Application of the REF Method in the Evaluation of Trade Efficiency in Serbia

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Abstract

The issue of trade efficiency analysis is very challenging, continuously current, significant and complex due to its specificity. In doing so, different research methodologies can be used: research analysis, DEA analysis and the REF method. In this paper, the efficiency of trade in Serbia is analyzed based on the REF-III method. In the specific case, in the period 2015-2021. the best efficiency of trade in Serbia was achieved in 2019. The following are: 2018, 2017, 2016, 2015, 2021 and 2020. In the observed period, the efficiency of trade in Serbia continuously increased from year to year until 2019. In 2021, compared to 2020, slightly improved efficiency of trade in Serbia. The unsatisfactory efficiency of trade in Serbia in 2020 was influenced, among other things, by the epidemic of the Covid-19 virus. It is partially mitigated with electronic commerce. In any case, the target efficiency of trade in Serbia can be achieved, among other things, by adequate management of human resources, assets, capital, sales, costs and profit. The REF-III method plays a significant role in this. It indicates which alternative is good and which is not effective. Where the efficiency is unsatisfactory, it is necessary to influence the improvement by applying adequate measures.

Keywords: *efficiency, factors, REF method, trade, Serbia*

JEL classification*:* L81, M31, M41, O32

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1. Introduction

In any case, the measurement and analysis of trade efficiency is very challenging, ongoing, significant and complex, given the specificity. In doing so, different research methodologies are used. Recently, DEA (Data Envelopment Analysis*)* models and multi-criteria decision-making methods (MCDM) have gained increasing importance. In this paper, a newer method of multi-criteria decision-making, known as the REF-III method, is used to measure and analyze the efficiency of trade in Serbia.

There is an increasing number of works in the world dedicated to the issue of measuring and analyzing the efficiency of all economic sectors, which means trade as well (Ersoy, 2017; Đalic et al., 2020; Kovač et al., 2021; Lalić, et al., 2021; Mikšić et al. al., 2021; Stankovič et al., 2020; Saaty, 2008; Trunkg, 2021; Senapati & Yager , 2019a,b; Senapati & Yager, 2020; Zavadskas et al., 2012; Chakraborty, 2014; Zavadskas, 2013a,b; Urosevic et al., 2017). This is also the case with works in Serbia (Lukic & Hadrovic, 2019, 2021, 2022; Lukic & Kozarevic, 2021; Lukic,

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2020; Lukic, 2021a,b,c,d; Lukic et al., 2020a,b; Lukic, 2022a,b,c,d, e,f,g,h 2023a,b,c,d,e,f,g,h,i,j,k,l). They provide a good theoretical, methodological and empirical basis for the analysis of trade efficiency.

Only continuous analysis of trade efficiency enables improvement in the future by applying relevant economic and other measures. In the methodological sense of the word, in addition to the DEA model, the REF-III method plays a significant role in this. In this paper, the REF-III method is used to answer the question: what is the dynamic efficiency of trade in Serbia? The Agency for Economic Registers of the Republic of Serbia provides relevant empirical data for researching the dynamics of trade efficiency in Serbia using the REF-III method.

2. Methodology

For the sake of completeness, we will briefly point out the characteristics of the REF-I, REF-III and REF-III methods side by side.

REF-I

Aytekin (2020) reviewed the REF-I (Nearest Solution to References-I) method for solving decision problems including criteria and preferences measured by different scales. Criteria measured by nominal (binary and multinomial), ordinal, interval or ratio scales can be used together, and the decision maker can use these criteria to determine a specific point, range or category as a reference in REF-I. The steps of the REF-I method are as follows (Aytekin, 2020, 2022; Aytekin & Durucasu, 2021; Kırda & Aytekin, 2023)

Step 1: Construction of the initial decision matrix

Decision matrix

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

where x_{ij} shows alternative performances, attributes, utilities, or preference values in relation to the j-th criterion, where i = 1,...,mi j = 1,...,n. Benefit criteria are j = 1,...,g. The cost criteria are j = g + 1, ...,n.

