

## LITERATURE REVIEW ON DEA BANKS' APPLICATION IN THE WESTERN BALKANS

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### ABSTRACT

*This study aims to identify and present the relevant studies employing DEA applications in bank efficiency evaluation in six Western Balkan (WB) countries as follows: North Macedonia, Serbia, Montenegro, Kosovo, Albania and Bosnia and Herzegovina (B&H).*

*This article implements an extensive systematic literature review of studies that employ the DEA methodology in the efficiency evaluation of Western Balkan countries' banking systems.*

*The conducted literature review has surveyed the Scopus, Web of Science (SSCI and SCI papers) and Google Scholar databases with „Data Envelopment Analysis“, „Western Balkan“ (and each of the WB countries as keywords) and „Bank“ as keywords for the search following the PRISMA guidelines for systematic literature review. Thereafter, a manual survey of these studies was conducted, which eventually resulted in 31 papers regarding the efficiency of WB countries' banking systems.*

*This study provides an in-depth literature review on bank efficiency studies with DEA in each of the analysed Western Balkan countries (eight in Serbia, six in North Macedonia, none in Montenegro, three in Albania, three in Kosovo, five in Bosnia and Herzegovina and six cross-country studies that include any of these Western Balkan countries), as well as a presentation of their used models, the selected variables and their findings. The findings reveal that, in most cases, the large banks in WB are most efficient and the small-sized banks are the least efficient.*

*This literature review indicates that the surveyed studies have been published in the period between 2008 and 2022. The findings primarily show the applicability of DEA in the bank efficiency literature.*

**Keywords:** *Data Envelopment Analysis (DEA), Banking, Western Balkan, efficiency measurement, nonparametric approach.*

**JEL classification:** *G21, G34, N24.*

### 1. INTRODUCTION

Besides their traditional activities, commercial banks in developing countries play a very important role in their national country's economic development, financial stability and thus, prosperity. Therefore, it comes as no surprise that their efficiency is regularly and consistently measured and evaluated. Their efficiency could be evaluated using the ratio

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indicators, the parametric and the nonparametric methodologies. DEA is nowadays one of the most popular and applied nonparametric methodologies, that is especially convenient for small samples, which in general includes the banking industry.

The main objective of this work is to identify and present the relevant studies employing DEA applications in bank efficiency evaluation in the six observed Western Balkan (WB) countries as follows: North Macedonia, Serbia, Montenegro, Kosovo, Albania and Bosnia and Herzegovina (B&H). For this purpose, the methodology known as PRISMA-compliant systematic literature review (SLR) has been conducted, which includes exploration and a survey of the three globally renowned scientific databases (i.e. Scopus, Web of Science and Google Scholar) in search of all the DEA applications in the banking sectors in the Western Balkan countries. The efficiency of commercial banks in the Western Balkan is vital, since all the banking sectors are banco-centric and their efficient operations impact the overall financial stability. The leading non-parametric methodology DEA is “the most widely used efficiency evaluation method” (Radojicic et al., 2018) and especially convenient for homogeneous peer units such as banks.

The findings of this paper reveal new insights to policymakers and government officials, as well as bank stakeholders, potential investors and the interested public, thus offering a solid scientific and practical contribution. Notwithstanding, at the best of authors’ knowledge, there is not any published paper synthesizing all the relevant papers applying the DEA methodology in the Western Balkan countries and their findings. Interestingly, the findings also confirm that, in most cases, the large banks in WB are most efficient and the small-sized banks are the least efficient.

The motivation behind this review can be mirrored in the effort to present and promote the DEA methodology as a very convenient method to be used in the bank evaluation in the Western Balkan countries, as well as the world, for that matter. Moreover, the authors believe that this paper would bring awareness to other scholars regarding the negligence and avoidance of the DEA methodology by academic members from the Western Balkan, which could contribute to its wider spread and application, not only in the banking sector, but any other sector as well.

The remainder of this paper is structured as follows. After the introduction, a short theoretical background on the DEA methodology is presented. Section 3 presents the research design and process and Section 4 reveals the results of this review: a qualitative review of the 31 surveyed papers together with their used DEA models, variables and findings. Section 5 opens up a discussion and Section 6 concludes this paper.

## **2. DATA ENVELOPMENT ANALYSIS (DEA)**

DEA is the leading nonparametric methodology that has been widely used in efficiency measurement in various industries since its introduction in the seminal paper of Charnes, Cooper and Rhodes (1978). Little it is known that DEA has been first and foremost developed for measuring efficiency of non-profit organizations, but its applicability and easiness to use have been the reasons of the ever-rising popularity of this nonparametric methodology.

Data Envelopment Analysis (DEA) is a data-oriented approach and a linear programming approach used for tackling and comparing the relative efficiency of a set of units called decision-making units (DMUs). It is an effective methodology for performance measurement commonly used in recent years and a popular analytical tool in the „new field of interdisciplinary research of operations research, management science and mathematical economics“ (Chen, 2019). It is considered an “excellent and easy-to-apply approach for modelling operational processes for performance evaluation” (Cooper et al., 2011). By means

of mathematical programming technique, it allows for a relative comparison of the efficiency and performance of each DMU relative to the other entities included in the analysis. This is done through the projection of all DMUs to the DEA frontier and comparing the deviations from the frontier of DEA production (Cvetkoska, 2010; Fan & Sun, 2017). Therefore, DEA is also a frontier methodology.

