

ANALYSIS OF THE EFFICIENCY OF BANKS IN SERBIA AND MONTENEGRO USING THE DEA METHOD

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ABSTRACT

The banking sector of a country plays a crucial role in the overall economy of a nation. The efficiency of banks is a critical factor in assessing their financial performance and competitiveness. The aim of this paper is to measure the relative efficiency of the commercial banks in Serbia and Montenegro by using the non-parametric methodology Data Envelopment Analysis (DEA). The efficiency of banks will be measured using DEA for two models with different input and output variables. The sample consists of banks from Serbia (21) and banks from Montenegro (11) for the period 2017-2022. According to the obtained results, there are four banks that are relatively efficient every year, two from Serbia and two from Montenegro (AIK banka and 3M banka according to the first model and Crnogorska komercijalna banka and Hipotekarna banka according to the second model). The findings from the paper are valuable for further use by regulators, policy makers and bank management who are expected to identify a sustainable business strategy in line with the company's capabilities.

Keywords: DEA analysis, business banks, efficiency, financial performance, business sustainability

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INTRODUCTION

Financial institutions are a very important part of the financial system, and their quality has a dominant influence on the development of the economy [1], emphasizing that bank efficiency is a very important issue especially in transition economies [2]. According to Bou-Hamad et al. [3], the efficiency of banks has a critical role in the development of sound financial systems in countries. In modern business conditions, it is emphasized that well-functioning financial markets and banking institutions are usually considered to be a condition favorable to economic growth [4]. In its business, each banking institution has its own business principles, and one of the keys to a financially sustainable business is the principle of efficiency [5][6]. The ranking of banks is of vital importance if it is taken into account that the banking sector plays a significant role in the economic development of countries and business improvement [7], on the one hand, and that today's financial world is very complex compared to that of from one generation ago [8].

The paper is based on a systematic and comparative analysis of the available scientific literature, as well as on the results of the author's research. The research procedure was carried out based on the content analysis of primary and secondary sources. Revised and high-quality financial information is needed for business decision-making [9][10]. Data from publicly published financial reports for business banks operating in Serbia and those operating in Montenegro were used. The assessment of the efficiency of business banks was carried out using the DEA - CSR model. Data Envelopment Analysis (DEA): DEA is a non-parametric method that evaluates the relative efficiency of decision-making units (DMUs) based on multiple inputs and outputs. It aids in comparing similar entities by identifying efficient DMUs that achieve the highest level of outputs using the least amount of inputs.

The paper is organized in the following order. After the theoretical review in chapter 2, in chapter 3, the data used for the research and the applied methodology are presented. The rest of this paper will present the implementation of the CRS input-oriented DEA method, a non-parametric approach, i.e. model D2 (B) was used for business banks. Concluding considerations are given at the end of the paper.

THEORETICAL BACKGROUND

Since DEA in its current form was first introduced in 1978, researchers in a number of fields quickly recognized it as an excellent and easy-to-use methodology for modeling business processes for performance evaluation [11]. Fukuyama et al. [12], state that traditional DEA-based models have been a vital tool case for the evaluation of banks' efficiency and productivity levels in different banking systems. As Lukić et al. [13] point out, due to the importance of the banking sector, its efficiency is being analyzed more and more. More and more attention is paid to the efficiency of financial institutions [14][15].

Data envelopment analysis (DEA) has become one of the most widely used instruments for measuring bank efficiency [16]. Four bank behaviour models which are most popularly employed to determine input and output factors in DEA studies - the intermediation approach, production approach, user cost approach and value-added approach [16].

DATA AND METHODOLOGY

In this research, we use DEA to assess relative efficiency for 21 business banks in Serbia and 11 banks in Montenegro. For the application of the CRS model, two aspects were used, that is, two models (model A and model B). The purpose of the first model is to define how much interest and non-interest expenses should be reduced so that the bank can achieve the highest interest and non-interest income. On the other hand (model B), transactions based on non-fund income are observed. The first combination used variables according to Fotova Čikić et al. [17] (Figure 1), and the second combination used variables according to Tandon et al. [18], using an intermediate approach with a limited choice of variables (Figure 2).

