UNIVERSITY OF BELGRADE
FACULTY OF AGRICULTURE

Book of Proceedings

The Seminar

AGRICULTURE AND RURAL DEVELOPMENT - CHALLENGES OF TRANSITION AND INTEGRATION PROCESSES

50th Anniversary
DEPARTMENT OF AGRICULTURAL ECONOMICS

Belgrade-Zemun, 2013.

Book of Proceedings

The Seminar
Agriculture and Rural Development - Challenges of Transition and Integration Processes

Published by Department of Agricultural Economics, Faculty of Agriculture, University of Belgrade

For the Publisher Prof Milica Petrović, dean
Faculty of Agriculture, University of Belgrade

Edited by Prof Natalija Bogdanov
Prof Simo Stevanović

Prepress Prof Simo Stevanović

ISBN: 978-86-7834-181-6

I-SQUARED DISTANCE IN ORDER OF RANKING COUNTRIES OF CENTRAL, EASTERN AND SOUTHEASTERN EUROPE ACCORDING TO THE LEVEL OF PRODUCTIVITY IN AGRICULTURE[1]

Svjetlana Janković Šoja[2], Dana Bucalo[3]

Summary

Agriculture is a specific sector of the economy, and it is a driving force of the economic development of a country, because it has got a significant share of the gross domestic product. According to the fact that the development of agriculture depends on a number of factors, in this paper we will examine the level of the productivity of agricultural production of the countries in three regions, Central, Eastern and Southeastern Europe, for the period 2005-2009. The level of agricultural productivity is represented by four agricultural indicators: intensity of agricultural production, labor productivity in agriculture, potato yield per hectare, corn yield per hectare. Policy development in the field of agriculture should be directed to the faster development of the less developed countries. In order to find them we used the I-squared distance. This method has ranked countries of the observed regions on the basis of the average values of mentioned indicators.

Key words: *ranking, I-squared distance, countries of Central, Eastern and Southeastern Europe, level of agricultural productivity.*

JEL classification: *C38; O13; L26; R11;*

1. Introduction

Economic development of a country depends on its international cooperation within the region to which it belongs. Due to the fact that agriculture is one of the driving forces of the economic development, regional cooperation and

[1] This paper is the part of research activities on the project No. 179028, financed by Ministry of Education and Science of the Republic of Serbia, titled: Rural Labor Market and Rural Economy of Serbia - Income Diversification as a Tool to Overcome Rural Poverty.

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development are very important in the field of agriculture. Countries of Central, Eastern and Southeastern Europe also have different level of economic development whose cause can be found in a different level of productivity of the agricultural production. For this reason it is necessary to reconsider their level of productivity in agriculture and make some comparison.

The paper considers the productivity of the agricultural production in the countries of these regions. The main reason for this is that agriculture has a significant share of gross domestic product. Thus, in these regions there is a tendency for a faster and harmonized development; analysis of the degree of productivity of the agricultural production is of a great importance. The reason for this is that the aforementioned analysis may represent a guideline for the policy that should be directed to less developed countries. (see more *Maletic et al., 2011; Popovic and Maletic, 2007).*

Level of agricultural productivity can be viewed through several indicators, which are specific and unique and each of them measures a level of productivity in its own way (see more *Bukvić, 1986; Maletić and Popović, 2011*). The selection of indicators has been made, taking into account the investigations carried out by Bogdanov et al. (2012) in which they researched the structural changes in agriculture of Serbia. Structural changes have been observed through four dimensions, and one of them is the performance of productivity. For consideration in productivity as a measure of productivity in agriculture, in this paper we analyze the following indicators: intensity of agriculture production, labor productivity in agriculture, potato yield per hectare and corn yield per hectare. The last two indicators are there to give a picture of the level of yields of agricultural crops, which in the above-mentioned survey partly describe the performance of productivity. This paper analyzes the yields of potatoes and corn crops because they are present in all observed countries.

The aim of this paper is that the countries of Central, Eastern and Southeastern Europe should be ranked according to the level of development of agriculture, taking into account the average values of the analyzed agricultural indicators for the period 2005-2009. For this purpose, we used the I-squared distance method.

2. Materials and Methods

The paper considers the level of productivity of agricultural production in the Central, Eastern and Southeastern Europe for a five-year period, 2005-2009. For the end of the period we took the 2009., because the data were not available for all indicators of all the countries for the year after. Data were taken from the site's: WORLD BANK, UNDATA (http://databank.worldbank.org/ddp/home.do; http://data.un.org/).

According to the geographical division of Europe, following countries belong to Central Europe: Austria, Czech Republic, Germany, Hungary, Poland, the Slovak Republic, Switzerland and Liechtenstein. However, the analysis does not include the last country, Liechtenstein, because there were no available data for this country. Eastern Europe includes countries: Belarus, Estonia, Latvia, Lithuania, Moldova, Ukraine and Russia partially. Data for Russia were available only for the country as a whole, so parts of Russia in the Eastern Europe were not taken into consideration. Estonia and Latvia were also omitted from the analysis because the data for the variable corn yield were not available for these countries. Southeast Europe is analyzed in its entirety: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Montenegro, Romania, Serbia, Slovenia and Turkey.

