ORIGINAL SCIENTIFIC PAPER

Analysis of Profitability and Efficiency of Trade in Serbia

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ABSTRACT
In this paper, the profitability and efficiency of trade in Serbia are analyzed in the period 2013 - 2019. Taking into account the complexity of the analyzed issues, the research methodology is predominantly based on the strategic profit model and programming based on the DEA approach. The results of the conducted research show that the profitability and overall efficiency of Serbian trade have recently improved. The better trade performance was positively influenced by both external and internal factors, including the application of new business models based on global retailers, multichannel sales - classic and electronic, and the digitalization of the entire business.

Key words: *return on sales, return on assets, return on equity, financial indebtedness, efficiency*

JEL Classification: L81, M31, M41, O32

INTRODUCTION

Due to the importance it has for the functioning of national economies, trade is continuously researched, especially in terms of profitability and its efficiency. The subject of research in this paper is a complex analysis of the factors of profitability and efficiency of trade in Serbia. The goal and the purpose of this research is to create measures to improve the profitability and efficiency of trade in Serbia in the future, based on the current situation, by applying the strategic profit model and DEA approach. This, among other things, reflects the scientific and professional contribution of this paper. The obtained results provide a theoretical-methodological and empirical basis for further research on the treated issues, as well as for international comparative analysis.

Due to the importance of this topic, numerous papers have been written that are dedicated to measuring the performance of trade and researching the factors that significantly determine such performance, and above all profitability and efficiency (Berman, Evans & Chatterjee, 2018). A particularly rich literature has been created to evaluate the efficiency and productivity of companies in the world, including trade companies, based on DEA analysis (Malmquist, 1953; Asmild et al., 2004; Andersen & Petersen, 1993; Donthu & Yoo, 1998; Tone, 2001; Tone, 2002; Tone & Tsutsui, 2009; Tone & Tsutsui, 2010; Fare et al., 1994; Fare, Grosskopf & Roos, 1995; Moreno, 2010; Vaz, Camanho & Guimarães 2010; Wang & Lan, 2011; Moreno & Maria, 2011; Vaz & Camnho, 2012; Lau, 2013; Lee, 2013; Gandhi & Shankar, 2014; Al-Refaae, 2015; Anand & Grover, 2015; Majumdar & Asgari, 2017; Barros & Alves, 2004; Barros, 2006; Bambe, 2017; Qiu & Meng, 2017; Sarmento, Renneboog & Matos, 2017; Ko et al., 2017; Hsu, 2018; Haidar, 2018;

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Camanho, Portela & Vaz, 2009 ; Caves, Christensen & Diewert, 1982; Jorge & Suárez, 2009; Melo & Sampaio, 2018; Yu & Ramanathan, 2009; Busu, Vargas & Gherasim, 2020; Cheng, Chu & Ohlson, 2020).

However, the national literature in this area lags significantly behind (Lukic, 2018; Lazic & Domazet, 2019; Radović-Marković, Brnjas & Simović, 2019; Lukic & Hadrovic Zekic, 2019; Lukic, Hadrovic Zekic & Crnjac Milic, 2020). It can be claimed that according to our knowledge, there is no extensive study dedicated to the analysis of efficiency and productivity of trade companies in Serbia, which is predominantly based on the DEA approach. In that sense, this paper represents a special scientific-professional contribution.

The basic research hypothesis is that continuous measurement of profitability and efficiency of trade provides a basis for international comparison and its improvement by imposing appropriate measures and adequate control of internal and external factors. This setting fully refers to trade in Serbia, which is empirically investigated here primarily from the point of view of profitability and efficiency. Empirical knowledge of the legality of trade and factors that determine its performance and adequate control of key factors can significantly contribute to improving the overall profitability and efficiency of trade in Serbia in the future.

The methodology of research of the problem discussed in this paper, in accordance with the defined basic hypothesis, is based on the strategic profit model and DEA analysis. In order to transform the initial data into useful information and draw appropriate conclusions, certain statistical analysis techniques are also used here.

For the purpose of researching the profitability and efficiency of trade in Serbia, the empirical data contained in the publications and financial reports of the Business Registers Agency of the Republic of Serbia were used. They are "produced" in accordance with the relevant international standards, so there are no restrictions in terms of international comparison of the obtained research results in this paper.

RESEARCH METHODOLOGY

The research of the issues stated in this paper is based on the application of the strategic profit model and DEA analysis. In addition to the basic methods of descriptive analysis, standard techniques of correlation analysis were used in the paper.

