Analysis of Productivity of Distribution Trade of Selective Countries of the European Union, Russia and Serbia Based on the OCRA Method

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Abstract

Recently, as it is known, the measurement of market performance of sheep companies is increasingly performed on the basis of multi-criteria analysis. With this in mind, this paper analyzes the productivity of distribution trade of selective countries of the European Union, Russia and Serbia on the basis of the OCRA method, and in this context, adequate measures for improvement in the future are proposed. Obtained results of empirical research on the productivity of distribution trade of selective countries of the European Union, Russia and Serbia using the OCRA method show that Germany is in the first place. Then they follow in order: France, Italy, Poland, Netherlands, Slovenia, Russia, Estonia, Croatia and Serbia. The productivity of distribution trade in Russia is lower compared to Germany, France and Italy. The productivity of distribution trade in Serbia is at a lower level compared to the analyzed countries of the European Union, Russia, and countries in the region (i.e. Slovenia and Croatia). This positioning of the distribution trade of the selective countries of the European Union, Russia and Serbia in terms of productivity was influenced by numerous macro and micro factors (economic climate, living standard, private label, sale of organic products, digitalization of business and others). In order to improve the productivity of the distribution trade of the respective countries in the future, it is necessary to manage human capital, investments, sales and profits as efficiently as possible.

Keywords: *productivity, distribution trade, European Union, Russia, Serbia, determinants, OCRA method*

JEL classification: L81, M31, M41, O32
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1. Introduction

The problem of measuring the productivity of distribution trade on the basis of multi-criteria analysis is very current, complex and significant (Berman, 2018; Levy, 2019). Given that, the *subject* of research in this paper is the analysis of the productivity of distribution trade of selective countries of the European Union, Russia and Serbia based on the OCRA method. The *aim* and purpose of this is that the data problems as complex analysis and propose appropriate measures to improve the productivity of the selective distribution of trade of the European Union, Russia

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and Serbia in the future. This, among other things, reflects the scientific and professional contribution of this paper.

Recently, as it is known, an increasingly rich *literature* is dedicated to the analysis of the efficiency of companies from different economic sectors based on the OCRA method. Unlike the application of AHP and TOPSIS methods, however, there are very few works of this type from the trade sector (Ersoy, 2017; Lukic, 2011, 2019, 2020a, b, c, d, e, 2021a, b, c; Gaur, 2020, Cristache, N, 2019). As far as we know, there is no complete work in the literature dedicated to the analysis of the productivity of distribution trade based on the OCRA method. In this paper, following the example of contemporary literature, for the first time the analysis of the productivity of distribution trade is performed using the OCRA method. And that, among other things, reflects the scientific and professional contribution of this paper.

Research through the literature in this paper serves as a theoretical-methodological and empirical basis for a proper analysis of the productivity of distribution trade of selective countries of the European Union, Russia and Serbia on the basis of the OCRA method. This is certainly in the function of improving their productivity in the future by taking adequate measures.

The basic *hypothesis* of the research in this paper is that continuous monitoring of the productivity of distribution trade is a precondition for improvement in the future: in our case, the selective countries of the European Union, Russia and Serbia. This facilitates and indicates what adequate measures should be taken to create the target productivity of the distribution trade of the respective countries.

In that, in the *methodological* sense of the word, the application of the OCRA method has a significant role.

The required *empirical data* were collected from Eurostat, the Russian Statistical Yearbook 2020 and the Business Registers Agency of the Republic of Serbia. They are "manufactured" in accordance with relevant international standards. In terms of international comparability, there are no restrictions in this regard.