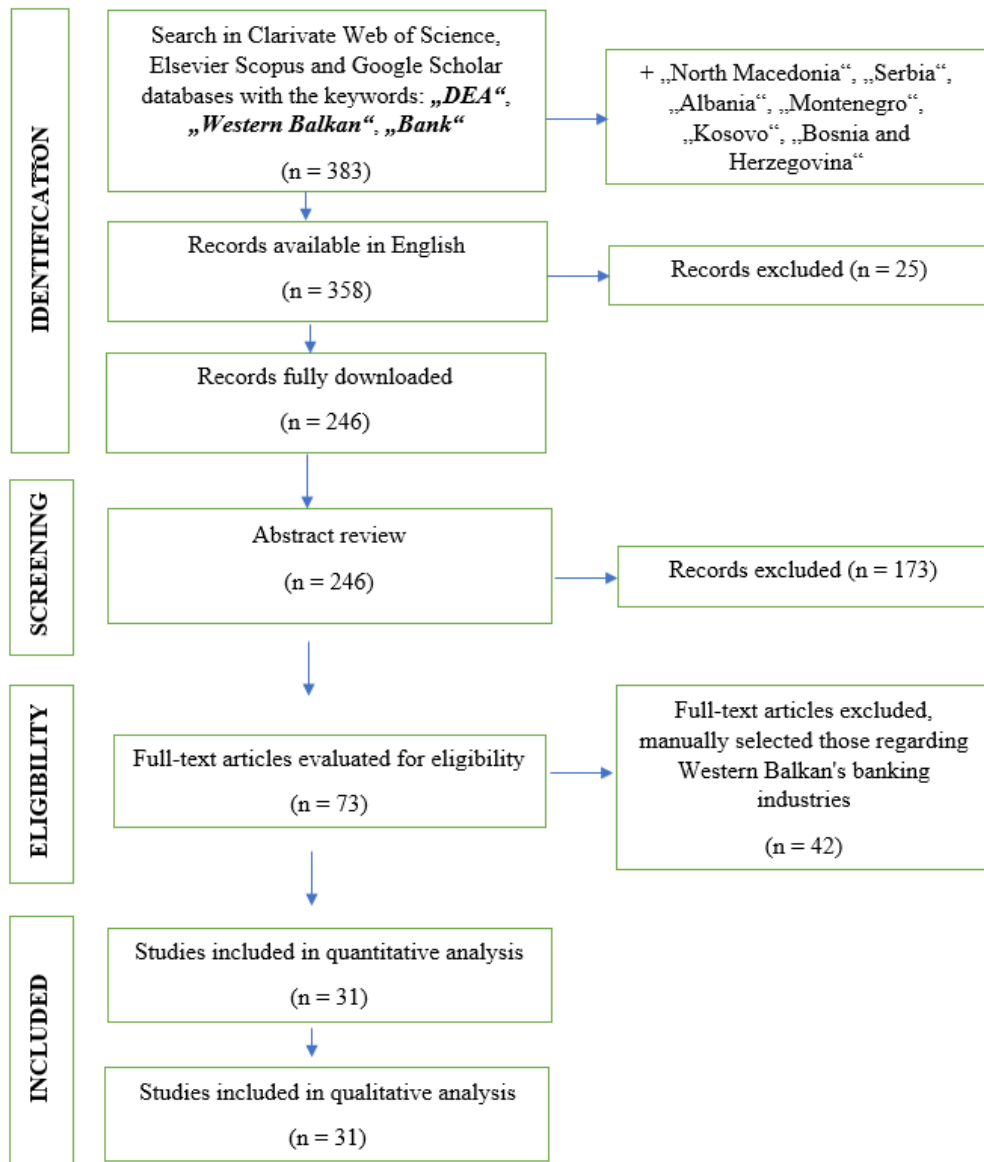
DEA has a few advantages over parametric methodologies. First and foremost, it does not require a prior specification of the model, and it provides information on whether the observed DMUs are positioned below or above the „efficient frontier“ instead (Giustiniani & Ross, 2008). Second, there is no need for pre-required “knowledge of the explicit functional form linking input variables and output variables nor a priori determination of the weights for these variables” (Fotova Čiković & Lozić, 2022). Third, it can handle the use of multiple input and output variables. However, the DEA methodology is not flawless. For example, it is mostly recommended for small samples and its main disadvantage is the assumption “that random errors do not exist”, but this leads to “frontier sensitivity to extreme observations and measurement errors” (Jemrić & Vujčić, 2002).

CCR and BCC are the basic DEA models. The CCR model has been introduced in 1978 and the latter has been developed and introduced in 1984 by Banker, Charnes and Cooper. The main difference between these models is the assumption regarding the returns to scale. The CCR model has a constant return to scale, whereas the BCC model variable return to scale (and therefore, it represents an extension to the CCR model).