Strategic profit model

The strategic profit model indicates the key determinants of return on assets and return on equity. Their adequate control can significantly improve returns on assets and capital.

Return on assets is determined by the formula:

$$Return\ on\ assests = \frac{Net\ profit}{Sale} \times \frac{Sale}{Assets} \tag{1}$$

The return on assets is, as can be seen from this formula, d function of the return on sales and the turnover ratio of the assets.

Return on equity is determined by the following formula:

$$Return\ on\ equity = \frac{Net\ profit}{Sale} \times \frac{Sale}{Assets} \times \frac{Assets}{Equity} \tag{2}$$

Return on equity is therefore a function of return on sales, the ratio of turnover of assets and financial indebtedness, i.e. the return on assets and financial indebtedness.

DEA models

In the context of a brief theoretical analysis of the DEA model, the CCR model and the BCC model will be presented in briefly.

The CCR model is based on a fixed or constant scale yield. This means that a proportional increase in all inputs results in the same proportional increase in all outputs. The dual of CCR efficiency is expressed as:

$Min\ \theta$

under restrictions

$\sum_{j=1}^{n} \lambda_j x_{ij}\ \leq\ \theta x_{io} \qquad i = 1 \ldots m$

$\sum_{j=1}^{n} \lambda_j y_{kj}\ \geq\ y_{ko} \qquad k = 1 \ldots s$

$\lambda_j\ \geq 0 \qquad\qquad j = 1 \ldots n$ $\hfill$ (3)

where θ the technical efficiency of DMU units is 0, λ is a dual variable for identifying comparable inefficient units. If the value of θ * is equal to one, the observed unit of DMU is technically efficient.

The concept of the CCR model was modified by the introduction of the BCC model (by Banker-Charnes-Cooper) by replacing the constant scale yield (CRS) with the variable scale yield (VRS). A DMU unit operates under a variable scale yield if the increase in input does not result in proportional changes in output. The BCC model is shown as:

$Min\ \theta$

under restrictions

$\sum_{j=1}^{n} \lambda_j x_{ij}\ \leq\ \theta x_{io} \qquad i = 1 \ldots m$

$\sum_{j=1}^{n} \lambda_j y_{kj}\ \geq\ y_{ko} \qquad k = 1 \ldots s$

$\sum_{j=1}^{n} \lambda_{j=1} = 1 \qquad j = 1 \ldots n$

$\lambda_j\ \geq 0 \qquad\qquad j = 1 \ldots n$ $\hfill$ (4)

The BCC model divides the technical efficiency (TE) obtained by the CCR model into two parts: 1) pure technical efficiency (PTE), which ignores the influence of scale size by comparing a DMU unit with units of similar scale and measures how a DMU unit uses inputs under exogenous conditions; and 2) scale efficiency (SE), which shows how scale size affects efficiency, formulated as follows:

$SE\ =\ TE\ /\ PTE$ $\hfill$ (5)

PROFITABILITY OF TRADE IN SERBIA

The original data used for the analysis of profitability and efficiency of trade in Serbia are shown in Table 1.

Table 1. Initial data for measuring the profitability and efficiency of trade in Serbia, 2013 - 2019

DMU	(I) Number of employees	(I) Earnings per employee (in thousand RSD)	(I) Assets (in thousand RSD)	(I) Equity (in 000 din) (in thousand RSD)	(O) Sale (in thousand RSD)	(O) Net profit (in thousand RSD)
2013	193210	151978	2160474	746992	2891518	89730
2014	191621	154833	2157564	761305	2594602	86955
2015	159621	164718	2197931	805009	2731999	95265
2016	206092	180367	2324843	859749	3009651	105238
2017	208020	194924	2375290	920992	3172393	122727
2018	219373	218410	2524897	1007972	3361094	121816
2019	222049	238022	2682931	1073056	3608329	139409
CAGR	2.01%	6.62%	3.14%	5.31%	3.21%	6.5%

Note: Authors' calculation of annual growth rates using CAGR calculator (Compound Annual Growth Rate calculator). (I) – input elements. (O) – output elements.
Source: Business Registers Agency of the Republic of Serbia

Recently, the indicator of earnings per employee has been used more and more often to measure the profitability of companies, regardless of their activity, including trade companies. Among other influences, this measure expresses the influence of "hidden characteristics" (for example, skills) of employees on the profitability and efficiency of companies. Table 2 and Figure 1 show earnings per employee who works in trade in Serbia for the period 2013 - 2019.