The core profit efficiency model essentially seeks to evaluate how efficiently a bank transforms its input expenses (interest and non-interest expenses) into output incomes (net interest income and non-interest income) (model A). In other words, it assesses how well a bank manages its cost structure and revenue generation to maximize its profitability.

The choice of inputs and outputs for model B is guided by the previous choices of the mentioned studies and data availability. In addition to the above, the choice is also in line with recent trends in the Serbian banking industry. Namely, in addition to traditional activities such as borrowing and lending activities, banks are emphasizing transactions that generate more income without funds in order to encourage revenue growth. The trends in banking are different, but their impact on competitiveness is indisputable. Some of them are deregulation, technological progress and diversity of banking services [19], including the adoption of ESG products [20]. Over the past two decades, banking institutions have entered new product areas, moving from traditional lending to new strategies based on generating non-fund-based income through the provision of various services (securities trading, support for firms to issue new equity financing, securities commissions from values and asset management, etc.).

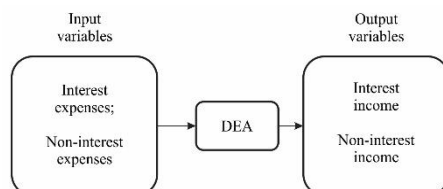


Figure 1. Parameters of the DEA - model A.

Source: Authors

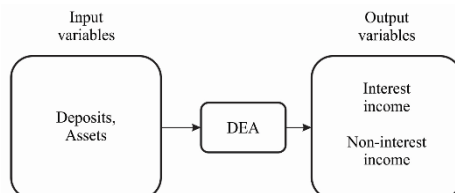


Figure 2. Parameters of the DEA - model B.

Source: Authors

The DEA method is a specifically defined procedure for measuring the efficiency of complex units of a business system with different inputs and outputs [21]. DEA is one of the most widely recognized methods or approaches for calculating the relative efficiency of DMUs [22]. Decision Making Unit (DMU) is the standard name for business units (here business banks). DEA gives results about the DMU in terms of efficiency and inefficiency, as well as how much it is necessary to reduce a certain input and/or increase a certain output in order to make a certain DMU effective. The DEA model can be constructed either to minimize inputs or to maximize outputs [23].

The following form is used to apply DEA efficiency:

DEA Efficiency = Weighted sum of outputs / Weighted sum of inputs

The above definition of DEA Efficiency enables the aggregation of observed inputs and outputs into one virtual input and virtual output as a quotient of the sum of the product of weight coefficients and input values and the sum of the product of weight coefficients and output values.

The CRS models assume constant returns to scale (The Constant Returns to Scale Model). If the condition that is $\sum_{j=1}^n \lambda_j = 1$ is added, then models are obtained, known as BCC DEA models [24] or VRS

(The Variable Returns to Scale Model) models, depending on the literature used. Basic DEA models have various variants in terms of certain restrictions, such as restrictions on weights or depending on the type of input or output, etc. In the following, two selected basic DEA models will be presented.

MODEL D1. Let x_{ij} – be the observed value of the input of the i -th row for DMU_j ($x_{ij} > 0$, $i = 1, 2, \dots, m$, $j = 1, 2, \dots, n$), and y_{rj} – the observed value of the output of the r -th row for DMU_j ($y_{rj} > 0$, $r = 1, 2, \dots, s$, $j = 1, 2, \dots, n$).