### **3. RESEARCH DESIGN**

The used methodology for this work is a systematic literature review (SLR), which represents a very powerful methodology for summarizing past findings in a research field. For this reason, three globally reputable scientific databases have been surveyed, as follows: Google Scholar, Scopus and Clarivate Web of Science. The PRISMA-guided literature review and the research design are presented in Figure 1. In the first step of the research, a survey of the above-mentioned databases has been conducted with the use of several keywords and key phrases in order to encompass all relevant published studies. The used keywords are as follows: “DATA ENVELOPMENT ANALYSIS (DEA)”, “WESTERN BALKAN”, “BANK” and/or “NORTH MACEDONIA”, “SERBIA”, “MONTENEGRO”, “ALBANIA”, “KOSOVO”, “BOSNIA AND HERZEGOVINA”. In the second step, the search was refined and the focus was set on studies published in the English language and on fully downloadable studies. No publication period has been pre-set, which means all the published studies since the introduction of DEA in 1978 have been included. In the following steps (screening and eligibility), an exclusion criterion has been applied to duplicate papers (i.e. papers that were indexed in both Scopus and Clarivate Web of Science database) and to papers that did not concern the banking sectors in Western Balkan countries (which was decided after the initial screening and abstract review). Finally, after applying all of the exclusion criteria, 31 publications remained in the inclusion phase, and they represent the basis for our further and more qualitative analysis, which is carried out in the next section.

Figure 1: The research design and the PRISMA-guided literature review process.



(Source: Authors)

#### 4. RESEARCH RESULTS - APPLICATIONS OF DEA IN BANK EFFICIENCY EVALUATION IN THE WESTERN BALKAN COUNTRIES

This study provides an in-depth literature review on bank efficiency studies with DEA in each of the analysed Western Balkan countries (eight in Serbia, six in North Macedonia, none in Montenegro, three in Albania, three in Kosovo, five in Bosnia and Herzegovina and six cross-country studies that include any of these Western Balkan countries). A detailed overview of the scholarly literature regarding the bank efficiency in each of the analysed countries follows in subsections 4.1.- 4.6.

##### 4.1. Studies on Bank Efficiency with DEA in Serbia

*Mihailović et al. (2009)* employed the DEA methodology and the I-distance procedure to rank the banks in Serbia in the year 2005. They have selected three inputs (total asset, total capital and number of employees) and two outputs (Interest revenue and revenue before taxation) for their output-oriented Andersen – Petersen’s DEA model. The findings show that

only 9 out of 41 banks in Serbia were relative efficient in 2005. Their scientific contribution is reflected in the implementation and combination of two different methodologies when solving the complicated problem of ranking.

**Marković et al. (2015)** measure the productivity change of commercial banks in Serbia over the period 2007- 2010. They implement the DEA methodology with assets, the number of employees and equity as inputs and the total revenue and EBT as outputs and the Malmquist index to estimate the bank efficiency and productivity changes. The obtained results indicate that the mean efficiency of the banking sector in Serbia “does not substantively change from year to year”. Furthermore, they found that the decrease in productivity in the banking sector is not related to technical efficiency, but rather to the reduction in technology.

**Radojicic et al. (2015)** have introduced a novel DEA approach, namely DEA based on the bootstrapping distance-based analysis (DBA). They use four inputs (Number of employees, Fixed assets, Capital and Deposits) and three outputs (Loans, Other placement and Noninterest income) to a sample of 29 Serbian banks that operate in 2010. In this study, they develop six different DEA models: 3 models assumed constant return to scale, and 3 assumed a variable return to scale, 2 models did not use any weight restriction while 4 models did. The obtained results show that in the CCR model there were 7 efficient banks, whereas in the BCC model 18 banks were efficient. The mean efficiency result in the CCR model is 0.867 while in the BCC it is 0.9302.

**Popović, Stanković & Marjanović (2017)** focus on the efficiency of Serbian banks in the period from 2014 to 2016 with the implementation of the input-oriented CRS/VRS DEA methodology. They used interest expenditure, total assets, number of employees and operating expenditures as input variables, whereas interest income and profit before tax as output variables. Their findings show that “almost two-thirds of banks operated inefficiently in the observed period”.

**Lukić, Sokić & Kljenak (2017)** implemented the DEA CCR input-oriented model to a sample of thirty (30) banks in the year 2016. They chose total assets, number of employees and capital as inputs and operating income and net profit as outputs. Their findings indicate that only eight banks were relative efficient, whereas the remaining 22 operated inefficiently.

**Savić et al. (2012)** implemented the input-oriented window CCR DEA technique with an intermediation approach for the sample of 28 Serbian banks in the period from 2005 to 2011, with two inputs (Interest expenses and Non-interest expenses) and two outputs (Interest income and Non-interest income) for the profit efficiency model and four inputs (Number of employees, Fixed assets and intangible investments, Capital and Deposits) and two outputs (Granted loans and deposits and Non-interest income) for the operating efficiency model. Their findings from the profit efficiency model show that only two banks are efficient in the whole observed period, while all the other banks show inefficiencies. According to the operating efficiency model, Erste Bank and Findomestic bank are the only banks that sustained their efficiency (with an exception in the year 2006 for Erste Bank). Furthermore, the majority of banks note efficiency scores between 60% and 70%, regardless of whether it is a profit or operating efficiency of the bank.