Step 2: The reference points/range of each criterion is defined by the decision maker. In the context of a decision criterion j, a reference is a specific value or range of values that a decision maker uses to evaluate alternatives. If the reference is specified as a specific value for criterion j, this value is denoted by R_j. If the reference (R_j) is marked as a range, the lower limit is expressed as (${}_1R_j$), and the upper limit is expressed as (${}_2R_j$). In a decision problem, the decision maker may consider that the distances from the reference point should be evaluated differently in certain ranges/points or in a certain direction. Values to the right of the reference point/range may seem more acceptable than values to the left, or the levels of preference values to the right and left of different ranges may differ. In the case where the value/range is considered less important than the reference, the successor value/range is called. ${}_{v}V_{j}$ denotes the successor of the value / range of criterion j. As a result, it is possible to determine many subsequent ranges/values for criterion j, where $v = 1, \ldots, q$. Decision maker determines whether the successor ranges affect the decision problem symmetrically or asymmetrically. The no-accept value (β) is determined for each value / range successor. β indicates an unacceptable value level within the successor range compared to the reference point / range. Also, β it has a value between 0 and 1. The following steps of applying the REF-I method will be detailed in the case of specifying a reference as a single value.

Step 3: Calculating the distance of the alternatives from the reference values in the qualitative criterion, which has a binary structure, using the following equation

$$d_{ij} = \begin{cases} 0, & x_{ij} = R_j \\ 1, & \text{in other cases} \end{cases} \tag{2}$$

Distances of alternatives from reference values in multinomial qualitative criteria are calculated using the following equation

$$d_{ij} = \left|\hat{x}_{j_c} - \hat{x}_{j_R}\right| \tag{3}$$

In this equation, $\hat{x}_{j_c}$ is the relative frequency value c_{th} of the category in criterion j, and $\hat{x}_{j_R}$ denotes the reference value. The relative frequency $\left(\hat{x}_{j_c}\right)$was calculated using the following equation, where y_{j_c}denotes the number of observations of category c in criterion j, and m is the number of alternatives

$$\hat{x}_{j_c} = \frac{y_{j_c}}{m} \tag{4}$$

The distances of the alternatives from the reference values in the ordinal criteria are calculated using the following equation, where S_j denotes the rank number in criterion j.

$$d_{ij} = \frac{\left|x_{ij} - R_j\right|}{S_j - 1} v\beta j \tag{5}$$

The value of not accepting intervals /points v is shown by $v\beta j$, where $v = 1, \ldots, q$.

The distance of the alternatives from the reference values in the cardinal criteria is calculated using the following equation

$$d_{ij} = \left|x_{ij} - R_j\right| v\beta j \tag{6}$$

If the inheritance point/range is not used, the non-acceptance value cannot be included or considered equal to 1 in the calculations. If the reference range is specific, instead of R_j, the nearest $_1R_j$ or $_2R_j$ according to the value of x_{ij} is used in equation (3-5-6). If the alternative is within the reference range, the distance from the reference is zero.

Step 4: Construction of the normalized decision matrix using the following equation

$$f_{ij} = \frac{d_{ij}}{\sum_{i=1}^{m} d_{ij}} \tag{7}$$

Step 5: Construction of weight normalized decision matrix using the following equation

$$h_{ij} = f_{ij} w_j \tag{8}$$

Step 6: Calculating the overall performance value using the following equation

$$U_i = \sum_{j=1}^{n} h_{ij} \tag{9}$$

Alternatives are ranked in ascending order based on *Ui* value.

REF-II

Aytekin (2020) proposed the REF-II (Nearest Solution to References-II) method to solve the rank change problem as well as the requirement to recalculate the current alternatives when a new alternative is added or removed from the decision problem. On the other hand, the REF-II method, as with most multi-criteria decision-making methods, requires criterions that have a cardinal structure. The steps of applying the REF-II method are as follows (Aytekin, 2020, 2021, 2022).