Charnes, Cooper & Rhodes proposed (known as the CCR ratio model) that for each DMU_k , $k = 1, 2, \dots, n$, an optimization problem should be solved which is in the following form:

$$\max h_k(u, v) = \frac{\sum_{r=1}^s u_r y_{rk}}{\sum_{i=1}^m v_i x_{ik}},$$

with conditions

$$\frac{\sum_{r=1}^s u_r y_{rk}}{\sum_{i=1}^m v_i x_{ik}} \leq 1, u_r \geq 0, v_i \geq 0, r = 1, 2, \dots, s, j = 1, 2, \dots, m,$$

where

h_k - relative efficiency of the k -th DMU, n - number of observed DMUs, m - number of inputs, s - number of outputs, u_r - weighting coefficient for output r , v_i - weighting coefficient for input i . Weighting coefficients u_r and v_i represent the unknowns in the model that are determined by optimization, and are essential for the construction of the virtual input and the virtual output.

From the above it can be seen that $0 \leq h_k \leq 1$. First, if h_k is equal to 1 then the k -th DMU is relatively efficient, meaning that no other DMU can achieve a higher output value for a given input. The efficient k -th DMU has optimal values for the weighting coefficients. Second, if h_k is less than 1 then the k -th DMU is relatively inefficient and the value h_k indicates by what percentage the k -th unit should reduce its inputs. Third, it should be emphasized that the weighting coefficients u_r and v_i show the degree of importance of each input and output for each DMU so that each DMU is as efficient as possible. The characteristics of this model are non-linearity and non-convexity with linearly decomposed objective function and associated constraints.

MODEL D2. Model D1 can be reduced to a linear model as follows

$$(A) \quad \max z = \sum_{r=1}^s u_r y_{rk}, \text{ with conditions}$$

$\sum_{i=1}^m v_i x_{ik} = 1, u_r \geq 0, v_i \geq 0, \sum_{r=1}^s u_r y_{rj} - \sum_{i=1}^m v_i x_{ik} \leq 0, j = 1, 2, \dots, n, u_r \geq \varepsilon, v_i \geq \varepsilon$, where ε is a small positive value, i.e. $\varepsilon > 0$, $r = 1, 2, \dots, s, j = 1, 2, \dots, m$,

Model D2 maximizes the virtual output provided that its virtual input is equal to 1.

For model (A), the dual linear programming problem is

$$(B) \quad \theta^* = \min \theta,$$

with the conditions that is

$$\sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{ik}, i = 1, 2, \dots, m, \sum_{j=1}^n \lambda_j y_{rj} \geq y_{rk}, r = 1, 2, \dots, s, \lambda_j \geq 0, j = 1, 2, \dots, n.$$

RESEARCH RESULTS

The total efficiency of the selected banks was calculated using Excel Solver [25] to set the appropriate conditions of model D2 (B). The results are shown in Table 1. The research results indicate good efficiency for some banks, or wrong allocation or inefficient use of resources in the implementation of business activities for other banks for the observed period from 2017 to 2022. In addition, this research provides target values for improving the efficiency of business banks.

The results of the analysis of the efficiency of commercial banks in Serbia are presented in chapter 4.1, while the results of the analysis of the efficiency of commercial banks in Montenegro are presented in chapter 4.2.

Efficiency of banks in Serbia

The results of the analysis of the efficiency of banks in Serbia in the period from 2017 to 2022, using model A, are shown in Table 1.