**Radojicic et al. (2018)** have analysed the efficiency of 25 Serbian banks from the period 2005–2016. In their study, they highlight the “importance of applying weight restrictions in Data Envelopment Analysis (DEA)” and thus, they introduce a novel approach to GAR DEA, which is based on the multivariate statistics I-distance method. They have selected deposits, personnel expenses, fixed assets and capital as inputs and loans, other placements and non-interest income as outputs for this model. The obtained results indicate that the average efficiency in the observed period was between 0.869 and 0.940. At least 11 banks were efficient in each analysed year, whereas three banks noted relative efficiency in the

whole analysed period. The lowest efficiency score was noted in 2010, whereas the highest was in 2005, 2008 and 2013.

**Bošković & Krstić (2020)** have combined the BCC DEA with the Balanced Scorecard to assess the relative efficiency of all branches of a bank in Serbia, whose identity and observed year are not disclosed. The scientific contribution of this paper is in the fact that the authors “have applied four interconnected DEA models, one for each one of the BSC perspectives, by using the outputs of one model as inputs for the following model”. Each of these four DEA models has two inputs and two outputs. Their findings indicate that the average efficiency of all the analysed branches (a total of ten) varies from 87% to 94.30%.

#### **4.2. Studies on Bank Efficiency with DEA in North Macedonia**

**Giustianiani & Ross (2008)** have measured the degree of competition and relative efficiency of the Macedonian banking system in 33 quarters from end-1997 to end-2005, with the application of both CCR and BCC DEA models with adopting the intermediation approach. They selected deposits (sight, bank, short and long-term deposits) and borrowings (short and long-term) as inputs, whereas loans (placements to other banks and clients) and securities (holdings of central bank bills, government treasury bills and other equity investments) as outputs. The results from the CCR and BCC DEA model show that the average efficiency of the whole banking system was highest in 1997 (0.77 in the CCR and 0.92 in the BCC model), whereas lowest in 2001 (0.45 and 0.75 for CCR and BCC respectively). Moreover, the obtained results from the BCC DEA model show that large banks are in general more efficient than small banks and foreign banks are more efficient than domestic banks. The CCR DEA model confirms that foreign banks are on average more efficient than domestic banks but does not support the result that large banks are more efficient than small-sized banks.

**Micajkova & Poposka (2013)** estimate the technical, pure technical and scale efficiency of the Macedonian banking sector in the period 2008-2011. They implement both the input-oriented CCR and BCC DEA models, with total deposits received and labour costs as input variables and loans to banks and customers, and investments as output variables. The efficiency results show that the average efficiency of the Macedonian banking system has noted an increase in the period 2008-2010, which was followed by a decrease in 2011. Moreover, they found that large banks are the group of banks with the “highest pure efficiency but the greatest scale inefficiency”, whereas the group of small banks is technically the least efficient.

**Naumovska & Cvetkoska (2014)** have implemented the output-oriented CCR DEA model to evaluate the relative efficiency of Macedonian banks in the period from 2003 – 2012. In their DEA model, they have chosen deposits and operating costs as input variables and loans and net interest income as output variables. The efficiency results show that Macedonian banks were most efficient in the year 2008 (90.3%), whereas 2012 was the least efficient year with an efficiency result of 79.8%.

**Naumovska & Cvetkoska (2016)** use the same variables and period as in Naumovska & Cvetkoska (2014) to assess the relative efficiency of Macedonian commercial banks. However, they implement the output-oriented BCC DEA model. The obtained results show that four banks are relative efficient in the whole analysed period (2003 – 2012). The Macedonian banking system was most efficient in 2008 and least efficient in 2009 with 93.6% and 86.9%, respectively.

**Fotova Čiković & Cvetkoska (2017)** implement the output-oriented BCC DEA window analysis technique with three inputs (Total deposits, Interest costs and Operating / non-interest costs) and three outputs (Total loans, Interest revenue and Non-interest revenue). They analyse the period from 2008 to 2015 and their sample consists of 14 commercial banks

operating in North Macedonia. The obtained results show that the average relative efficiency of the whole sample in the analysed period is 88.70%. Moreover, the lowest efficiency result was noted in 2011, whereas the highest efficiency was in 2015 (83.26% and 96.35% respectively). They also found that the group of large banks is the most efficient in the whole banking sector.

The output-oriented BCC DEA window analysis model has been applied by *Cvetkoska and Fotova Čiković (2020)* to a sample of 14 Macedonian banks in the period from 2007 to 2017. They have chosen two input variables (interest and non-interest expenses) and two output variables (interest and non-interest revenue) for their DEA model. Their findings indicate that the GFC (global financial crisis) has left quite an impact on the banking system, lowering its efficiency. According to the results, 2011 has been the least efficient year (with an efficiency score of 65.25%), whereas the year before the GFC has been most efficient (the year 2007 with an efficiency score of 84.04%).

#### **4.3. Studies on Bank Efficiency in Albania**

*Spaho (2015)* measures the efficiency of Albanian banks for the year 2013, using both input-oriented and output-oriented CCR and BCC DEA methods with the intermediation approach and the Tobit regression. The input and output variables for the DEA model were: non-interest expenses and total deposits as inputs and non-interest income and total loans as outputs. The findings of this study showed an average efficiency score of 0.813 with a standard deviation of 0.2. Five of the analysed banks were relative efficient in 2013, whereas the other inefficient banks noted efficiency scores between 0.256 and 0.961.