Steps 1-2 apply as defined in REF-I

Columns 3-4: Calculation of the normalized distance value using the following equation

$$f_{ij} = \frac{\left|x_{ij} - R_j\right|}{\left|R_j\right| + 10^{p_j}} v\beta j \tag{10}$$

On the other hand, if the reference is specified as a range, the following equation is used for normalization

$$f_{ij} = \begin{cases} \dfrac{\left|x_{ij} - {}_1R_j\right|}{\text{maks}\left(\left|{}_1R_j\right|, \left|{}_2R_j\right|\right) + 10^{p_j}} v\beta j, & x_{ij} < {}_2R_j \\ & {}_1R_j \leq x_{ij} \leq {}_2R_j \\ \dfrac{\left|x_{ij} - {}_2R_j\right|}{\text{maks}\left(\left|{}_1R_j\right|\left|{}_2R_j\right|\right) + 10^{p_j}} v\beta j, & x_{ij} > {}_2R_j \end{cases} \tag{11}$$

Steps 5 - 7 apply as defined in REF-I. Finally, the alternatives are ranked in ascending order based on *Ui* ${}_v$alue.

REF-III

DEA is often used to assess the efficiency of institutions or individuals. However, there are some inconsistencies between the DEA-based methodologies used to rank DMUs (decision-making units) and DEA efficiency results. EATW(I)OS and OCRA are two alternative approaches for determining the efficiency ranking of DMUs. This paper proposes a new method for evaluating the efficiency of the DMU, which is based on the reference values that should be determined in the input and output criteria. The primary objective of this new approach, known as REF-III; is to evaluate the efficiency of the DMU by comparing the input and output levels. The steps for implementing REF-III are as follows:

Step 1. Defining the decision problem, which includes determining both input and output criteria, as well as specifying decision units or alternatives for efficiency analysis. The decision matrix shown in the following equation is created independently for the input and output criteria.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \begin{matrix} i = 1, \dots, m \\ j = 1, \dots, n \end{matrix} \quad (12)$$

In the equation, the performance value of alternative *i* according to criterion *j* is represented by x_{ij}.

In the following equations, *G* represents the input decision matrix, while *O* denotes the output decision matrix, where is $j = 1, \dots, g$ for the input criteria and $j = g + 1, \dots, n$ for the output criteria.

$$G = \begin{bmatrix} x_{11} & \cdots & x_{1g} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mg} \end{bmatrix} \begin{matrix} i = 1, \dots, m \\ j = 1, \dots, g \end{matrix} \quad (13)$$

$$O = \begin{bmatrix} x_{1g+1} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{mg+1} & \cdots & x_{mn} \end{bmatrix} \quad \begin{matrix} i = 1, \dots, m \\ j = g + 1, \dots, n \end{matrix} \quad (14)$$

Step 2. Determination of reference point or interval, next point or interval, and rejection value for each criterion. For the analysis of efficiency, a reference point or interval and successor points or intervals with the degree of non-acceptance of input criteria are defined in order to use resources minimally. Similarly, reference and succession points or intervals should be set for input output criteria to maximize the generation of products or outputs. Additionally, a utopian or ideal solution approach can be used to define reference and successor values or intervals independent of the decision matrix.

Step 3. Establishing the priority level of the evaluated criteria, which often differ. Subjective judgments or different techniques can be applied to determine the weight values of the criteria in REF-III. For scaling, it is important that the weights of the criteria range from 0 to 1 and that their sum is equal to 1.

Step 4. Calculating the weighted normalized distance of the alternatives from the references. In this context, different evaluations are used. Calculating the input-weighted normalized value of the distance (Φ_{ij}) from *i* -alternative in criterion *j* using the following equation, where a_{*j} denotes the value

$$\Phi_{ij} = \mathcal{W}_j \frac{|x_{ij} - a_{*j}|vBj}{\sum_{j=1}^{g}(|x_{ij} - x_{*j}|vBj)} \quad (15)$$

