden, 2003).

The classification of the districts of Vojvodina according to the share of rural population in municipalities indicates that in the majority of districts predominantly rural or mixed regions dominate. Only in the northern Banat district and the south Bačka district there are municipalities that are characterized as extremely urban. The northern Bačka district, the middle Banat, the south Banat and Srem districts have more rural than intermediate municipalities. The northern Banat and western Bačka districts have more intermediate than predominantly rural municipalities. The southern Bačka district has the same number of predominantly rural and intermediate municipalities.

Table 1 - Classification of the municipalities of Vojvodina according to the share of rural population

DISTRICT	Rural	Intermediate	Urban	Total
Northern Bačka	2	1	0	3
Middle Banat	3	2	0	5
Northern Banat	2	3	1	6
Southern Banat	5	3	0	8
Western Bačka	1	3	0	4
Southern Bačka	5	5	2	12
Srem	4	3	0	7
Total	22	20	3	45

In 2005 in Vojvodina only 3 municipalities were predominantly urban, 22 were predominantly rural, while 20 municipalities are characterized as belonging to the mixed type of rurality. Accordingly, Vojvodina and its regions have the profile of an extremely rural area (Table 1).

The share of the national income from agriculture in the overall national income (%) in 2005 is high and it is the highest in the middle Banat district (47.5%). It is followed by the southern Banat district (45.4%), Srem (44.4%), northern Bačka (41.3%), northern Banat (35.6%), southern Bačka (34.3%), and finally the western Bačka district (28.9%) presented in Table 2.

Table 2 - Share of the national income from agriculture in the total national income (%) in the districts of Vojvodina

Districts		$\overline{X}$	C_V (%)	X_{min}	X_{max}
Northern Bačka	1997	34.64	39.21	18.97	43.07
	2002	38.60	55.70	15.90	58.60
	2005	41.30	51.50	17.90	59.40
Middle Banat	1997	55.60	41.48	20.80	74.00
	2002	45.10	45.31	17.71	66.45
	2005	47.49	36.76	17.20	61.75
Northern Banat	1997	36.91	25.23	22.81	47.62
	2002	30.96	39.09	19.05	52.11
	2005	35.56	36.47	18.50	54.80
Southern Banat	1997	49.88	46.59	14.37	79.28
	2002	47.52	44.29	13.22	69.44
	2005	45.40	43.84	13.99	68.33
Western Bačka	1997	28.64	36.45	14.10	65.72
	2002	27.99	52.20	7.87	41.42
	2005	28.86	30.87	18.07	38.88
Southern Bačka	1997	40.32	46.45	14.10	65.72
	2002	37.34	53.23	9.71	72.48
	2005	34.30	64.89	4.87	77.51
Srem	1997	50.11	40.07	32.43	81.27
	2002	48.20	38.64	24.13	74.92
	2005	44.43	45.00	22.43	82.37

Applied model of Cobb-Douglas function in double logarithmic form for Vojvodina was

$$\ln \hat{Y} = 5.599013 + 0.841785 \cdot \ln X_1 + 0.1412163 \cdot \ln X_2, \overline{R}^2 = 0.8321, \overline{R}^2 = 0.8233,$$
$$(9.40^{**}) \qquad (4.42^{**})$$

The specified model of Cobb-Douglas function indicates that the achieved national income from agriculture of Vojvodina in 2005 (Y) is strongly influenced by the both analyzed variables: agricultural population (X_1) and investments in agriculture (X_2). By applying the Wald test the hypothesis on homogeneity of the parameters of (F = 0.040571, p = 0.8414) model has been confirmed.

Graphical presentation in three-dimensional space illustrates the relation of the dependent variable and independent variables (Figure1):