Table 2. Net profit per employee and earning per employee who work in trade in Serbia

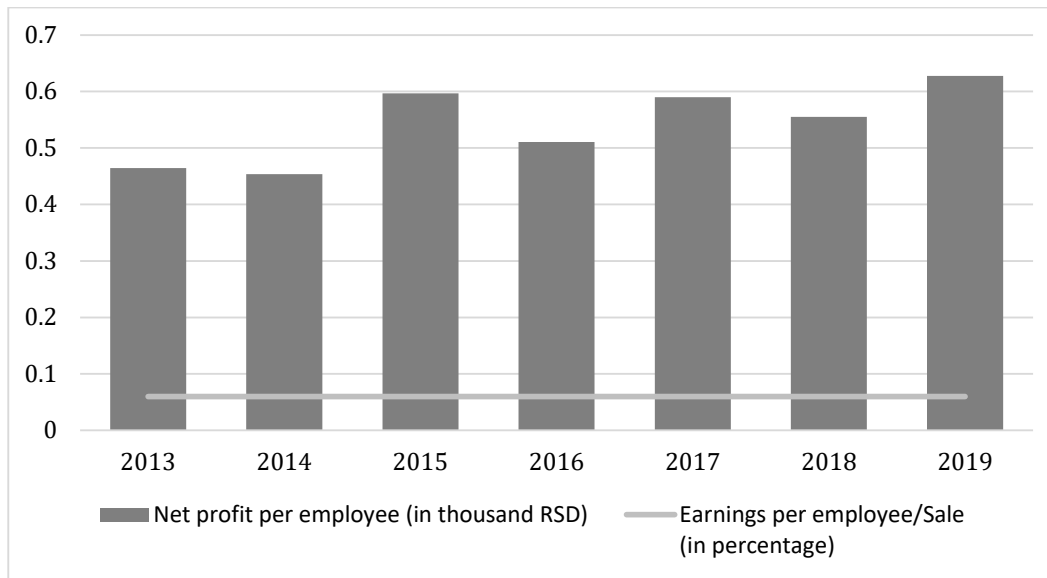| Year	Net profit per employee (in thousand RSD)	Earnings per employee/Sale (in percentage)
2013	0.464417	5.26
2014	0.453786	5.97
2015	0.596820	6.03
2016	0.510636	5.99
2017	0.589977	6.14
2018	0.555292	6.50
2019	0.627830	6.60

Source: Authors' calculations

Figure 1. Net profit per employee and earnings per employee who work in trade in Serbia

Source: Authors' calculations

During the analyzed period, earnings per employee in Serbian trade increased steadily. This was, among other things, influenced by the improvement of the "quality" of human resources management in Serbian trade and the improvement of the culture of relations between employees and consumers. This was certainly contributed by the greater presence of foreign retail chains in Serbia, which invest significantly more in the training and education of employees.

Table 3 shows the strategic profit model - return on assets of trade in Serbia. As the data in this table indicate,

Table 3. Strategic profit model - Return on assets of trade in Serbia

Year	Return on assets	Return on sale	Asset turnover ratio
2013	4.15%	3.10%	0.041533
2014	4.03%	3.35%	0.040302
2015	4.33%	3.49%	0.043343
2016	4.53%	3.50%	0.045267
2017	5.17%	3.87%	0.051668
2018	4.82%	3.62%	0.048246
2019	5.20%	3.86%	0.051961

Source: Authors' calculations

Table 3 shows the strategic profit model - return on assets in trade in Serbia. As the data in this table indicate, in 2019 the return on assets in trade in Serbia increased significantly, which is a consequence of the increase in both the return on sales and the asset turnover ratio

Table 4 shows a strategic profit model – return on equity in trade in Serbia

In 2019, the return equity in trade in Serbia also increased significantly. This was influenced by an increase in return on sales and asset turnover ratio, on the one hand, and a decrease in financial indebtedness, on the other.

Table 4. Strategic profit model – Return on equity in trade in Serbia

Year	Return on equity	Return on sales	Asset turnover ratio	Financial indebtedness
2013	4.15%	3.10%	0.041533	2.892232
2014	4.03%	3.35%	0.040302	2.834034
2015	4.33%	3.49%	0.043343	2.730319
2016	4.53%	3.50%	0.045267	2.704095
2017	5.17%	3.87%	0.051668	2.579056
2018	4.82%	3.62%	0.048246	2.504928
2019	5.20%	3.86%	0.051961	2.500271

Source: Authors' calculations

It can be concluded that all analyzed indicators reveal that there has been a significant increase in the profitability of trade in Serbia recently. Factors that influenced this are the following: improvement of general economic conditions, low inflation, stable exchange rate, low bank interest rate, significant inflow of foreign direct investments (increasing presence of foreign retail chains in the Serbian retail market), more efficient management of sales, costs, assets and profits, accelerated digitalization of the entire trade business and others.