Table 1. Efficiency of banks in Serbia - Model A

Banks	2017	2018	2019	2020	2021	2022	Average
Addiko banka	64.71%	62.42%	77.60%	82.48%	100.00%	98.23%	80.91%
AIK banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Alta banka	54.99%	76.29%	67.38%	63.24%	68.90%	77.41%	68.03%
API banka	51.23%	29.05%	44.77%	25.41%	50.62%	55.67%	42.79%
Bank of China	100.00%	79.22%	100.00%	97.77%	100.00%	100.00%	96.17%
Banca Intesa	73.59%	88.34%	87.51%	48.99%	92.80%	76.10%	77.89%
Banka poštanska štedionica	48.54%	57.84%	54.02%	96.32%	68.19%	63.51%	64.74%
RBA banka	57.16%	65.80%	63.02%	70.43%	79.78%	79.63%	69.30%
Erste banka	78.32%	78.67%	71.81%	84.74%	90.83%	94.34%	83.12%
Euro banka	94.20%	89.77%	91.34%	56.56%	87.34%	71.42%	81.77%
Expo banka	100.00%	58.83%	51.19%	56.01%	57.37%	69.28%	65.45%
Halk banka	70.12%	73.35%	72.50%	71.31%	72.29%	65.79%	70.89%
Mira banka	22.58%	32.48%	27.75%	34.45%	36.38%	40.90%	32.42%
Mobi banka	25.73%	46.78%	40.73%	22.61%	51.95%	52.34%	40.02%
NLB Komercijalna banka	77.31%	68.57%	71.71%	72.36%	76.72%	100.00%	77.78%
3M banka	84.38%	96.75%	88.85%	90.40%	100.00%	100.00%	93.40%
Procredit banka	54.03%	68.38%	70.80%	75.68%	94.69%	100.00%	77.26%
Raiffeisen bank	100.00%	100.00%	100.00%	100.00%	100.00%	88.72%	98.12%
Srpska banka	69.33%	62.33%	67.24%	60.66%	71.60%	70.37%	66.92%
Unicredit banka	85.98%	100.00%	92.15%	99.61%	100.00%	90.80%	94.76%
OTP banka	69.32%	75.17%	74.93%	83.14%	98.33%	95.51%	82.74%
Average	70.55%	71.91%	72.16%	71.06%	80.85%	80.48%	

Source: authors based on data from financial reports of banks

As can be seen from Table 1, only AIK banka operated efficiently during the observed period. In other words, only this bank had 100% efficiency in all observed years. It is a bank that belongs to the large banks in terms of size. After AIK banka, the highest efficiency was recorded at Raiffeisen banka. The average efficiency of Raiffeisen banka during the observed period is 98.12%, and during the first five years that efficiency was 100%. Also, this bank belongs to the group of large banks. The lowest efficiency was recorded at Mira banka, which belongs to the group of small banks. The average efficiency of this bank in the period from 2017 to 2022 was 32.42%. After Mira banka, the lowest efficiency during the observed period was recorded at Mobi bank (average efficiency 40.02%). Observed by year, the lowest efficiency (70.55%) was recorded in 2017, while the highest (80.85%) was recorded in 2021.

Table 2 shows the value of chain indexes.

Table 2. Chain indexes of efficiency of banks in Serbia - Model A

Bank name	Chain index				
	2018/2017	2019/2018	2020/2019	2021/2020	2022/2021
Addiko banka	0.96	1.24	1.06	1.21	0.98
AIK banka	1.00	1.00	1.00	1.00	1.00
Alta banka	1.39	0.88	0.94	1.09	1.12
API banka	0.57	1.54	0.57	1.99	1.10
Bank of China	0.79	1.26	0.98	1.02	1.00
Banca Intesa	1.20	0.99	0.56	1.89	0.82
Banka Poštanska štedionica	1.19	0.93	1.78	0.71	0.93
RBA banka	1.15	0.96	1.12	1.13	1.00
Erste banka	1.00	0.91	1.18	1.07	1.04
Euro banka	0.95	1.02	0.62	1.54	0.82
Expo banka	0.59	0.87	1.09	1.02	1.21
Halk banka	1.05	0.99	0.98	1.01	0.91
Mira banka	1.44	0.85	1.24	1.06	1.12
Mobi banka	1.82	0.87	0.56	2.30	1.01
NLB Komercijalna banka	0.89	1.05	1.01	1.06	1.30