2. OCRA method

The OCRA (*Operational Competitiveness Rating*) method was proposed by Parkan (1994) and further developed by Parkan and Wu (1997, 1999, 2000). Originally, this method was developed to measure the relative performance of a set of production units, whereby resources are expended to create value-added outputs (Chatterjee, 2012, Gabor M.R. et al, 2021). It was later used to solve other different problems of multi-criteria decision making. The OCRA method is based on the application of an intuitive approach incorporating the preferences of the decision maker regarding the relative importance of the criteria (Parkan, 1997). The main advantage of the OCRA method is that it can be applied in MCDM (Multiple Criteria Decision Making) situations where the relative weights of the criteria depend on the alternatives, and different weights are assigned to the criteria for different

alternatives, given that some of the criteria not applicable to all alternatives, etc. (Chatterjee, 2012). The basic idea of the OCRA method is to perform an independent evaluation of the alternative against the benefit and cost criteria and, finally, to combine the two aggregate scores to obtain a competitive score, which helps the decision maker not to lose information during the decision-making process (Madic, 2015). The procedure of the improved OCRA method is as follows (Parkan, 2000; Chatterjee, 2012; Liu, 2013; Stanujkic, 2017):

Step 1: Calculate the aggregate performance estimate for the cost criterion as follows:

$$\overline{I}_i = \sum_{j \in \Omega_{min}} w_j \frac{max_j x_{ij} - x_{ij}}{min_j x_{ij}} \in [-1,1], \qquad (1)$$

where $\overline{I}_i$ denotes the aggregate performance rating of the alternative *i*, obtained on the basis of the cost (Input) criterion, x_{ij} denotes the performance rating of the alternative *i* with respect to the *j*-th criterion, and Ω_{min} is a set of cost (minimization) criteria.

Based on Lui et al (2013), the previous equation can be replaced by the following:

$$\overline{I}_i = \sum_{j \in \Omega_{min}} w_j \frac{max_j x_{ij} - x_{ij}}{max_j x_{ij} - min_j x_{ij}} \in [-1,1]. \qquad (2)$$

Step 2: Calculate the linear performance estimate for the cost criterion as follows:

$$\overline{\overline{I}}_i = \overline{I}_i - min_i \overline{I}_i, \qquad (3)$$

where it $\overline{\overline{I}}_i$ denotes a linear performance estimate of alternative *i*, obtained on the basis of a cost criterion.

Linear scaling in the OCRA method was performed with the aim of assigning a score of zero as the least desirable alternative.

Step 3: Calculate the aggregate performance score with respect to the benefit criterion as follows:

$$\overline{O}_i = \sum_{j \in \Omega_{max}} w_j \frac{x_{ij} - min_j x_{ij}}{min_j x_{ij}} \in [-1,1], \qquad (4)$$

where it $\overline{O}_i$ denotes the aggregate performance evaluation of the alternative *i*, obtained on the basis of the benefit (Output) criterion *i*, Ω_{max} is a set of benefit (maximization) criteria.

Based on Louis et al. (2013), the previous equation can be replaced by the following equation:

$$\overline{O}_i = \sum_{j \in \Omega_{max}} w_j \frac{x_{ij} - min_j x_{ij}}{max_j x_{ij} - min_j x_{ij}} \in [-1,1], \qquad (5)$$

Step 4: Calculate the linear performance score for the benefit criterion as follows:

$$\bar{\bar{O}}_i = \overline{O}_i - min_i \overline{O}_i, \qquad (6)$$

where it $\bar{\bar{O}}_i$ denotes a linear performance evaluation of alternative *i*, obtained on the basis of a benefit criterion.

Step 5: Calculate the global performance score as follows:

$$P_i = \bar{\bar{I}}_i + \bar{\bar{O}}_i - \min\left(\bar{\bar{I}}_i + \bar{\bar{O}}_i\right), \qquad (7)$$

where *Pi* denotes the global performance rating of alternative *i*.

Step 6: Select the most desirable alternative. Based on OCRA method alternative to the highest value of P_i is the most desirable.