TRADE EFFICIENCY IN SERBIA

The assessment of trade efficiency in Serbia was performed using DEA analysis with constant and variable yield. The following are used as input variables: number of employees, earnings per employee, assets and equity, and as output: sales and net profit. Table 5 shows the descriptive statistics on input / output data.

Table 5. Statistics on input/output data

Statistics on Input/Output Data						
	Number of employees	Earnings per employees (in thousand RSD)	Assets (in thousand RSD)	Equity (in thousand RSD)	Sale (in thousand RSD)	Net profit (in thousand RSD)
Max	222049	238022	2682931	1073056	3608329	139409
Min	159621	151978	2157564	746992	2594602	86955
Average	199998	186179	2346276	882154	3052798	108734
SD	19674.8	30354.2	184656	115331	329218	18271.8

Source: Authors' calculations by software DEA model = DEA-Solver LV8.0/CCR(CCR-I)

In the observed period (2013 - 2019), almost all input / output data were from 2016 above the average for Serbian trade. This had a positive effect on her overall performance.

Table 6 shows the correlation matrix of input / output data.

Table 6. Correlation matrix on input/output data

Correlation						
	Number of employees	Earnings per employee	Assets	Equity	Sale	Net profit
Number of employees	1	0.75677	0.77928	0.74712	0.81175	0.74553
Earnings per employee	0.75677	1	0.99507	0.99931	0.9549	0.97268
Assets	0.77928	0.99507	1	0.99085	0.96466	0.96467
Equity	0.74712	0.99931	0.99085	1	0.94954	0.97371
Sale	0.81175	0.9549	0.96466	0.94954	1	0.95619

Source: Authors' calculations by software DEA model = DEA-Solver LV8.0/CCR(CCR-I)

Based on the numerical values of the correlation coefficients given in the last column of the extended correlation matrix, it can be concluded that there is a strong positive correlation between the input and output data.

Table 7 and Figures 2 and 3 show the efficiency of Serbian trade measured using the DEA model: CCR (CCR-I; CCR-O).

Table 7. Efficiency of trade in Serbia – CCR model

No.	DMU	Model = CCR-I		Model = CCR-O	
		Score	Rank	Score	Rank
1	2013	1	1	1	1
2	2014	0.929	7	0.929	7
3	2015	1	1	1	1
4	2016	0.9671	6	0.9671	6
5	2017	1	1	1	1
6	2018	0.9904	5	0.9904	5
7	2019	1	1	1	1
	Average	0.9838		0.9838	
	Max	1		1	
	Min	0.929		0.929	
	St Dev	0.027		0.027	

Source: Authors' calculation by software DEA model = DEA-Solver LV8.0/ CCR (CCR-I; CCR-O)

According to the CCR model, with input and output orientation, trade in Serbia was efficient in 2013, 2015, 2017 and 2019, while in other observed years of the analyzed period (2014, 2016 and 2018) it was (slightly) less efficient. In order to improve the efficiency of trade in Serbia in these years, and in general, it was necessary to manage human capital, assets, equity, sales and profits more efficiently.
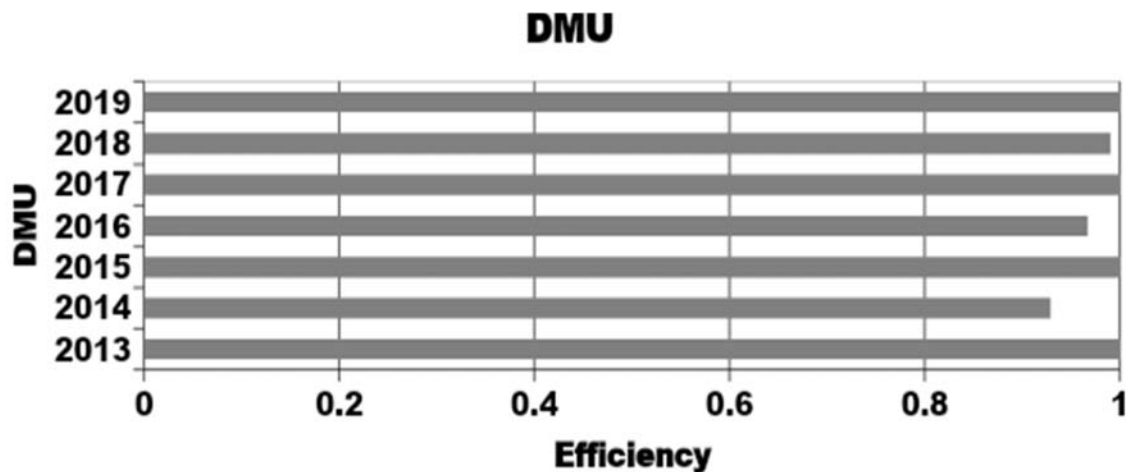