3M banka	1.15	0.92	1.02	1.11	1.00
Procredit banka	1.27	1.04	1.07	1.25	1.06
Raiffeisen banka	1.00	1.00	1.00	1.00	0.89
Srpska banka	0.90	1.08	0.90	1.18	0.98
Unicredit banka	1.16	0.92	1.08	1.00	0.91
OTP banka	1.08	1.00	1.11	1.18	0.97

Source: authors

Oscillations in the level of efficiency are present in the largest number of banks during the observed period (Table 2). Only at AIK banka, the level of efficiency is constant during the entire observed period. Also, a constant level of efficiency was recorded during the first five years at Raiffeisen banka. The biggest decrease and increase in efficiency was recorded at Mobi banka. That decrease, of 44%, was recorded in 2020 compared to 2019. On the other hand, the highest growth, of 130%, was recorded in 2021 compared to 2020.

The results of the analysis of the efficiency of banks in Serbia in the period from 2017 to 2022, using model B, are shown in Table 3.

Table 3. Efficiency of banks in Serbia - Model B

	2017	2018	2019	2020	2021	2022	Average
Addiko banka	37.74%	59.86%	62.86%	62.77%	50.60%	60.56%	55.73%
AIK banka	49.80%	49.64%	61.86%	91.58%	34.21%	26.46%	52.26%
Alta banka	31.35%	45.71%	43.74%	44.12%	35.95%	59.28%	43.36%
API banka	26.49%	36.39%	45.98%	38.78%	46.82%	58.59%	42.17%
Bank of China	100.00%	39.41%	73.91%	35.50%	42.38%	29.66%	53.48%
Banca Intesa	34.50%	63.71%	60.21%	57.19%	50.93%	55.60%	53.69%
Banka Poštanska štedionica	47.23%	55.07%	64.42%	100.00%	43.64%	50.29%	60.11%
RBA banka	34.73%	57.25%	58.57%	53.16%	41.93%	48.00%	48.94%
Erste banka	35.45%	46.00%	50.78%	48.68%	39.61%	42.94%	43.91%
Euro banka	37.74%	66.54%	60.34%	58.46%	28.57%	41.93%	48.93%
Expo banka	100.00%	47.26%	46.95%	45.12%	34.25%	66.57%	56.69%
Halk banka	34.14%	49.25%	50.20%	47.84%	40.05%	46.15%	44.60%
Mira banka	36.31%	58.37%	50.72%	57.92%	35.61%	50.70%	48.27%
Mobi banka	44.34%	100.00%	100.00%	100.00%	100.00%	100.00%	90.72%
NLB Komercijalna banka	45.45%	53.37%	54.53%	55.46%	45.55%	43.15%	49.58%
3M banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Procredit banka	33.79%	38.82%	42.05%	40.54%	33.48%	40.51%	38.20%
Raifaisen banka	32.89%	58.19%	60.45%	51.00%	43.79%	46.27%	48.77%
Srpska banka	16.84%	32.81%	33.51%	27.94%	28.64%	25.08%	27.47%
Unicredit banka	30.67%	41.30%	48.31%	46.65%	39.15%	44.18%	41.71%
OTP banka	29.58%	59.15%	45.72%	54.25%	32.96%	44.14%	44.30%
Average	44.72%	55.15%	57.86%	57.95%	45.15%	51.43%	

Source: authors based on data from financial reports of banks

As can be seen from Table 3, during the observed period, the highest level of efficiency was recorded at 3M banka and Mobi banka. 3M banka had an efficiency of 100% during the entire observed period. On the other hand, Unicredit banka achieved an average efficiency during the observed period of 90.72%, and in 5 out of 6 years it had an efficiency of 100%. The lowest level of efficiency was recorded by Srpska banka. Its average efficiency was 27.47%. Observed by year, the lowest efficiency (44.72%) was recorded in 2017, while the highest (57.95%) was recorded in 2020.