Figure 1 - Applied model of Cobb-Douglas function
$$\hat{Y} = 270.15063 X_1^{0.84178} X_2^{0.14216}$$
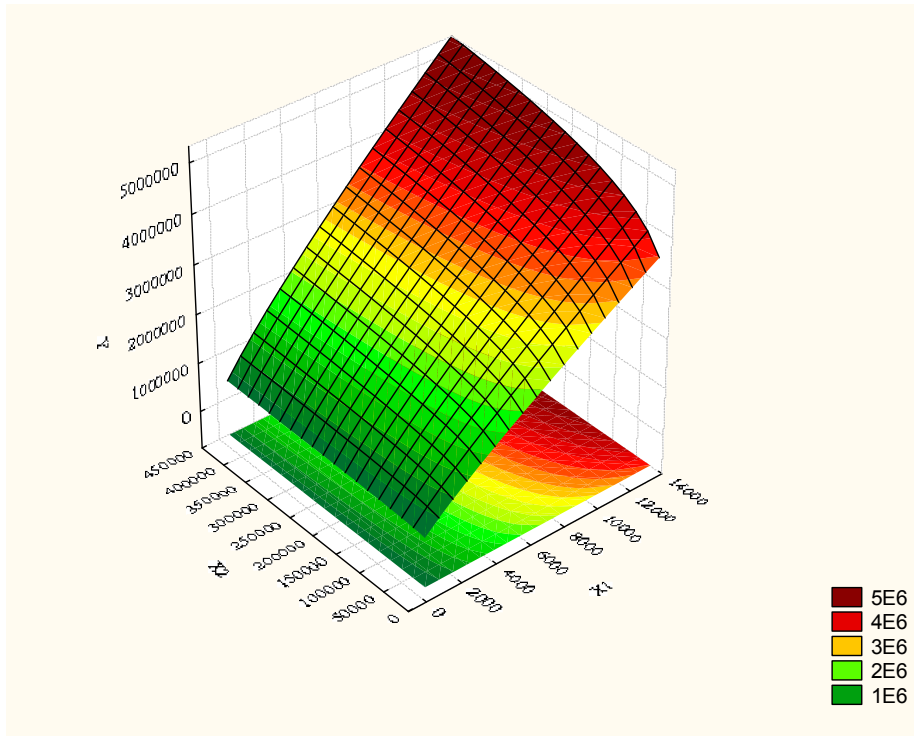
In order to determine whether there are regional differences in the degree of influence of the analyzed factors on the national income from agriculture, the regression models of the same form were applied for Bačka, Banat and Srem:

$$\ln \hat{Y} = 5.47089 + 0.886188 \cdot \ln X_1 + 0.125807 \cdot \ln X_2, R^2 = 0.8790, \overline{R}^2 = 0.8629,$$
$$(7.02^{**}) \qquad\qquad (2.36^*)$$

$$\ln \hat{Y} = 4.162296 + 1.073061 \cdot \ln X_1 + 0.078459 \cdot \ln X_2, R^2 = 0.7834, \overline{R}^2 = 0.7524,$$
$$(4.67^{**}) \qquad\qquad (1.28)$$

$$\ln \hat{Y} = 6.354630 + 0.816372 \cdot \ln X_1 + 0.088164 \cdot \ln X_2, R^2 = 0.9112, \overline{R}^2 = 0.8520,$$
$$(4.47^*) \qquad\qquad (0.81)$$

The values of Wald statistics for Bačka $F = 0.012946$ ($p = 0.9109$), for Banat

F = 0.589772 (p=0.4553) and Srem F = 0.342771 (p=0.5994) suggest that the null hypothesis on restrictions of parameters $\alpha + \beta = 1$ can be accepted and the homogeneous Cobb-Douglas model can be applied..

The influence of first variable (agricultural population) is determined by higher partial regression coefficient in Banat region than in Bačka and Srem regions. In the same time the degree of influence of second variable (investments in agriculture) is higher in Bačka region than in Banat and Srem regions.

The similar conclusions were obtained if the influence of the combination of active agricultural population (X_3) and investment in agriculture (X_2) on the achieved national income from agriculture, was considered.

The paper also considers the extended form of Cobb-Douglas function, which includes the arable areas, X_4, as well. The estimated extended model of Cobb-Douglas function in double logarithmic form for Vojvodina was:

$$\ln \hat{Y} = 5.201357 + 0.562476 \cdot \ln X_3 + 0.292956 \cdot \ln X_4 + 0.142536 \ln X_2,$$
$$(4.40^{**}) \qquad\qquad (2.05^{*}) \qquad\qquad (4.27^{**})$$

$R^2 = 0.8340$, $\overline{R}^2 = 0.8205$. On the base of nonlinear model of Cobb-Douglas function

$$\hat{Y} = 181.518395 \cdot X_3^{0.562476} \cdot X_4^{0.292956} \cdot X_2^{0.142536}$$

it may be concluded that the highest contribution to the growth of national income had agricultural population and the investment in agriculture the least.

Conclusion

Based on the indicators of the level of development (corrected national income per capita) of Serbian municipalities in 2005, it was concluded that Vojvodina, as one of three regions in Serbia, can be included in developed regions.

Grouping districts according to the share of rural population in municipalities showed that rural and mixed regions are dominant in Vojvodina.

The share of national income from agriculture in the overall national income in 2005, analyzed for the districts of Vojvodina, is high and it ranges from 29 (%) to 48 (%). For example, the share is the highest in the middle Banat district (47.5%), while it is the lowest in the western Bačka district (28.9%). In all districts except Northern and and Wester Bačka in the period 1997-2005 the share of national income from agriculture in the overall national income decreased.

The paper examines the influence of the number of agricultural population, active agricultural population, investments and arable area on the national income from agriculture, both for Vojvodina as a whole, and for its separate regions: Bačka, Banat and Srem.

The model of Cobb-Douglas production function, formulated by American economist Paul Douglas and mathematician Charles Cobb in 1928, was employed in this paper. This is a simple model which can be used to successfully model the influence of labour and capital on the achieved production, as was also confirmed by this research. In all the instances, it was determined that the influence of the demographic factors is higher compared to the analyzed economic factors.

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