*Spaho, Mitre & Shehu (2015)* measured the technical efficiency and the super-efficiency of Albanian banks in Albania in the year 2014 using the input-oriented BCC DEA model with the intermediation approach. The variables for the DEA model are total deposits, personnel expenses and fixed assets as inputs and total loans and investments as outputs. The findings show that only 4 out of 16 banks were technically inefficient. The least efficient bank is ProCredit bank with a BCC efficiency score of 0.867. They furthermore ranked the banks using the super-efficiency model. The overall efficiency of Albanian banks in 2014 is relatively high.

*Braimllari & Benga (2019)* have analysed the cost efficiency of Albanian banks in the period 2015-2017 using the input-oriented BCC DEA with the intermediation approach. In their DEA model, they selected three inputs (total deposits, number of employees and fixed assets) and two outputs (total loans and other earning assets). The results for the technical efficiency show that “7 out of 16 banks were technically efficient in 2015; 8 out of 16 banks were technically efficient in 2016 and 9 out of 15 banks were technically efficient in 2017”, showing that each year more banks are technically efficient. As for cost efficiency, the findings show that each year six banks were cost-efficient. The average efficiency score for 2015, 2016 and 2017 were 0.829, 0.804 and 0.837, respectively.

#### **4.4. Studies on Bank Efficiency in Kosovo**

*Zogjani & Kelmendi (2015)* focus on the impact of the global financial crisis 2008/09 on the banking efficiency in Kosovo. In their study, they implemented the DEA methodology with a constant and variable return to scale and the OLS method. The selected variables for the DEA model are total assets and the number of employees as inputs and the level of loans and the level of bank profits as outputs. Their findings indicate „a constant increase of efficiency from 0.795 (CRS & VRS) in 2008 to 0.832 (CRS) and 0.913 (VRS) in 2010”.

*Zogjani, Mazelliu & Humolli (2018)* analyse the efficiency of banking electronic services in Kosovo in the period 2012-2016 with the application of CRS and VRS DEA method and OLS. In their DEA model, they have chosen one input (Net Profit) and three outputs (ATM

Withdrawals, ATM Withdrawals and E-banking Services). Based on the obtained results, the highest technical efficiency based on both CRS and VRS DEA models is noted in the year 2013, whereas the lowest was in 2015 (CRS = 0.70 and VRS = 0.97).

*Sahiti & Sahiti (2021)* focus on the credit risk efficiency to a sample of seven commercial banks in Kosovo for the period 2008-2016 with DEA methodology and Tobit regression. In their DEA model, they have selected three inputs (Ratio of total loans to total assets, Ratio of deposit reserve to total deposits and Credit report overdue) and two outputs (Return on equity and Return on assets). The results from the DEA model show that no bank has been relative efficient in all of the analysed years. Moreover, the results show that Kosovo's commercial banks during this study period experienced a more allocative efficiency than technical and cost-efficiency. Their findings show “a statistically significant positive relationship between bank efficiency, capital adequacy, and loans”. Interestingly, they found that profitability, deposits, costs, bank size, GDP growth, and inflation, are not statistically significant.

#### **4.5. Studies on Bank Efficiency with DEA in Bosnia and Herzegovina**

*Efendić & Avdić (2011)* explored the technical, cost, allocative and scale efficiency of 19 banks in B&H in the year 2009, using the intermediation approach through the input-oriented DEA methodology. Their findings indicate that the B&H banks are “on average significantly inefficient”. Moreover, they found large banks to be the most efficient group in the market and domestic-owned banks to be on average more technically efficient than foreign-owned and banks with mixed ownership. However, foreign-owned banks were found to be more cost-efficient than domestic banks.

*Abu-Alkheil et al. (2012)* have conducted research which focuses on the efficiency performance of two Islamic banks (namely, the Bosna Bank International - BBI in Bosnia & Herzegovina and the Islamic Bank of Britain - IBB in the UK) in comparison with small conventional banks in each country and with small and large Islamic banks from Muslim-majority countries. Their study includes cross-country bank-level panel data for a sample of 23 Islamic banks in 10 countries. However, they focus on 12 small conventional commercial banks in B&H and the UK, six from each country. The DEA methodology with an intermediation approach, OLS regression analysis and Malmquist indexes have been implemented for the four years from 2005 to 2008. The chosen inputs are total deposits and short-term funding, total expenses, and total staff costs, whereas the chosen outputs are as follows: total (non) interest-bearing loans and total revenues. Their findings indicate that both IBB and BBI are technically inefficient and “lag relatively behind their conventional peer banks in terms of efficiency and productivity performance”. BBI shows higher efficiency relative to conventional banks than IBB.