As can be seen from Table 4, oscillations in the level of efficiency of banks in Serbia were recorded when another approach is used to determine efficiency. The greatest increase in the level of efficiency was recorded at Mobi banka. Namely, this bank recorded a 126% increase in efficiency in 2018 compared to 2017. The biggest drop in the level of efficiency, of 61%, was recorded at the Bank of China in 2018 compared to 2017.

Table 4. Chain indexes of efficiency of banks in Serbia - Model B

Banks	Chain indexes				
	2018/2017	2019/2018	2020/2019	2021/2020	2022/2021
Addiko banka	1.59	1.05	1.00	0.81	1.20
AIK banka	1.00	1.25	1.48	0.37	0.77
Alta banka	1.46	0.96	1.01	0.81	1.65
API banka	1.37	1.26	0.84	1.21	1.25
Bank of China	0.39	1.88	0.48	1.19	0.70
Banca Intesa	1.85	0.95	0.95	0.89	1.09
Banka Poštanska štedionica	1.17	1.17	1.55	0.44	1.15
RBA banka	1.65	1.02	0.91	0.79	1.14
Erste banka	1.30	1.10	0.96	0.81	1.08
Euro banka	1.76	0.91	0.97	0.49	1.47
Expo banka	0.47	0.99	0.96	0.76	1.94
Halk banka	1.44	1.02	0.95	0.84	1.15
Mira banka	1.61	0.87	1.14	0.61	1.42
Mobi banka	2.26	1.00	1.00	1.00	1.00
NLB Komercijalna banka	1.17	1.02	1.02	0.82	0.95
3M banka	1.00	1.00	1.00	1.00	1.00
Procredit banka	1.15	1.08	0.96	0.83	1.21
Raiffeisen bank	1.77	1.04	0.84	0.86	1.06
Srpska banka	1.95	1.02	0.83	1.03	0.88
Unicredit bank	1.35	1.17	0.97	0.84	1.13
OTP banka	2.00	0.77	1.19	0.61	1.34

Source: authors

The efficiency of banks in Montenegro

The results of the analysis of the efficiency of commercial banks in Montenegro in the period from 2017 to 2022, using model A, are shown in Table 5.

Table 5. The efficiency of banks in Montenegro - Model A

Banks	2017	2018	2019	2020	2021	2022	Average
Crnogorska komercijalna banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Hipotekarna banka	100.00%	100.00%	88.55%	83.34%	71.82%	85.58%	88.21%
Prva banka	84.25%	80.53%	76.79%	77.25%	64.51%	44.61%	71.32%
Erste banka	100.00%	100.00%	100.00%	100.00%	100.00%	49.93%	91.65%
NLB banka	100.00%	100.00%	100.00%	100.00%	83.31%	76.80%	93.35%
Addiko banka	82.73%	88.15%	84.28%	81.49%	80.57%	100.00%	86.20%
Universal capital banka	77.66%	96.27%	100.00%	100.00%	100.00%	100.00%	95.66%
Lovćen banka	99.54%	100.00%	100.00%	100.00%	100.00%	45.23%	90.79%
Zapad banka	75.77%	86.99%	55.62%	57.73%	63.95%	40.27%	63.39%
Zirrat banka	62.46%	65.56%	85.36%	80.81%	66.20%	32.97%	65.56%
Adriatic banka	28.14%	35.84%	35.55%	50.34%	100.00%	100.00%	58.31%
Average	82.78%	86.67%	84.20%	84.63%	84.58%	70.49%	

Source: authors based on data from financial reports of banks

During the observed period, the highest level of efficiency was recorded at Crnogorska komercijalna banka. Namely, this bank had an efficiency level of 100% during all six years. Universal capital banka (with an average efficiency of 95.66%), or NLB banka (with an average efficiency of 93.35%) is in second and third place, respectively, in terms of average efficiency. Universal capital banka had an efficiency level of 100% during the last four observed years, while NLB banka had an efficiency level of 100% during the first four observed years. The lowest level of average efficiency during the observed period was recorded at Adriatic bank (58.31%). Observed by year, the lowest efficiency (70.49%) was recorded in 2022, while the highest (86.67%) was recorded in 2018.