The calculation procedure of the OCRA method is based on the use of the distance from the least desirable performance criteria, i.e. $max_j\, x_{ij} - x_{ij}$ for cost criteria and $x_{ij} - min_j\, x_{ij}$ for benefit criteria. This indicates a certain similarity with the TOPSIS and VIKOR methods. Nevertheless, the OCRA method has its own specifics: The specific normalization procedure is shown in equations (1) and (3). Compared to conventional normalization procedures, the normalization procedure in the conventional OCRA method does not allow the values of the normalized performance score to always belong to the interval [0,1], which in certain cases may be greater than one. An improvement in the OCRA method was achieved by replacing equations (1) and (4) with equations (2) and (5). This allows normalized performance scores to always belong to the interval [0,1].

3. Analytical hierarchical process (AHP) method

In this paper, for the purposes of applying the OCRA method in evaluating the productivity of distribution trade of selective countries of the European Union, Russia and Serbia, weight coefficients are determined on the basis of AHP

(*Analytical Hierarchical Process*) method. With this in mind, we will briefly review the theoretical characteristics of the AHP method.

The Analytical Hierarchical Process (AHP) method takes place through the following steps (Saaty, 2008):

Step 1: Forming a matrix of comparison pairs

$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \quad (8)$$

Step 2: Normalize the matrix of comparison pairs

$$a_{ij}^{*} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}, i, j = 1, \ldots, n \quad (9)$$

Step 3: Determining the relative importance, i.e. vector weight

$$w_i = \frac{\sum_{i=1}^{n} a_{ij}^{*}}{n}, i, j = 1, \ldots, n \quad (10)$$

Consistency index - CI (consistency index) is a measure of deviation *n* from λ_{max} and can be represented by the following formula:

$$I = \frac{\lambda_{max} - n}{n} \quad (11)$$

If CI <0,1 the estimated values of the coefficients a_{ij} are consistent, and the deviation λ_{max} of *n* is negligible. This means, in other words, that the AHP method accepts an inconsistency of less than 10%.

Using the consistency index, the consistency ratio CR = CI / RI can be calculated, where RI is a random index.

4. Estimation of productivity of distribution trade of selective countries of the European Union, Russia and Serbia based on OCRA method

When measuring the productivity of distribution trade in selective countries of the European Union, Russia and Serbia using the OCRA method, the following criteria were taken: C1 - number of employees, C2 - personnel costs per employee, C3 - turnover per employee, C4 - investments per employee and C5 - gross operating surplus / turnover. Alternative countries were observed: A1 - Germany, A2 - Estonia, A3 - France, A4 - Croatia, A5 - Italy, A6 - Netherlands, A7 - Poland, A8 - Slovenia,

A9 - Russia and A10 – Serbia. The obtained results are shown in the tables below, as well as graphically.

Table 1 shows the initial data for measuring the productivity of distribution trade of selective countries of the European Union, Russia and Serbia for 2018 based on the OCRA method.

Table 1. Initial data

	Number of employees	Personnel costs per employee (in thousands of euros)	Turnover per employee (in thousands of euros)	Investments per employee (in thousands of euros)	Gross operating surplus / turnover (%)
Germany	6524359	32.9	311.5	4.9	6.0
Estonia	93814	17.8	299.3	3.8	4.3
France	3365801	45.4	402.5	7.0	3.4
Croatia	232488	13.8	157.8	2.5	4.4
Italy	3415751	34.7	292.7	4.3	6.5
Netherlands	1562384	33.3	441.7	4.4	6.2
Poland	2390479	12.5	175.6	3.0	5.9
Slovenia	120141	24.0	172.4	5.7	5.3
Russia *	453900	10.1	150.1	1.4	7.3
Serbia *	262523	7.3	123.9	1.9	4.5

Note: * Author's calculation for Russia and Serbia, except for the number of employees. The number of employees is expressed in whole numbers

Source: Eurostat, Russian Statistical Yearbook. 2020: Stat.sb./Rosstat. - R76 M., 2020 - 700 pp., and the Agency for Business Register of the Republic of Serbia

Table 2 shows the statistics of the initial data.