*Memić & Škaljić-Memić (2013)* have focused on the efficiency of B&H banks by implementing DEA methodology for the period from 2008 to 2010 (three years). In their study, they have compared the performances of banks in FBH and RS, taking into consideration the different legal frameworks under which the banks operate. They have applied a modified DEA model suggested by Halkos and Salamouris (2004), with financial ratios as outputs while inputs are not taken directly into consideration. The outputs, i.e. the five financial ratios are ROA, ROE, NIM, 1/EFF and P/L. Their sample constitutes of 26 out of 29 commercial banks operating on the B&H market and the results of the modified DEA model have ranked all of them and banks have been categorized in one of the four predefined efficiency groups: highly efficient, relatively efficient, average efficient and inefficient. They conclude that the “overall average efficiency of the banking sector has improved over the analysed period, even though the profitability has declined”. Furthermore, the five-ratio DEA model shows that in one out of the three observed periods, small-sized banks in Bosnia & Herzegovina are more efficient than large banks.



*Efendić (2017)* has employed the multistage DEA with an output-oriented intermediation approach on a pooled sample of banks in B&H on “a grand-frontier (one frontier for all banks and all years)” in an effort to compare the Islamic and conventional banking efficiency in B&H. The observed period is from 2002 to 2015. The selected variables for the DEA model are as follows: Fixed assets, Deposits, Equity and Operating expenses as inputs and Loans and Other earning assets as outputs. The average efficiency for the whole B&H banking sector “is at a seventy-seven per cent moderate level”, which highlights the improvement possibilities and potentials for the B&H banks. The obtained results show that conventional banks note higher efficiency than the existing Islamic bank. Moreover, they show that larger banks note higher efficiency than small-sized banks.

*Husejinović (2019)* has applied the DEA methodology with two inputs (Capital and Number of Employees) and three output variables (Loan Amount, Deposit Amount and P/L Amount) to measure the efficiency of banks in the Federation of BH in the period 2016-2017. The findings of his research show that large banks note higher efficiency than small-sized banks. Moreover, the efficiency results show a “significant difference in the relative efficiency” of the top two banks and the rest of the banks in the analysed sample. The large UniCredit bank is the most efficient in both 2016 and 2017.

#### **4.6. Cross-country studies on bank efficiencies with DEA in the Western Balkans**

*Toci (2009)* investigates the intermediation bank efficiency in four SEE countries, namely Bulgaria, Croatia, Kosovo and Montenegro in the period 2002-2005, by implementing both CRS and VRS output-oriented multi-stage DEA models. He chose deposits and total costs as input variables and loans net of provisions and total revenues as output variables. The findings indicate that foreign-owned banks „outperform domestic banks in terms of the number of banks dominating the frontier and average efficiency in both the CRS and VRS models and the gap was increasing over the years”.

*Anayiotos et al. (2010)* measure the relative efficiency of banks in emerging Europe in the period before and right after the crisis (i.e. from 2007-2009), using a Data Envelopment Analysis (DEA) under the intermediation approach on a sample of 125 large commercial banks from 14 emerging European economies. They selected total capital, interest expense and operating expense as inputs, whereas total loans, pre-tax profit and securities portfolio as outputs. Their findings suggest that banks were increasingly efficient during the pre-crisis boom, but their relative efficiency fell during the crisis. Moreover, they found “foreign-owned banks in emerging Europe to be less efficient than their mother banks”, but were more efficient than domestic banks in the period before the crisis.

*Toci & Hashi (2013)* explored the intermediation efficiency of banks in four South-East Europe countries (Bulgaria, Croatia, Kosovo and Montenegro) in the period from 2002 to 2005 with an application of the output-oriented DEA model and the Malmquist Index. They implemented both the CRS and VRS DEA models with deposits and total costs as inputs and loans net of provisions and total revenues as outputs. Their findings show that “Bulgarian banks are, on average, more efficient in intermediation than Croatian banks, while banks in Kosovo appear to be the least efficient compared to other countries in the region”. Furthermore, the efficiency results indicate that foreign banks are more efficient than domestic banks and more importantly, that the efficiency gap had “continuously widened”. They also found large banks to be more efficient than small-sized banks.

*Varesi (2015)* conducted a comparative study of the banking efficiencies of six Western Balkan countries (Albania, Bosnia & Herzegovina, Kosovo, Macedonia FYR, Montenegro and Serbia) in the period from 2007 to 2012. She used both CCR and BCC DEA models with an intermediation approach with two inputs (Number of branches and Total assets) and one output (Total loans). The average technical efficiency from the DEA CRS model for the

whole analysed period 2007-2012 and the whole sample is at 0.686 or 68.6%. The BCC DEA model show higher technical efficiency results of 0.921 (92.1%) and the scale results (CRSTE/VRSTE) are at 0.735 (73.5%). The obtained results show that Albania notes the lowest technical efficiency (0.433) whereas Montenegro highest efficiency. The other four Western Balkan countries noted efficiency results as follows: Kosovo noted 0.481, Macedonia 0.616, Serbia 0.617 and Bosnia and Herzegovina 0.939.

*Cvetkoska, Fotova Čiković & Tasheva (2021)* have measured the relative efficiency of the banking sectors of three developing economies, i.e. North Macedonia, Serbia and Croatia with the implementation of the DEA BCC output-oriented model in the period from 2015 to 2019. They have selected interest and other operating (non-interest) expenses as input variables, and interest and other operating (non-interest) revenues as output variables. They furthermore apply the super-efficiency procedure and identify outliers and provide targets for improvement for the inefficient banks by using DEA. Their findings show that the Macedonian commercial banking system notes the highest efficiency (91.1%), and is followed by the Croatian (90.9%) and the Serbian (81.9%) banking system.