Determination of the output - weighted normalized value of the distance θ_{ij} from the *i* -alternative in criterion *j* using the following equation

$$\theta_{ij} = \mathcal{W}_j \frac{|x_{ij} - a_{*j}|vBj}{\sum_{j=g+1}^{n}(|x_{ij} - a_{*j}|vBj)} \quad (16)$$

a_{*j}values are determined with the following equation

$$a_{*j} = \begin{cases} R_j, & if\ the\ reference\ is\ detremined\ as\ a\ point \\ {}_1R_j, & if\ the\ reference\ is\ determined\ as\ an\ interval\ and\ x_{ij} < {}_1R_j \\ {}_2R_j, & if\ the\ reference\ is\ determined\ as\ an\ interval\ and\ x_{ij} > {}_2R_j \\ x_{ij}, & if\ the\ reference\ is\ determined\ as\ an\ interval\ and\ {}_1R_j \le x_{ij} \le {}_2R_j \end{cases} \quad (17)$$

Step 5. Calculating the input-total result (Φ_i) and the output-total result (Θ_i) for each alternative using the following equations

$$\Phi_i = \sum_{j=1}^{g} \Phi_{ij} \quad (18)$$

$$\Theta_i = \sum_{j=g+1}^{n} \theta_{ij} \quad (19)$$

Step 6. Calculating the total efficiency score distance (δ_i) using the following equation

$$\delta_i = \frac{\Theta_i}{\Phi_i} \quad (20)$$

(δ_i)represents the ratio between the total value of the output and the total value of the input. Ranking the alternatives from the least to the greatest distance of their overall efficiency results. For alternatives with utopian or ideal efficiency, (δ_i) it will be 0.

2. Results and discussion

In this paper, the criteria (C1, C2, C3, C4 and C5) are grouped into two groups. Input criteria (I) are: Number of employees, Assets and Capital. Output criteria (0) are: Sales and Net profit. The selected input-output criteria are, by nature, an adequate measure of trade efficiency. Table 1 and Figure 1 show input-output criteria, alternatives (years) and original empiric data for trade in Serbia.

Initial data

Table 1

		(I) Number of employees	(I) Assets	(I) Capital	(O) Sales	(A) Net profit
		C1	**C2**	**C3**	**C4**	**C5**
A1	2015	159621	2197931	805009	2731999	95265
A2	2016	206092	2324843	859749	3009651	105238
A3	2017	208020	2375290	920992	3172393	122727
A4	2018	219373	2524897	1007972	3361094	121816
A5	2019	222049	2682931	1073056	3608329	139409
A6	2020	227618	2837599	1183026	3664505	171010
A7	2021	234727	3166529	1318126	4754169	170703
	Statistics					
	Mean	211071.4286	2587145.7140	1023990.0000	3471734.2860	132309.7143
	Median	219373.0000	2524897.0000	1007972.0000	3361094.0000	122727.0000
	Std. Deviation	24846.36383	335816.22330	182578.22840	653584.11790	29802.93997
	The minimum	159621.00	2197931.00	805009.00	2731999.00	95265.00
	Maximum	234727.00	3166529.00	1318126.00	4754169.00	171010.00

Note: Data are expressed in millions of dinars. The number of employees is expressed in whole numbers. I – inputs. O – outputs. Author's statistics