Table 2. Statistics

Statistics						
		Number of employees	Personnel costs per employee	Turnover per employee	Investments per employee	Gross operating surplus / turnover
N	Valid	10	10	10	10	10
	Missing	0	0	0	0	0
Mean		1842164.0000	23.1800	252.7500	3.8900	5.3800
Std. Error of Mean		667792.48560	4.05279	35.57539	.55065	.38146
Median		1008142.0000	20.9000	234.1500	4.0500	5.6000
Std. Deviation		2111745.25900	12.81603	112.49925	1.74130	1.20628
Skewness		1.312	.397	.528	.277	-.097
Std. Error of Skewness		.687	.687	.687	.687	.687
Kurtosis		1.445	-1.142	-1.148	-.448	-.826
Std. Error of Kurtosis		1.334	1.334	1.334	1.334	1.334
Minimum		93814.00	7.30	123.90	1.40	3.40
Maximum		6524359.00	45.40	441.70	7.00	7.30

Note: Author's calculation using the SPSS software program

Below average (Median 5,6000) gross operating surplus / turnover was therefore achieved by Estonia, France, Croatia and Serbia.

Table 3 shows a nonparametric test of statistical variables.

Table 3. NPar Tests

NPar Tests	
Ranks	
	Mean Rank
Number of employees	5.00
Personnel costs per employee	3.00
Turnover per employee	4.00
Investments per employee	1.20
Gross operating surplus / turnover	1.80
Test Statistics[a]	
N	10
Chi-Square	38.720
df	4
Asymp. Sig.	.000
a. Friedman Test	

Note: Author's calculation using the SPSS software program

In the present case, therefore, the null hypothesis is rejected (Asymp. Sig. .000 < .05). There are significant statistical differences between the observed variables.

Table 4 shows the correlation matrix of the initial data.

Table 4. Correlation matrix

Correlations						
		1	**2**	**3**	**4**	**5**
1 Number of employees	Pearson Correlation	1	.637 *	.480	.464	.176
	Sig. (2-tailed)		.048	.160	.177	.627
	N	10	10	10	10	10
2 Personnel costs per employee	Pearson Correlation	.637 *	1	.852 **	.884 **	-.133
	Sig. (2-tailed)	.048		.002	.001	.714
	N	10	10	10	10	10

Correlations						
		1	**2**	**3**	**4**	**5**
3 Turnover per employee	Pearson Correlation	.480	.852 **	1	.681 *	-.111
	Sig. (2-tailed)	.160	.002		.030	.761
	N	10	10	10	10	10
4 Investments per employee	Pearson Correlation	.464	.884 **	.681 *	1	-.361
	Sig. (2-tailed)	.177	.001	.030		.305
	N	10	10	10	10	10
5 Gross operating surplus / turnover	Pearson Correlation	.176	-.133	-.111	-.361	1
	Sig. (2-tailed)	.627	.714	.761	.305	
	N	10	10	10	10	10
*. Correlation is significant at the 0.05 level (2-tailed).						
**. Correlation is significant at the 0.01 level (2-tailed).						

Note: Author's calculation using the SPSS software program

There is a significant correlation to the level of statistical significance between personnel costs and, investment and trade. This means, in other words, that investing in human resources and innovations can significantly increase the productivity of distribution trade in the observed countries of the European Union, Russia and Serbia.

The weighting coefficients of the criteria were determined using the AHP (Analytical Hierarchical Process) method (Saaty, 2008). They are shown in Table 5, as well as in Figure 1.