Table 6 shows the value of the chain indexes.

Table 6. Chain indexes of efficiency of banks in Montenegro - Model A

Banks	Chain indexes				
	2018/2017	2019/2018	2020/2019	2021/2020	2022/2021
Crnogorska komercijalna banka	1.00	1.00	1.00	1.00	1.00
Hipotekarna banka	1.00	0.89	0.94	0.86	1.19
Prva banka	0.96	0.95	1.01	0.84	0.69
Erste banka	1.00	1.00	1.00	1.00	0.50
NLB banka	1.00	1.00	1.00	0.83	0.92
Addiko banka	1.07	0.96	0.97	0.99	1.24
Universal capital banka	1.24	1.04	1.00	1.00	1.00
Lovćen banka	1.00	1.00	1.00	1.00	0.45
Zapad banka	1.15	0.64	1.04	1.11	0.63
Zirrat banka	1.05	1.30	0.95	0.82	0.50
Adriatic bank	1.27	0.99	1.42	1.99	1.00

Source: authors

At the largest number of banks in Montenegro during the observed period, oscillations in the level of efficiency are present. Only Crnogorska komercijalna banka recorded a constant level of efficiency during the entire observed period. A constant level of efficiency during the first 5 years was recorded at Erste banka. The highest increase in the level of efficiency, of 99%, was recorded at Adriatic banka in 2021 compared to 2020. The biggest drop in the level of efficiency, of 55%, was recorded at Lovćen banka in 2022 compared to 2021.

The results of the analysis of the efficiency of banks in Montenegro in the period from 2017 to 2022, using model B, are shown in Table 7.

Table 7. Efficiency of banks in Montenegro - Model B

Banks	2017	2018	2019	2020	2021	2022	Average
Crnogorska komercijalna banka	96.16%	83.70%	76.17%	84.70%	95.85%	81.34%	86.32%
Hipotekarna banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Prva banka	65.93%	60.22%	60.06%	73.93%	85.69%	62.32%	68.02%
Erste banka	88.59%	92.74%	87.36%	79.65%	85.18%	63.42%	82.83%
NLB banka	98.57%	88.48%	81.61%	90.17%	81.38%	81.55%	86.96%
Addiko banka	86.97%	100.00%	100.00%	100.00%	100.00%	100.00%	97.83%
Universal capital banka	34.96%	41.93%	64.22%	70.01%	61.94%	55.92%	54.83%
Lovćen banka	100.00%	100.00%	87.54%	82.44%	72.20%	46.82%	81.50%
Zapad banka	97.52%	91.44%	42.33%	65.85%	51.07%	28.80%	62.83%
Zirrat banka	93.91%	100.00%	65.46%	100.00%	95.76%	49.35%	84.08%
Adriatic banka	46.29%	59.39%	59.34%	43.13%	78.01%	52.27%	56.41%
Average	82.63%	83.45%	74.92%	80.90%	82.46%	65.62%	

Source: authors based on data from financial reports of banks

The highest level of efficiency in the period from 2017 to 2022 was recorded at Hipotekarna banka and Addiko banka. Namely, during all six years, Hipotekarna banka had 100% efficiency. On the other hand, Addiko banka only in the first observed year did not have 100% efficiency, but 86.97%. Thus, the average efficiency of Addiko banka during the observed period is 97.83%. The lowest level of efficiency was recorded at Adriatic banka and its average efficiency was 56.41%. Observed by year, the lowest average efficiency was recorded in 2022 (65.62%), while the highest was recorded in 2018 (83.45%).