Source: Agency for Economic Registers of the Republic of Serbia

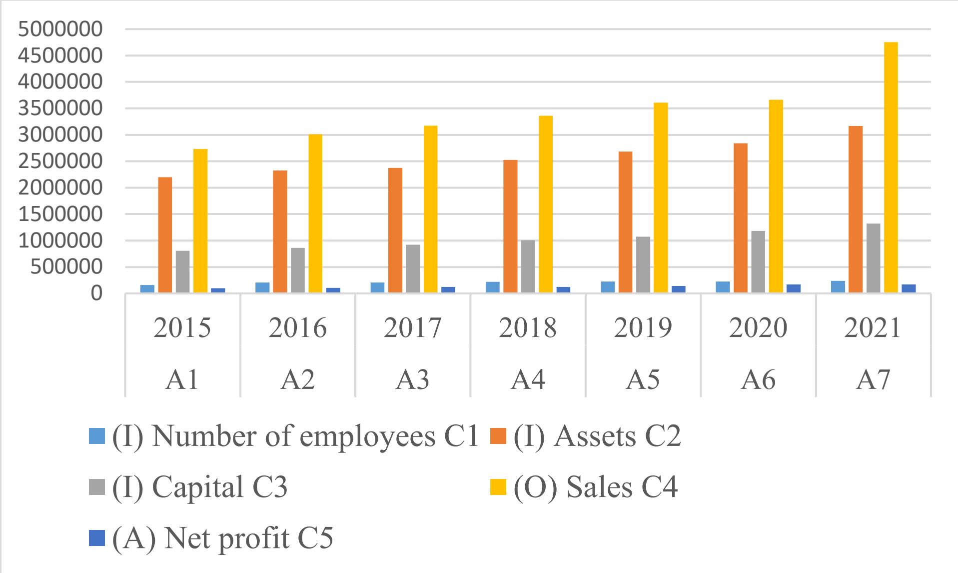

Figure 1. Input-Output criteria
Source: Author's picture

The correlation matrix of the input-output criteria is shown in Table 2. It can therefore be confirmed that in this particular case there is a significant correlation between the observed input-output criteria, at the level of statistical significance.

Correlation of input-output criteria

Table 2

Correlations						
		(I) C1	(I) C2	(I) C3	(O)C4	(O)C5
(I) C1	Pearson Correlation	1	.806 *	.823 *	.774 *	.812 *
	Sig. (2-tailed)		.029	.023	.041	.026
	N	7	7	7	7	7
(I) C2	Pearson Correlation	.806 *	1	.995 **	.975 **	.946 **
	Sig. (2-tailed)	.029		.000	.000	.001
	N	7	7	7	7	7
(I) C3	Pearson Correlation	.823 *	.995 **	1	.957 **	.965 **
	Sig. (2-tailed)	.023	.000		.001	.000
	N	7	7	7	7	7
(O)C4	Pearson Correlation	.774 *	.975 **	.957 **	1	.869 *
	Sig. (2-tailed)	.041	.000	.001		.011
	N	7	7	7	7	7
(O)C5	Pearson Correlation	.812 *	.946 **	.965 **	.869 *	1
	Sig. (2-tailed)	.026	.001	.000	.011	
	N	7	7	7	7	7
*. Correlation is significant at the 0.05 level (2-tailed).						
**. Correlation is significant at the 0.01 level (2-tailed).						

Note: Author's statistics

Table 3 shows the Friedman test.

Friedman test

Table 3

NPar Tests	
Friedman Test	
Ranks	
	Mean Rank
(I) C1	2.00
(I) C2	4.00
(I) C3	3.00
(O)C4	5.00
(O)C5	1.00 am
Test Statistics [a]	
N	7
Chi-Square	28,000
df	4
Asymp. Sig.	.000
a. Friedman Test	

Note: Author's statistics

There is therefore a significant difference between the input-output criteria (Asymp. Sig. .000).

Evaluation and weight coefficients of input-output criteria are shown in Table 4.

Evaluation and weight coefficients of the criteria

Table 4

KIND	Criteria	DM1	DM2	DM3	SUM	Wj
1	**(I) C1**	**100**	**100**	**100**	**300**	**0.25**
1	**(I) C2**	**70**	**80**	**60**	**210**	**0.17**
1	**(I) C3**	**70**	**75**	**65**	**210**	**0.17**
1	**(O)C4**	**70**	**90**	**80**	**240**	**0.20**
1	**(O)5**	**80**	**80**	**90**	**250**	**0.21**
				Total Sum	**1210**	**1**

Note: Author's calculation

In the specific case, the most important criterion is (I)C1 - the number of employees. This means, in other words, that the effective use of human resources (training, flexible employment, rewards, promotion, social and health insurance) in the trade of Serbia can influence the achievement of target efficiency.