Table 5. Criterion weighting coefficients

Criterion	Weights	+/-
Number of employees	8.9%	4.3%
Personnel costs per employee	11.2%	3.4%
Turnover per employee	18.8%	4.9%
Investments per employee	27.8%	7.5%
Gross operating surplus / turnover	33.9%	12.4%
Consistency Ratio	0.37	

Note: Author's calculation using AHPSoftware-Excel

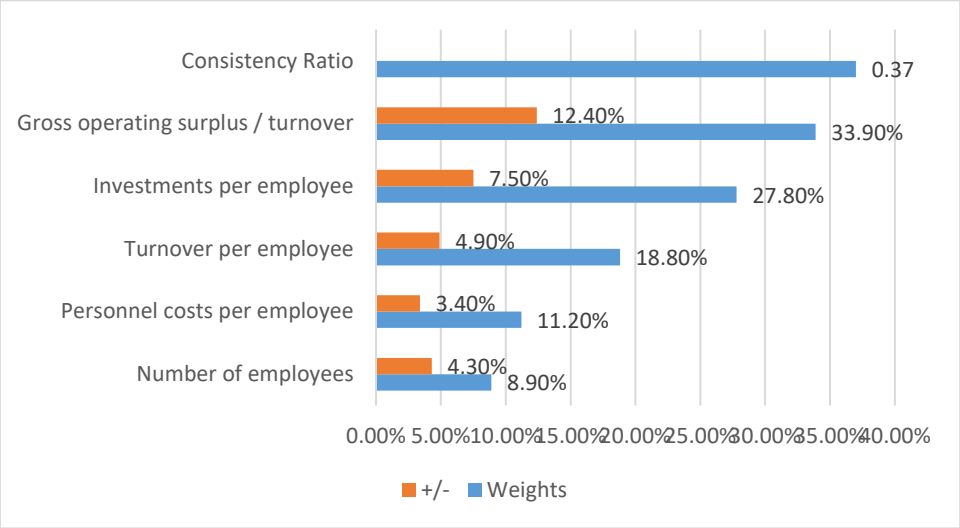

Figure 1. Weighting coefficients of the criteria
Source: Author's picture

Therefore, in terms of importance, the criterion gross operating surplus / turnover is in the first place. The criteria are as follows: investments per employee, turnover per employee, personnel costs per employee and number of employees. The productivity of distribution trade of selective countries of the European Union, Russia and Serbia can therefore be significantly increased by more efficient management of profit, investments, sales, earnings and the number of employees.

In Table 6 the initial decision matrix is shown.

Table 6. Initial Matrix

Initial Matrix					
weights of criteria	0.089	0.112	0.188	0.272	0.339
kind of criteria	1	-1	1	1	1
	C1	**C2**	**C3**	**C4**	**C5**
A1	6524359	32.9	311.5	4.9	6
A2	93814	17.8	299.3	3.8	4.3
A3	3365801	45.4	402.5	7	3.4
A4	232488	13.8	157.8	2.5	4.4
A5	3415751	34.7	292.7	4.3	6.5
A6	1562384	33.3	441.7	4.4	6.2
A7	2390479	12.5	175.6	3	5.9
A8	120141	24	172.4	5.7	5.3
A9	453900	10.1	150.1	1.4	7.3
A10	262523	7.3	123.9	1.9	4.5
MAX	6524359	45.4	441.7	7	7.3
MIN	93814	7.3	123.9	1.4	3.4

Note: Author's calculation using OCRASoftware-Excel

Table 7 shows the assessment of preferences in relation to cost criteria.

Table 7. Preference Ratings with respect to Non-Beneficial Criteria

Preference Ratings with respect to Non-Beneficial Criteria							
	C1	C2	C3	C4	C5	Measure of Relative Performance	Linear Preference Rating
A1	0.0000	0.1918	0.0000	0.0000	0.0000	0.1918	0.1918
A2	0.0000	0.4235	0.0000	0.0000	0.0000	0.4235	0.4235
A3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
A4	0.0000	0.4848	0.0000	0.0000	0.0000	0.4848	0.4848
A5	0.0000	0.1642	0.0000	0.0000	0.0000	0.1642	0.1642
A6	0.0000	0.1856	0.0000	0.0000	0.0000	0.1856	0.1856
A7	0.0000	0.5048	0.0000	0.0000	0.0000	0.5048	0.5048
A8	0.0000	0.3283	0.0000	0.0000	0.0000	0.3283	0.3283
A9	0.0000	0.5416	0.0000	0.0000	0.0000	0.5416	0.5416
A10	0.0000	0.5845	0.0000	0.0000	0.0000	0.5845	0.5845
						0.0000	
						MIN	