Figure 2. Efficiency of trade in Serbia (CCR-I)
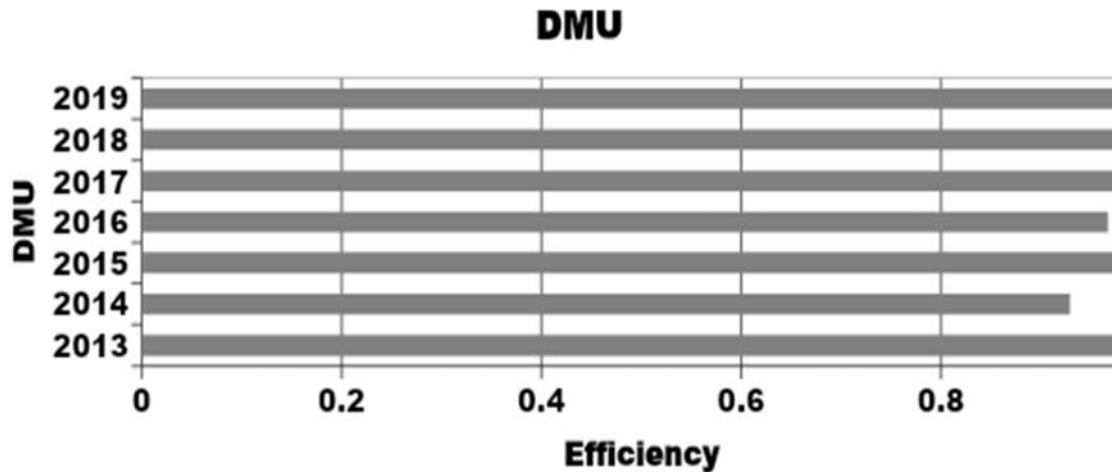*Source:* Authors' calculations

Figure 3. Efficiency of trade in Serbia (CCR-O)
Source: Authors' calculations

Table 6 and Figures 4 and 5 show the trade efficiency in Serbia measured using the BCC model with input and output orientation (BCC-I; BCC-O).

Table 6. Efficiency of trade in Serbia – BCC model

No.	DMU	Model = BCC-I		Model = BCC-O		Model = BCC-I	Model = BCC-O
		Score	Rank	Score	Rank	RTS of Projected DMU	RTS of Projected DMU
1	2013	1	1	1	1	Constant	Constant
2	2014	1	1	0.9998	5	Increasing	Increasing
3	2015	1	1	1	1	Constant	Constant
4	2016	0.9727	7	0.9693	7	Constant	Constant
5	2017	1	1	1	1	Constant	Constant
6	2018	0.9912	6	0.991	6	Constant	Constant
7	2019	1	1	1	1	Constant	Constant
	Average	0.9948		0.9943		No. of Increasing RTS=1	No. of Increasing RTS=1
	Max	1		1		No. of Constant RTS=6	No. of Constant RTS=6
	Min	0.9727		0.9693		No. of Decreasing RTS=0	No. of Decreasing RTS=0
	St Dev	0.0103		0.0115			

Source: Authors'calculation by software DEA model = DEA-Solver LV8.0/ BCC (BCC-I; BCC-O)

According to the BCC model with input orientation (BCC-I), trade in Serbia was efficient in 2013, 2014, 2015, 2017 and 2019, and inefficient in 2016 and 2018.

According to the BCC model with output orientation (BCC-I), trade in Serbia was efficient in 2013, 2015, 2017 and 2019, and inefficient in 2014, 2016 and 2018.