In the following, we will present the results of the application of the REF-III method in the analysis of the efficiency of trade in Serbia for the period 2015-2021 (Table 5-9).

Decision matrix and additional information

Table 5

	Decision matrix and additional information				
	Successor Interval/Point 1 (V1)	**13000**	**4000**	**18000**	**2000**	
	β 1 for V1	**0.67**	**0.5**	**0.17**	**0.33**	
	Weight coefficients of criteria	**0.25**	**0.17**	**0.17**	**0.2**	**0.21**
	Upper bond/limit of REFERENCE	**200000.000**	**300000**	**100000**	**450000**	**150000**
	Lower bond/limit of REFERENCE	**50000.000**	**25000**	**10000**	**10000**	**40000**
	Input-Output Orientation	**Input**	**Input**	**Input**	**Output**	**Output**
		I1	**I2**	**I3**	**O1**	**O2**
2015	**A1**	159621	2197931	805009	2731999	95265
2016	**A2**	206092	2324843	859749	3009651	105238
2017	**A3**	208020	2375290	920992	3172393	122727
2018	**A4**	219373	2524897	1007972	3361094	121816
2019	**A5**	222049	2682931	1073056	3608329	139409
2020	**A6**	227618	2837599	1183026	3664505	171010
2021	**A7**	234727	3166529	1318126	4754169	170703

Notes: Research was conducted according to: References: Aytekin, A. (2022). *Çok Kriterli Karar Analisi* . Nobel Bilimsel. Aytekin, A., Korucuk, S., & Karamasa, C. (2023). Ranking countries according to logistics and international trade efficiencies via REF-III. J. Intell Manag. Decis, 2(2), 74-84.

Determining the a_{i*j} values to be taken into account in the calculation of the distances

Table 6

	Determining the a_{i*j} values to be taken into account in the calculation of the distances					
		I1	**I2**	**I3**	**O1**	**O2**
2015	**A1**	**159621.000**	**300000**	**100,000**	**450000.00**	**95265.00**
2016	**A2**	**200000.000**	**300000**	**100,000**	**450000.00**	**105238.00**
2017	**A3**	**200000.000**	**300000**	**100,000**	**450000.00**	**122727.00**
2018	**A4**	**200000.000**	**300000**	**100,000**	**450000.00**	**121816.00**
2019	**A5**	**200000.000**	**300000**	**100,000**	**450000.00**	**139409.00**
2020	**A6**	**200000.000**	**300000**	**100,000**	**450000.00**	**150000.00**
2021	**A7**	**200000.000**	**300000**	**100,000**	**450000.00**	**150000.00**

Note: Author's calculation

The distance matrix

Table 7

	The distances matrix					
		I1	**I2**	**I3**	**O1**	**O2**
2015	**A1**	**0.00**	**1897931.00**	**705009.00**	**2281999.00**	**0.00**
2016	**A2**	**6092.00**	**2024843.00**	**759749.00**	**2559651.00**	**0.00**
2017	**A3**	**8020.00**	**2075290.00**	**820992.00**	**2722393.00**	**0.00**
2018	**A4**	**19373.00**	**2224897.00**	**907972.00**	**2911094.00**	**0.00**
2019	**A5**	**22049.00**	**2382931.00**	**973056.00**	**3158329.00**	**0.00**
2020	**A6**	**27618.00**	**2537599.00**	**1083026.00**	**3214505.00**	**21010.00**
2021	**A7**	**34727.00**	**2866529.00**	**1218126.00**	**4304169.00**	**20703.00**

Note: Author's calculation

The normalized distance matrix

Table 8

	The normalized distance matrix					
		I1	**I2**	**I3**	**O1**	**O2**
2015	**A1**	**0.0000**	**0.1185**	**0.1090**	**0.1079**	**0.0000**
2016	**A2**	**0.0517**	**0.1265**	**0.1175**	**0.1210**	**0.0000**
2017	**A3**	**0.0680**	**0.1296**	**0.1269**	**0.1287**	**0.0000**
2018	**A4**	**0.1643**	**0.1390**	**0.1404**	**0.1376**	**0.0000**
2019	**A5**	**0.1870**	**0.1488**	**0.1504**	**0.1493**	**0.0000**
2020	**A6**	**0.2343**	**0.1585**	**0.1674**	**0.1520**	**0.5037**
2021	**A7**	**0.2946**	**0.1790**	**0.1883**	**0.2035**	**0.4963**