Note: Author's calculation using OCRASoftware-Excel

In Table 8 the evaluation of preferences in relation to income criteria is presented.

Table 8. Preference Ratings with respect to Beneficial Criteria

Preference Ratings with respect to Beneficial Criteria							
	C1	C2	C3	C4	C5	Measure o Relative Performance	Linear Preference Rating
A1	6.1006	0.0000	0.2847	0.6800	0.2592	7.3245	6.9576
A2	0.0000	0.0000	0.2661	0.4663	0.0897	0.8222	0.4553
A3	3.1041	0.0000	0.4227	1.0880	0.0000	4.6148	4.2480
A4	0.1316	0.0000	0.0514	0.2137	0.0997	0.4964	0.1295
A5	3.1515	0.0000	0.2561	0.5634	0.3091	4.2801	3.9132
A6	1.3932	0.0000	0.4822	0.5829	0.2792	2.7375	2.3706
A7	2.1788	0.0000	0.0784	0.3109	0.2493	2.8174	2.4505
A8	0.0250	0.0000	0.0736	0.8354	0.1894	1.1234	0.7566

Preference Ratings with respect to Beneficial Criteria							
	C1	C2	C3	C4	C5	Measure o Relative Performance	Linear Preference Rating
A9	0.3416	0.0000	0.0398	0.0000	0.3889	0.7702	0.4033
A10	0.1601	0.0000	0.0000	0.0971	0.1097	0.3669	0.0000
						0.3669	
						MIN	

Note: Author's calculation using OCRASoftware-Excel

In Table 9 and Figure 2 global preference (P) and ranking of alternatives are shown.

Table 9. Overall preference and ranking alternatives

	ALTERNATIVES						Overall Preference (P)	Ranking
Germany	A1	0.1918	0.1918	7.3245	6.9576	7.1494	6.5648	1
Estonia	A2	0.4235	0.4235	0.8222	0.4553	0.8787	0.2942	8
France	A3	0.0000	0.0000	4.6148	4.2480	4.2480	3.6634	2
Croatia	A4	0.4848	0.4848	0.4964	0.1295	0.6144	0.0298	9
Italy	A5	0.1642	0.1642	4.2801	3.9132	4.0774	3.4929	3
Netherlands	A6	0.1856	0.1856	2.7375	2.3706	2.5562	1.9717	5
Poland	A7	0.5048	0.5048	2.8174	2.4505	2.9553	2.3707	4
Slovenia	A8	0.3283	0.3283	1.1234	0.7566	1.0849	0.5003	6
Russia	A9	0.5416	0.5416	0.7702	0.4033	0.9449	0.3604	7
Serbia	A10	0.5845	0.5845	0.3669	0.0000	0.5845	0.0000	10