*Milenković et al. (2022)* employed a two-stage DEA analysis for the Western Balkan countries in the period from 2015 to 2019. In the first stage of their research, they explored the efficiency of the intermediate function of banks with the application of an output-oriented DEA model using three inputs (deposits, labor costs, and capital) and two outputs (loans and investments), whereas in the second phase they employed the regression analysis to determine the influence of the bank size, type of bank and mergers and acquisitions (M&A) transactions on the banks' efficiency. In their study, they focus on six Western Balkan countries (Serbia, Bosnia and Herzegovina, Montenegro, North Macedonia, and Albania).

A synthesis of the above-stated findings is given in Table 1 below.

*Table 1. Findings of the surveyed papers.*

<i>North Macedonia</i>	<i>Bosnia and Herzegovina</i>	<i>Serbia</i>	<i>Albania</i>	<i>Kosovo</i>
The average efficiency of the whole banking system was highest in 1997, whereas lowest in 2001. Large banks are in general more efficient than small banks and foreign banks are more efficient than domestic banks <b>(Giustianiani &amp; Ross, 2008)</b>	Large banks are the most efficient group in the market and domestic-owned banks are on average more technically efficient than foreign-owned and banks with mixed ownership <b>(Efendić &amp; Avdić, 2011)</b>	Only 9 out of 41 banks in Serbia were relative efficient in 2005 <b>(Mihailović et al., 2009)</b>	An average efficiency score of 0.813. Five of the analysed banks were relative efficient in 2013 <b>(Spaho, 2015)</b>	„A constant increase of efficiency from 0.795 (CRS & VRS) in 2008 to 0.832 (CRS) and 0.913 (VRS) in 2010” <b>(Zogjani &amp; Kelmendi, 2015)</b>
Large banks are the group of banks with the “highest pure efficiency but the greatest scale inefficiency”, whereas the group of small banks is technically the least efficient <b>(Micajkova &amp; Poposka, 2013)</b>	Both IBB and BBI are technically inefficient” <b>(Abu-Alkheil et al., 2012)</b>	The mean efficiency of the banking sector in Serbia “does not substantively change from year to year” <b>(Marković et al., 2015)</b>	The overall efficiency of Albanian banks in 2014 is relatively high <b>(Spaho, Mitre &amp; Shehu, 2015)</b>	Highest technical efficiency is noted in 2013, whereas the lowest in 2015 <b>(Zogjani, Mazelliu &amp; Humolli, 2018)</b>

<p>Macedonian banks were most efficient in the year 2008 (90.3%), whereas 2012 was the least efficient year with an efficiency result of 79.8% (Naumovska &amp; Cvetkoska, 2014)</p>	<p>The “overall average efficiency of the banking sector has improved over the analysed period, even though the profitability has declined” (Memić &amp; Škaljić-Memić, 2013)</p>	<p>The mean efficiency result in the CCR model is 0.867 while in the BCC it is 0.9302 (Radojicic et al., 2015)</p>	<p>Each year more banks are technically efficient (Braimllari &amp; Benga, 2019)</p>	<p>“A statistically significant positive relationship between bank efficiency, capital adequacy, and loans” (Sahiti &amp; Sahiti, 2021)</p>
<p>The Macedonian banking system was most efficient in 2008 and least efficient in 2009 (Naumovska &amp; Cvetkoska, 2016)</p>	<p>Conventional banks note higher efficiency than the existing Islamic bank. Larger banks note higher efficiency than small-sized banks (Efendić, 2017)</p>	<p>“Almost two-thirds of banks operated inefficiently in the observed period” (Popović, Stanković &amp; Marjanović, 2017)</p>		
<p>Average relative efficiency is 88.70%. The lowest efficiency result was noted in 2011, whereas the highest efficiency was in 2015. The group of large banks is the most efficient in the whole banking sector (Fotova Čiković &amp; Cvetkoska, 2017)</p>	<p>Large banks note higher efficiency than small-sized banks (Husejinović, 2019)</p>	<p>Only eight banks were relative efficient, whereas the remaining 22 operated inefficiently (Lukić, Sokić &amp; Kljenak, 2017)</p>		
<p>2011 has been the least efficient year, whereas the year 2007 was most efficient (Cvetkoska and Fotova Čiković, 2020)</p>		<p>The majority of banks note efficiency scores between 60% and 70%, regardless of whether it is a profit or operating efficiency of the bank (Savić et al., 2012)</p>		

The lowest efficiency score was noted in 2010, whereas the highest was in 2005, 2008 and 2013. The obtained results indicate that the average efficiency in the observed period was between 0.869 and 0.940  
**(Radojicic et al., 2018)**

The average efficiency of all the analysed branches (a total of ten) varies from 87% to 94.30%  
**(Bošković & Krstić, 2020)**