Based on both DEA models (CCR and BCC) with input and output orientation, it can be concluded that trade in Serbia was efficient in 2019. This was favourably influenced by external and internal factors, with a special contribution given by two factors: bigger number of foreign retail chains on the Serbian market, as well as the accelerated digitalization of the entire trade business.
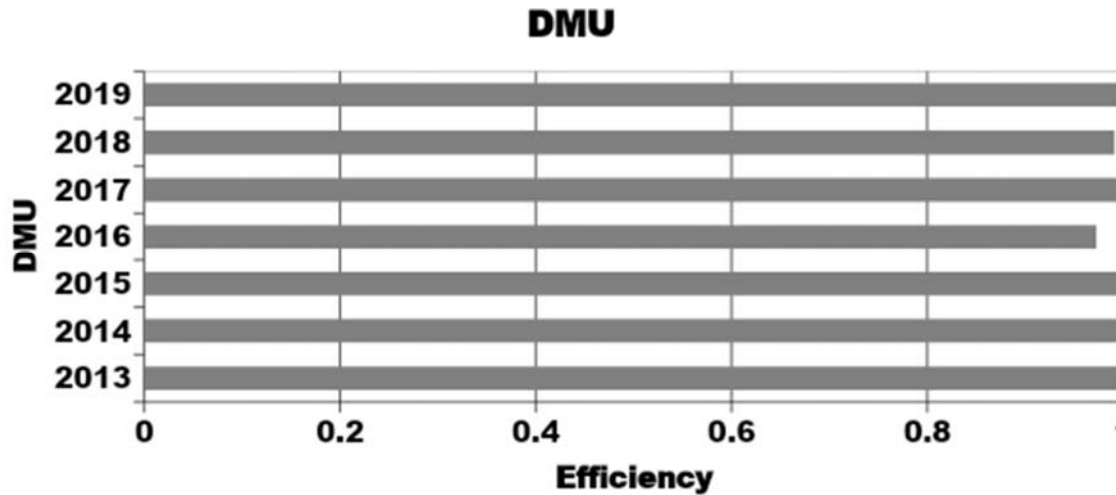
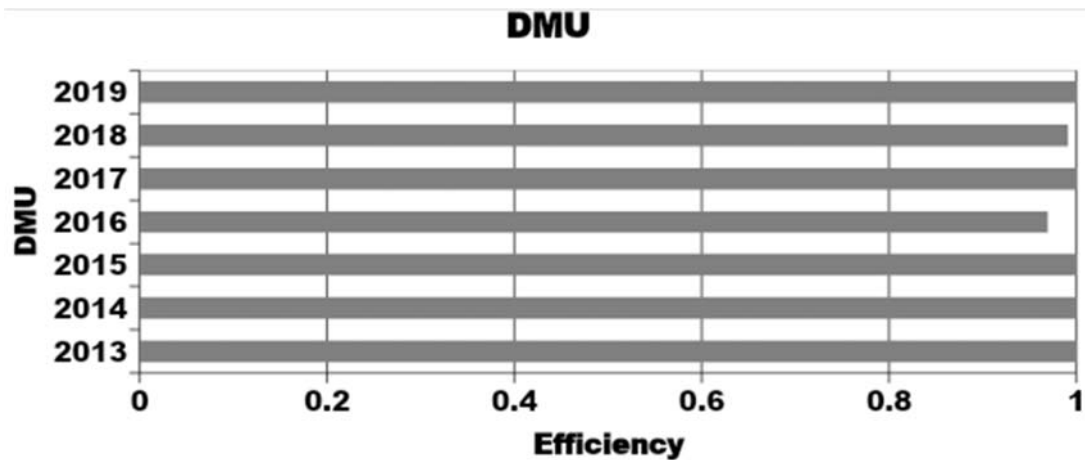**Figure 4.** Efficiency of trade in Serbia (BBC-I)
Source: Authors' calculations

Figure 5. Efficiency of trade in Serbia (BBC-O)
Source: Authors' calculations

CONCLUSION

Based on the conducted research, it can be concluded that there has been a significant increase in the profitability of trade in Serbia recently.

According to the CCR model, with input and output orientation, trade in Serbia was efficient in 2013, 2015, 2017 and 2019, and inefficient in 2014, 2016 and 2018.

According to the BCC model, with input orientation (BCC-I), trade in Serbia was efficient in 2013, 2014, 2015, 2017 and 2019, and inefficient only for two years of the analysed period - in 2016 and 2018.