The indicators that were chosen to represent the level of productivity of agriculture are:

- *intensity of agriculture production*, which is the agricultural value added on 1 ha of agricultural land (X_1);
- *labor productivity in agriculture*, which is the agricultural value added per a worker (X_2);
- *potato yield expressed in kg per hectare* (X_3);
- *corn yield expressed in kg per hectare* (X_4);

The method that applied for the purpose of ranking countries according to the level of productivity of agricultural production is I-squared distance. Value of the I-squared distance is calculated for each country of Central, Eastern and Southeastern Europe, according to the formula (*Ivanović, 1963; Lakić and Maletić,1996*):

$$D^2(r,s) = \sum_{i=1}^{k} \frac{d_i^2(r,s)}{\sigma_i^2} \prod_{j=1}^{i-1} \left(1 - r_{ji.12...j-1}^2\right) \tag{1}$$

where

$$d_i = \left| x_{ir} - x_i^- \right|,\ i = 1,2,...,k \tag{2}$$

represents discriminatory effect of the indicator X_i of the observed country and the fictive unit X_i^-, which is, in this case, defined by the minimum values for each observed indikator, σ_i is standard deviation of indicator X_i, and r_{ij} is correlation coefficient between indicators X_i and X_j. Due to the definition of a fictive unit,

the country with the largest value of the I-squared distance has the highest level of productivity of the agricultural production.

3. Results and Discussion

Descriptive statistics of indicators that have been selected to determine the level of agricultural productivity of individual countries is presented in Table 1. The analysis includes the average values of indicators for the five-year period, 2005-2009.

Table 1: Descriptive statistics of the observed indicators of agricultural

Indicators	Min value	Max value	Average value	Stand. deviation	Coefficient of variation (%)
X_1	203,95	3318,32	1082,80	749,94	69,26
X_2	1391,12	59152,04	10804,87	13181,32	121,99
X_3	90156,80	417422,40	199835,11	91076,86	45,58
X_4	26836,20	102952,60	59424,85	23258,72	39,14

Source: authors' calculations

Table 1 points to the high value of the coefficient of variation of the observed indicators which means that the values of indicators vary by country, so we can conclude that the data are non homogeneous. The highest value of the coefficient of variation was noted in the indicator labor productivity in agriculture (121.99%), while the smallest variation of data between countries has indicator corn yield per hectare (39.14%). Coefficients of variation of the two remaining indicator amounts 45.58% for the indicator potato yield per hectare and 69.26% for the indicator intensity of agricultural production.

It is known that, while ranking the observation unit using the procedure I-squared distance, the most important is to choose the proper indicator that will be the primary indicator. It is also known that this subjective selection of the primary indicator is a basic weakness of this procedure. Having in mind agricultural indicators that we considered in this paper, the labor productivity, as the primary indicator, could be used as a possibility for the future development of agriculture. The order of other indicators will determine the Pearson's correlation coefficient with the primary indicator. Their values are given in Table 2.

The table 2 shows that the highest degree of dependency with chosen primary indicator has the intensity of agricultural production, then the order of indicators for calculating the I-squared distance follows:

1. Labor productivity in agriculture	1,000
2. Intensity of agriculture production	0,592
3. Potato yield per hectare	0,540
4. Corn yield per hectare	0,491

To avoid the subjective judgment of a researcher in the selection of the primary indicator, the correlation matrix is calculated in the further analysis. On this basis, the degree of correlations between all observed indicators and the values of the I-squared distance is determined. In the first iteration the correlation matrix confirmed the exactness of the subjective choice of the primary indicators and the order of the others.

Table 2: Correlation matrix of the Pearson's correlation coefficient

	Labor productivity in agriculture	**Intensity of agriculture production**	**Potato yield kg/ha**	**Corn yield kg/ha**
Labor productivity in agriculture	1,000	0,592	0,491	0,540
Intensity of agriculture production		1,000	0,691	0,752
Potato yield kg/ha			1,000	0,833
Corn yield kg/ha				1,000

Source: authors' calculations

Based on the above order of indicators and the procedure of I-squared distance, the ranking list of countries of Central, Eastern and Southeastern Europe for the five years period 2005-2009 is obtained (Table 3).

The table 3 shows that Slovenia has the best position on the ranking list, although not significantly lag behind Switzerland, which takes the second place. The next four places are taken by countries: Germany, Austria, Greece and Croatia whose values of I-squared distance are quite different. These six countries have values of I-squared distance above the average, which is 27.27% of the surveyed countries. The remaining 72.73% of the countries is below the average value of I-squared distance, and their corresponding values of I-squared distances are in the interval from 0.00 to 4.06. These countries do not show a big difference in the value of I-squared distance compared to a country that precedes them. The worst ranking country is Moldova. Taking into account the percentage of countries above and below the average value of the I-squared distance, it can be concluded that there is

a significantly higher percentage of countries that have poor productivity performance in agriculture.

Obtained ranks of countries are shown in Figure 1, on which are particularly marked regions of Central, Eastern and Southeastern Europe, in order to gain insight about the level of the agricultural production productivity of those regions.