Note: Author's calculation

The weighted normalized distance matrix

Table 9

The weighted normalized distance matrix										
		I1	**I2**	**I3**	**O1**	**O2**	**Φi**	**θi**	**δ i**	**Ranking**
2015	**A1**	**0.0000**	**0.0202**	**0.0185**	**0.0216**	**0.0000**	**0.039**	**0.022**	**0.5578**	**5**
2016	**A2**	**0.0129**	**0.0215**	**0.0200**	**0.0242**	**0.0000**	**0.054**	**0.024**	**0.4450**	**4**
2017	**A3**	**0.0170**	**0.0220**	**0.0216**	**0.0257**	**0.0000**	**0.061**	**0.026**	**0.4246**	**3**
2018	**A4**	**0.0411**	**0.0236**	**0.0239**	**0.0275**	**0.0000**	**0.089**	**0.028**	**0.3108**	**2**
2019	**A5**	**0.0468**	**0.0253**	**0.0256**	**0.0299**	**0.0000**	**0.098**	**0.030**	**0.3058**	**1**
2020	**A6**	**0.0586**	**0.0269**	**0.0285**	**0.0304**	**0.1058**	**0.114**	**0.136**	**1.1946**	**7**
2021	**A7**	**0.0736**	**0.0304**	**0.0320**	**0.0407**	**0.1042**	**0.136**	**0.145**	**1.0648**	**6**

Note: Author's calculation

In this case, therefore, in the period 2015-2021. the best efficiency of trade in Serbia was achieved in 2019. Following: 2018, 2017, 2016, 2015, 2021 and 2020. In the observed period, the efficiency of trade in Serbia continuously increased from year to year from all the way to 2019. In 2021, compared to In 2020, the efficiency of trade in Serbia improved slightly. The unsatisfactory efficiency of trade in Serbia in 2020 was influenced, among other things, by the epidemic of the Covid-19 virus. It is partially mitigated with electronic commerce.

Generally speaking, the determinants of the efficiency of trade in Serbia are: geopolitical situation, economic climate, inflation, interest rate, unemployment, standard of living of the population, exchange rate, foreign direct investments, digitization of the entire business, energy crisis, concept of sustainable development (economic, social and environmental a dimension), new business models (multichannel sales - store and electronic, sales of organic products, private label, promotions, etc.), product category management, customer management, Japanese business philosophy, and others. In any case, the target efficiency of trade in Serbia can be achieved by adequate management of human resources, assets, capital, sales, costs and profit.

4. Conclusion

Research on the issue of trade efficiency in Serbia using the REF-III method shows that in the period 2015-2021. the best efficiency of trade in Serbia achieved in 2019. Next: 2018, 2017, 2016, 2015, 2021 and 2020. In the observed period, it is safe to say that the efficiency of trade in Serbia increased year after year until 2019. In 2021. compared to 2020, the efficiency of trade in Serbia improved slightly. The unsatisfactory efficiency of trade in Serbia in 2020 was influenced, among other things, by the epidemic of the Covid-19 virus. It is partially mitigated with electronic commerce.

In principle , the factors that influenced the efficiency of trade in Serbia are: geopolitical situation, economic climate, inflation, interest rate, unemployment, standard of living of the population, exchange rate, foreign direct investments, digitization of the entire business, energy crisis, concept of sustainable development (economic , social and environmental dimension), new business models (multichannel sales - store and electronic, sales of organic products, private label, promotions, etc.), product category management, customer management, Japanese business philosophy, new concepts of cost management and others . In any case, the target efficiency of trade in Serbia can be achieved by adequate management of human resources, assets, capital, sales, costs and profits. Of course, the REF-III method plays a significant role in the analysis of the efficiency of trade in Serbia. It indicates which alternatives (years) are good and which are not efficient. Where the efficiency is unsatisfactory, it is necessary to influence the improvement by applying adequate measures, depending on the character of the alternative.