According to the BCC model, with output orientation (BCC-O), trade in Serbia was efficient in 2013, 2015, 2017 and 2019, and inefficient in 2014, 2016 and 2018.

Based on all used DEA models (CCR and BCC), with input and output orientation, it can be concluded that trade in Serbia was efficient in 2019.

Factors that contributed to the improvement of profitability and efficiency of trade in Serbia are as follows: improvement of general economic conditions, low inflation, stable exchange rate, low bank interest rates, significant inflow of foreign direct investment (increasing presence of foreign retail chains in the Serbian retail market), more efficient management of sales, costs, assets and profits, accelerated digitalization of the entire trade business and others.

REFERENCES

Al-Refaie, Abbas, et al. 2015. "Window analysis and Malmquist index For assessing efficiency in a pharmaceutical industry." Paper presented at The World Congress on Engineering, London.

Andersen, Per, and Niels Christian Petersen. 1993. "A procedure for ranking efficient units in data envelopment analysis." *Management science* 39(10): 1261-1264.

Anand, Neeraj, and Neha Grover. 2015. "Measuring retail supply chain performance." *Benchmarking: An International Journal* 22(1): 135-166.

Asmild, Mette, et al. 2004. "Combining DEA window analysis with the Malmquist index approach in a study of the Canadian banking industry." *Journal of Productivity Analysis* 21(1): 67-89.

Barros, Carlos Pestana, and Carlos Alves. 2004. "An empirical analysis of productivity growth in a Portuguese retail chain using Malmquist productivity index." *Journal of Retailing and Consumer Services* 11(5): 269-278.

Barros, Carlos Pestana. 2006. "Efficiency measurement among hypermarkets and supermarkets and the identification of the efficiency drivers." *International Journal of Retail & Distribution Management*: 34(2): 135-154.

Bambe, Dayo Ife. 2017. "The Productivity Impact of New Technology: Evidence from the US Retailers Industry." *Advances in Social Sciences Research Journal* 4(22): 88-96.

Berman, Barry, Joel R. Evans, and Patrali Chatterjee. *Retail management: A strategic approach.* Pearson Education Limited, 2018.

Busu, Mihail, Madalina Vanesa Vargas, and Ioan Alexandru Gherasim. 2020. "An analysis of the economic performances of the retail companies in Romania." *Management & Marketing. Challenges for the Knowledge Society* 15(1): 125-133.

Camanho, Ana S., M. C. Portela, and Clara B. Vaz. 2009. "Efficiency analysis accounting for internal and external non-discretionary factors." *Computers & Operations Research* 36(5): 1591-1601.

Caves, Douglas W., Laurits R. Christensen, and W. Erwin Diewert. 1982. "The economic theory of index numbers and the measurement of input, output, and productivity." *Econometrica: Journal of the Econometric Society* 50: 1393–1414.

Cheng, CS Agnes, KC Kenneth Chu, and James Ohlson. 2020. "Analyst forecasts: sales and profit margins." *Review of Accounting Studies* 25: 1-30.

De Jorge, Justo, and Cristina Suárez. 2009. "Assessing productivity growth and technical efficiency in Spain's retail sector: An aggregate sectoral perspective." *Journal of Business and retail Management Research* 3(2): 1-19.

de Jorge Moreno, Justo. 2010. "Productivity growth of European retailers: a benchmarking approach." *Journal of Economic Studies* 37(3): 288-313.

de Jorge Moreno, Justo, and María Sanz-Triguero. 2011. "Estimating technical efficiency and bootstrapping Malmquist indices." *International Journal of Retail & Distribution Management* 39(4): 272-288.

de Melo, Felipe Luiz Neves Bezerra, Raquel Menezes Bezerra Sampaio, and Luciano Menezes Bezerra Sampaio. 2018. "Efficiency, productivity gains, and the size of Brazilian supermarkets." *International Journal of Production Economics* 197: 99-111.

Donthu, Naveen, and Boonghee Yoo. 1998. "Retail productivity assessment using data envelopment analysis." *Journal of retailing* 74(1): 89-105.

Gandhi, Aradhana, and Ravi Shankar. 2014. "Efficiency measurement of Indian retailers using data envelopment analysis." *International Journal of Retail & Distribution Management* 42(6): 500-520.

Färe, Rolf, et al. 1994. "Productivity growth, technical progress, and efficiency change in industrialized countries." *The American economic review* 84: 66-83.

Färe, Rolf, Shawna Grosskopf, and Pontus Roos. 1995. "Productivity and quality changes in Swedish pharmacies." *International Journal of Production Economics* 39(1-2): 137-144.