Table 3: Ranking list of the countries of Central, Eastern and Southeastern Europe, according to the level of productivity in agriculture, 2005-2009.

Rank	Country	I-squared distance
1	Slovenia	25,51
2	Switzerland	21,61
3	Germany	13,27
4	Austria	11,36
5	Greece	7,06
6	Croatia	5,83
	AVERAGE	***4,91***
7	Turkey	4,06
8	Slovkia	3,42
9	Czech Rep.	3,39
10	Albania	3,17
11	Hungary	2,66
12	Poland	1,60
13	Bosnia and Herzegovina	1,03
14	Belorus	0,75
15	Romania	0,74
16,5	Macedonia,FYR	0,68
16,5	Bulgaria	0,68
18	Serbia	0,52
19,5	Lithuania	0,28
19,5	Ukraine	0,28
21	Montenegro	0,21
22	Moldova	0,00

Source: authors' calculations

Looking at the image of the regions with the corresponding ranks of countries leads to interesting conclusions. Most of the countries that are better placed on the ranking list belong to the boundary of the regions Central Europe and Southeastern Europe. These are mostly countries that have access to the sea, except Switzerland and Austria. In the region of Central Europe, Switzerland stands out as the country with the highest level of agricultural productivity while the position of Poland is the worst. The top-ranked country in the region of Southeast Europe is Slovenia. It is also the best positioned country when one considers all regions. The worst ranking country in the region is Montenegro. Finally, there is the region of Eastern Europe, with the countries that are generally badly ranked. Best rank has Belarus, which is on the fourteenth place, and the worst rank has Moldova, which is also at the last place when we look all three regions together.

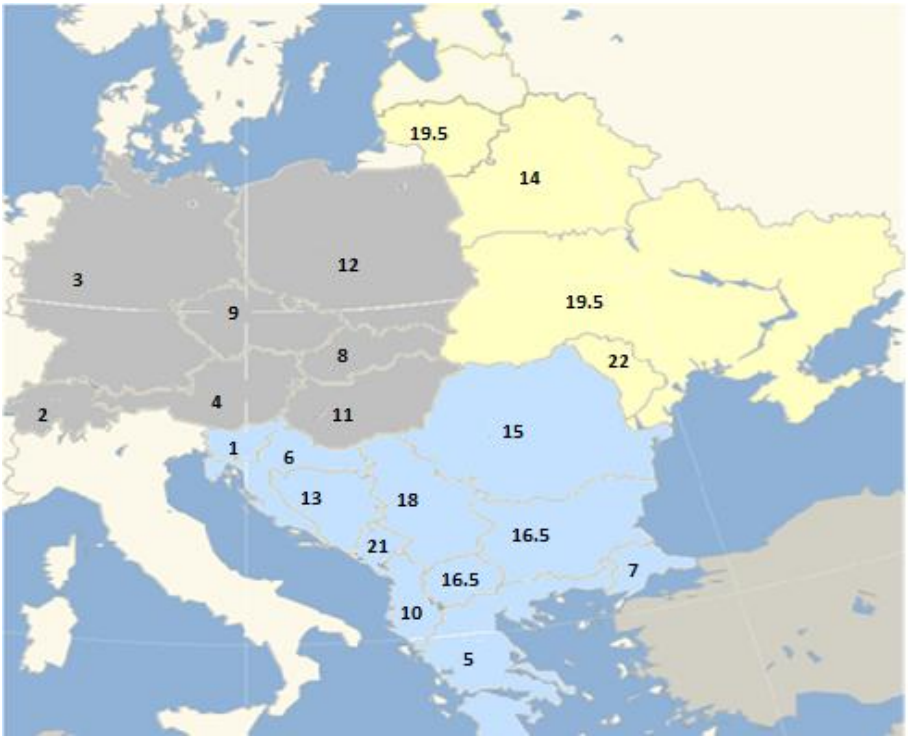

Figure 1 Central (gray), Eastern (yellow) and Southeast (blue) Europe with corresponding ranks for each country

4. Conclusion

One of the significant problems at the level of a region is the unbalanced economic development of the countries which belong to it. For this reason and for coherent development of the observed regions, special attention should be paid to the faster development of the countries with a low level of economic development. In order to identify the countries in Central, Eastern and Southeastern Europe, which could potentially have slower economic growth due to the lower level of production in agriculture, the procedure of I- squared distance was applied.

Ranking the countries of the mentioned regions based on the average values of selected agricultural indicators in the period 2005-2009, it is concluded that more than one-third, precisely, six surveyed countries have values of the I-squared distance above the average. Slovenia has the first position and the rest of the countries have very different values of the I-squared distance. The remaining 16 countries have values of the I-squared distance below the average and these values do not differ significantly and a lot. Moldova is a country with the lowest rank.

It is interesting to note that Slovenia as the best positioned country territory is much smaller than the lowest-ranking countries, Moldova. Also, Slovenia, on average, for the observed period, owns 80.10% less agricultural land than Moldova. As a result, we can conclude that despite the availability of human and land resources in agriculture, an important role is played by the degree of their utilization, as well as the way they are used with other agricultural resources.

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