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ANNEX

The distance matrix normalization scenario using the following equations

$$n_{ij} = \frac{t_{ij}}{C_j} \qquad (1)$$

$$r_{ij} = \frac{O_{ij}}{C_j} \qquad (2)$$

The distance matrix

Table 1

	The scenario when the normalization is applied via (Eq. (1) and Eq. (2) were used)					
	cj	**234,727.00**	**3,166,529.00**	**1,318,126.00**	**4,754,169.00**	**171,010.00**
	The distance matrix					
		I1	**I2**	**I3**	**O1**	**O2**
2015	**A1**	**0.00**	**1897931.00**	**705009.00**	**2281999.00**	**0.00**
2016	**A2**	**6092.00**	**2024843.00**	**759749.00**	**2559651.00**	**0.00**
2017	**A3**	**8020.00**	**2075290.00**	**820992.00**	**2722393.00**	**0.00**
2018	**A4**	**19373.00**	**2224897.00**	**907972.00**	**2911094.00**	**0.00**
2019	**A5**	**22049.00**	**2382931.00**	**973056.00**	**3158329.00**	**0.00**
2020	**A6**	**27618.00**	**2537599.00**	**1083026.00**	**3214505.00**	**21010.00**
2021	**A7**	**34727.00**	**2866529.00**	**1218126.00**	**4304169.00**	**20703.00**

Note: Author's calculation

The normalized distance matrix (Eq. (1) and Eq. (2) were used)

Table 2

	The normalized distance matrix (Eq. (29) and Eq. (31) were used)					
		I1	**I2**	**I3**	**O1**	**O2**
2015	**A1**	**0.0000**	**0.5994**	**0.5349**	**0.4800**	**0.0000**
2016	**A2**	**0.0260**	**0.6395**	**0.5764**	**0.5384**	**0.0000**
2017	**A3**	**0.0342**	**0.6554**	**0.6228**	**0.5726**	**0.0000**
2018	**A4**	**0.0825**	**0.7026**	**0.6888**	**0.6123**	**0.0000**
2019	**A5**	**0.0939**	**0.7525**	**0.7382**	**0.6643**	**0.0000**
2020	**A6**	**0.1177**	**0.8014**	**0.8216**	**0.6761**	**0.1229**
2021	**A7**	**0.1479**	**0.9053**	**0.9241**	**0.9053**	**0.1211**

Note: Author's calculation

The weighted normalized distance matrix

Table 3

	The weighted normalized distance matrix								
		I1	**I2**	**I3**	**O1**	**O2**	**Φi**	**θi**	**δ i**	**Ranking**
2015	**A1**	**0.0000**	**0.1019**	**0.0909**	**0.0960**	**0.0000**	**0.193**	**0.096**	**0.4979**	**3**
2016	**A2**	**0.0065**	**0.1087**	**0.0980**	**0.1077**	**0.0000**	**0.213**	**0.108**	**0.5051**	**4**
2017	**A3**	**0.0085**	**0.1114**	**0.1059**	**0.1145**	**0.0000**	**0.226**	**0.115**	**0.5071**	**5**
2018	**A4**	**0.0206**	**0.1194**	**0.1171**	**0.1225**	**0.0000**	**0.257**	**0.122**	**0.4762**	**1**
2019	**A5**	**0.0235**	**0.1279**	**0.1255**	**0.1329**	**0.0000**	**0.277**	**0.133**	**0.4798**	**2**
2020	**A6**	**0.0294**	**0.1362**	**0.1397**	**0.1352**	**0.0258**	**0.305**	**0.161**	**0.5274**	**6**
2021	**A7**	**0.0370**	**0.1539**	**0.1571**	**0.1811**	**0.0254**	**0.348**	**0.206**	**0.5934**	**7**

Note: Author's calculation