Note: Author's calculation using OCRASoftware-Excel

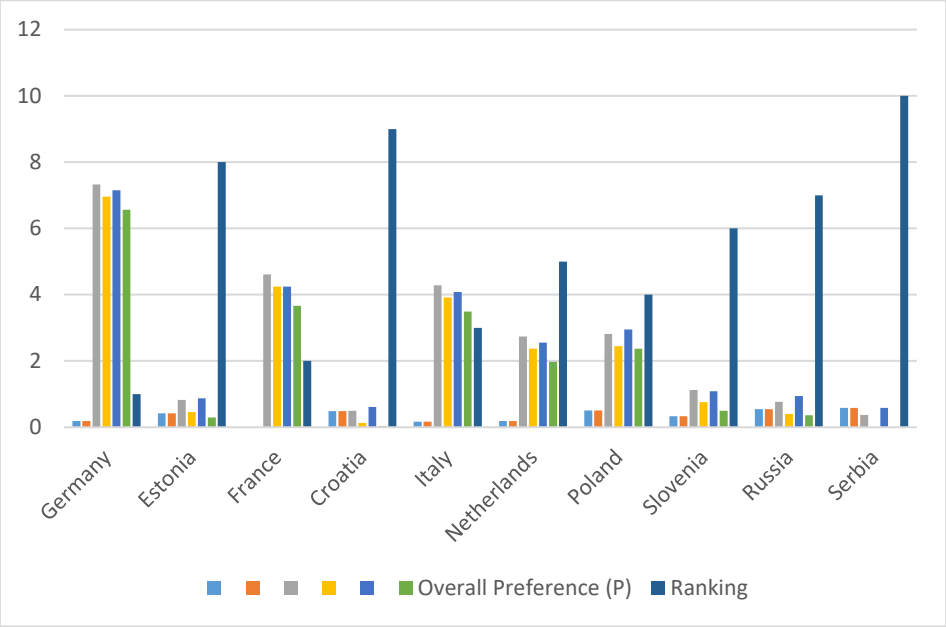

Figure 2. Overall preference and ranking alternatives
Source: Author's picture

The obtained results of the empirical research of the productivity of the distribution trade of the selective countries of the European Union, Russia and Serbia show that Germany is in the first place. Then they follow in order: France, Italy, Poland, Netherlands, Slovenia, Russia, Estonia, Croatia and Serbia. The productivity of distribution trade in Russia is lower compared to Germany, France and Italy. The productivity of distribution trade in Serbia is at a lower level in relation to the observed countries of the European Union, Russia and the countries in the region, i.e. Slovenia and Croatia. This positioning of distribution trade in selective countries of the European Union, Russia and Serbia in terms of productivity was influenced by numerous macro and micro factors, such as: economic climate, living standard, political stability, application of new business concepts (private label, sale of organic products, multichannel sales), product category management, customer management, cost management, Japanese business philosophy, etc.), business digitization and others.

Based on the above, it can be stated that the OCRA method provides a realistic basis for assessing the efficiency of distribution trade. This enables more efficient management of the distribution trade performance by timely undertaking appropriate organizational-technical, managerial and other measures.

5. Conclusion

The importance of the criterion in the first place is the criterion of gross operating surplus / turnover. The criteria are as follows: investments per employee,

turnover per employee, personnel costs per employee and number of employees. The productivity of distribution trade of selective countries of the European Union, Russia and Serbia can be significantly increased by more efficient management of profit (i.e. adequate control of costs and sales revenues).

The obtained results of the empirical research of the productivity of the distribution trade of the selective countries of the European Union, Russia and Serbia show that Germany is in the first place. Then they follow in order: France, Italy, Poland, Netherlands, Slovenia, Russia, Estonia, Croatia and Serbia. The productivity of distribution trade in Russia is lower compared to Germany, France and Italy. The productivity of distribution trade in Serbia is at a lower level compared to the analyzed countries of the European Union, Russia, Slovenia and Croatia. This positioning of the distribution trade of selective countries of the European Union, Russia and Serbia in terms of productivity was influenced by numerous macro and micro factors: economic climate, living standard, political stability, application of new business concepts (private label, sale of organic products, multichannel sales), digitalization of the entire business and others.

In order to improve the productivity of the distribution trade of the observed countries in the future, it is necessary to manage human capital, investments, sales and profits as efficiently as possible.

The OCRA method therefore provides an adequate basis for the efficient performance management of distribution trade. For these reasons, we recommend it, especially in combination with other methods of multi-criteria analysis.

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