As can be seen from Table 8, the largest number of banks in Montenegro have oscillations in the level of efficiency during the observed period. At Hipotekarna banka a constant level of efficiency was recorded during the observed period, while at Addiko bank, that level was recorded during the last five years. The highest increase in the level of efficiency, of 81%, was recorded at Adriatic banka in 2021 compared to 2020. On the other hand, the biggest drop in the level of efficiency, of 56%, was recorded at Zapad banka in 2019 compared to 2018.

Table 8. Chain efficiency indexes of banks in Montenegro - Model B

Banks	Chain indexes				
	2018/2017	2019/2018	2020/2019	2021/2020	2022/2021
Crnogorska komercijalna banka	0.87	0.91	1.11	1.13	0.85
Hipotekarna banka	1.00	1.00	1.00	1.00	1.00
Prva banka	0.91	1.00	1.23	1.16	0.73
Erste banka	1.05	0.94	0.91	1.07	0.74
NLB banka	0.90	0.92	1.10	0.90	1.00
Addiko banka	1.15	1.00	1.00	1.00	1.00
Universal capital banka	1.20	1.53	1.09	0.88	0.90
Lovćen banka	1.00	0.88	0.94	0.88	0.65
Zapad banka	0.94	0.46	1.56	0.78	0.56
Zirrat banka	1.06	0.65	1.53	0.96	0.52
Adriatic banka	1.28	1.00	0.73	1.81	0.67

Source: authors

DISSCUSSION

In this paper, we measured the relative efficiency of commercial banks in two developing countries in Europe - Serbia and Montenegro using the DEA method, for two combinations of variables (two models). For the observed period of five years (2017–2022), balanced panel data were used for both observed samples. Productivity and efficiency are essential metrics to realize company goals and diagnose critical points for performance improvement. “The CCR efficiency measure also reflects any inefficiencies due to divergence from the most productive scale size” [27].

According to model A, the average efficiency of the Serbian banking sector in the first observed year was 70.55%, while in the last observed year it was 80.48%. According to model B, the average efficiency of the Serbian banking sector in 2017 was 44.72%, and in 2022 it was 51.43%.

When it comes to the average efficiency of the banking sector of Montenegro, using model A, it was 82.78% in 2017, and it was 70.49% in 2022. According to model B, the average efficiency in 2017 was 82.36% and in 2022 it was 65.62%. This research suggests that banks in Serbia and Montenegro showed different efficiency during the observed five-year period. It is obvious that these two countries had different dynamics and challenges in their banking sectors.

The rationale for reducing the efficiency of banks in Montenegro should be investigated in a broader political and economic context [26]. Serbia and Montenegro are still candidate countries for EU membership. In addition to the broader political and economic context, it would also be useful to consider specific factors or changes in the banking sector of both countries that could contribute to the decrease in efficiency.

This research provides an important insight into the effectiveness of the banking sectors in Serbia and Montenegro. Furthermore, continuous monitoring and further analysis can help identify key areas for improvement and optimization of efficiency in those sectors to support economic growth and stability.

CONCLUSION

The aim of this paper was to present the application of an adequate method used in the assessment of the efficiency of banks, based on inputs from financial reports. Therefore, in this paper, the emphasis is placed on two different models (input and output combinations) to evaluate efficiency using the DEA method.

The research results can usefully serve managers and other interest groups (investors) who want insight into the efficiency of commercial banks. Based on the received efficiency data, it was identified for which banks and in which periods the efficiency was unsatisfactory, which certainly affected the financial viability of the observed financial organizations.

The results of this study can be further investigated by expanding the size of inputs and outputs and including a larger sample, that is, all the countries that make up the Western Balkans. The results of the research can usefully serve bank managers and other interest groups (investors) who want insight into the efficiency of the observed business banks. Based on the obtained efficiency data, it was identified for which banks and in which periods the efficiency was unsatisfactory, which certainly affected the

financial sustainability of the observed banks. Productivity and efficiency are essential metrics to realize banks' goals and diagnose critical points for performance improvement.

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