Hsu, Spring C. 2018. "Performance Analysis for Major Chain Convenience Stores in Taiwan." *Journal of Social Science Studies* 5(1): 214-222.

Almohri, Haidar. 2018. "Mixture Models With Grouping Structure: Retail Analytics Applications." Wayne State University Dissertations. 1911.https://digitalcommon s.wayne.edu/oa_dissertations/1911.

Hsu, Spring C. 2018. "Performance Analysis for Major Chain Convenience Stores in Taiwan." *Journal of Social Science Studies* 5(1): 214-222.

Ko, Kyungwan, et al. 2017. "Efficiency analysis of retail chain stores in Korea." *Sustainability* 9(9): 1-14.

Lau, Kwok Hung. 2013. "Measuring distribution efficiency of a retail network through data envelopment analysis." *International Journal of Production Economics* 146(2): 598-611.

Lazić, Milena and Ivana Domazet. 2019. "Theoretical and Practical Foundations of Inflation Targeting with Special Emphasis on the Experience of Serbia." *Economic Analysis* 52(2): 152-162

Lee, Boon L. 2013. "Productivity performance of Singapore's Retail Sector: A two-stage non-parametric approach." *Economic Analysis and Policy* 43(1): 67-77.

Lukić, Radojko. 2018. "The Analysis of the Operative Profit Margin of Trade Companies in Serbia." *Revista de Management Comparat Internaţional* 19(5): 458-475.

Lukic, Radojko, and Blaženka Hadrovic Zekic, 2019. "Evaluation of efficiency of trade companies in Serbia using the DEA approach". Paper presented at 19 th International Scientific Conference Business Logistics in Modern Management, Osijek.

Lukic, Radojko, Blaženka Hadrovic Zekic, and Dominika Crnjac Milic. 2020. "Financial performance evaluation of trading companies in Serbia using the integrated Fuzzy AHP - Topsis Approach". Paper presented at 9th International scientific symposium Region, entrepreneurship, development, Osijek.

Goldin, Claudia. 2006. "The Quiet Revolution That Transformed Women's Employment, Education, and Family." Paper presented at the annual meeting of the Allied Social Science Associations, Boston.

Majumdar, Sudipa. 2017. "Performance analysis of listed companies in the UAE-Using DEA Malmquist index approach." *American Journal of Operations Research* 7: 133-151.

Malmquist, Sten. 1953. "Index numbers and indifference surfaces."*Trabajos de estadística* 4(2): 209-242.

Radović-Marković, Mirjana, Zvonko Brnjas, and Vladimir Simović. 2019. "Impact of Globalization on Entrepreneurship." *Economic Analysis* 52(1): 56-58

Sarmento, Joaquim, Luc Renneboog, and Pedro Verga Matos. 2017. "Measuring highway efficiency by a DEA approach and the Malmquist index." *European Journal of Transport and Infrastructure Research* 17(4): 530-551.

Tone, Kaoru. 2001. "A slacks-based measure of efficiency in data envelopment analysis."*European journal of operational research* 130(3): 498-509.

Tone, Kaoru, and Miki Tsutsui. 2009. "Network DEA: A slacks-based measure approach."*European journal of operational research* 197(1): 243-252.

Tone, Kaoru, and Miki Tsutsui. 2010. "Dynamic DEA: A slacks-based measure approach." *Omega* 38(3-4): 145-156.

Qiu, Cheng, and Linjie Meng. 2017. "Study on total factor productivity of retail industry in east China." *Advances in Economics, Business and Management Research*, 33: 756-763.

Vaz, Clara B., Ana S. Camanho, and Romeu Cardoso Guimarães. 2010. "The assessment of retailing efficiency using network data envelopment analysis." *Annals of Operations Research* 173(1): 5-24.

Vaz, Clara B., and Ana S. Camanho. 2012. "Performance comparison of retailing stores using a Malmquist-type index." *Journal of the Operational Research Society* 63(5): 631-645.

Wang, Ying-Ming, and Yi-Xin Lan. 2011. "Measuring Malmquist productivity index: A new approach based on double frontiers data envelopment analysis." *Mathematical and Computer Modelling* 54(11-12) : 2760-2771.

Yu, Wantao, and Ramakrishnan Ramanathan. 2009. "An assessment of operational efficiency of retail firms in China." *Journal of Retailing and Consumer Services* 16(2): 109-122.