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#### Cross-country studies

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<p>Foreign-owned banks „outperform domestic banks in terms of the number of banks dominating the frontier and average efficiency in both the CRS and VRS models and the gap was increasing over the years” <b>(Toci, 2009)</b></p>	<p>“Foreign-owned banks in emerging Europe to be less efficient than their mother banks” <b>(Anayiotos et al., 2010)</b></p>	<p>Foreign banks are more efficient than domestic banks and large banks to be more efficient than small-sized banks <b>(Toci &amp; Hashi, 2013)</b></p>	<p>Albania notes the lowest technical efficiency whereas Montenegro highest efficiency <b>(Varesi, 2015)</b></p>	<p>The Macedonian commercial banking system notes the highest efficiency (91.1%), and is followed by the Croatian (90.9%) and the Serbian (81.9%) banking system <b>(Cvetkoska et al., 2021)</b></p>
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The impact of the COVID-19 pandemic on the banking sector efficiencies has not been explored yet. Therefore, this study will be the first empirical study that would incorporate the first COVID-19 year and its impact on the Western Balkan banking systems.

## 5. DISCUSSION OF THE RESULTS

Banks hold a very special position in the financial systems of developing countries, such as the Western Balkan countries. Their financial systems are “bank-centric” and impact massively on the stability of the whole financial system. Therefore, the need to investigate the efficiency of banks has become crucial to the maintenance of the national financial stability. The DEA methodology is the leading nonparametric approach for efficiency measurement that is mostly used in the banking industry, along with the supply chain, public sector, agriculture and transportation industry (Emrouznejad & Yang, 2018).

The conducted in-depth systematic PRISMA-compliant literature review reveals many interesting facts and states in the Western Balkan countries that bring new insights for bank management, governments and regulators. This review has highlighted the discrepancies in the application of the DEA in different countries (i.e. by different scholars). For example, most of these studies have been published regarding the Serbian and Macedonian banking sectors, and there aren't any studies employing DEA in the evaluation of banking in Montenegro. Therefore, in future work, the application of the DEA methodology in an empirical assessment of the relative efficiency of the Montenegrin banking system is recommended. Considering the great advantages DEA has to offer, this study represents an incentive for scholars in the observed Western Balkan countries to employ this methodology more often in banking but also other industries.

This literature review indicates that the surveyed studies have been published in the period between 2008 and 2022. Most of the 31 surveyed papers employ both the CCR and BCC DEA models. However, there are some differences between the applications between countries. For instance, the studies regarding the Macedonian banking sector mostly apply the BCC DEA model, whereas the Serbian studies mostly employ the CCR DEA model. The studies regarding the Kosovar banking system all include both the BCC and CCR DEA models. Only 3 studies (Savić et al., 2012; Fotova Čiković & Cvetkoska, 2017; and Cvetkoska and Fotova Čiković, 2020) have incorporated the window technique DEA model, which calls for the additional presentation of the window DEA methodology in future work. Many different approaches have been combined with the DEA methodology in this review, such as the I-distance procedure in Mihailović et al. (2009); the superefficiency procedure in Cvetkoska, Fotova Čiković & Tasheva (2021) and Spaho, Mitre & Shehu (2015); the Malmquist Index in Marković et al. (2015), Abu-Alkheil et al. (2012) and Toci & Hashi (2013); the OLS method in Abu-Alkheil et al. (2012), Zogjani & Kelmendi (2015) and Zogjani, Mazelliu & Humolli (2018); the bootstrapping distance-based analysis (DBA) in Radojicic et al. (2015); the Tobit regression in Sahiti & Sahiti (2021) and Spaho (2015); the Balanced Scorecard in Bošković & Krstić (2020) etc. Moreover, Radojicic et al. (2018) have introduced a novel approach to GAR DEA, which is based on the multivariate statistics I-distance method.

## **6. CONCLUSION**

The findings of these studies are really interesting and reveal new insights that could be beneficial to all bank stakeholders. As shown in Table 1, most of the surveyed papers found that large banks are the most efficient group of banks in the Western Balkan countries (Giustianiani & Ross, 2008; Efendić & Avdić, 2011; Efendić, 2017; Toci & Hashi, 2013; Fotova Čiković & Cvetkoska, 2017; Micajkova & Poposka, 2013). Moreover, most of these studies found that foreign banks are more efficient than domestic banks (Giustianiani & Ross, 2008; Toci, 2009; and Toci & Hashi, 2013). However, some studies claim quite the opposite. Namely, Anayiotos et al. (2010) found “foreign-owned banks in emerging Europe to be less efficient than their mother banks”, but were more efficient than domestic banks in the period before the crisis and Efendić & Avdić (2011) found domestic-owned banks to be on average more technically efficient than foreign-owned and banks with mixed ownership. Sahiti & Sahiti (2021) concluded that there is “a statistically significant positive relationship between bank efficiency, capital adequacy, and loans”.

The main objective of this paper is to identify, survey, analyse and summarize the past findings regarding the efficiency of the banking sectors with the Data Envelopment Analysis methodology in the six observed Western Balkan countries as follows: North Macedonia, Serbia, Montenegro, Kosovo, Albania and Bosnia and Herzegovina (B&H). Notwithstanding,

another goal was to give a short theoretical background on the DEA methodology and present its strengths and limitations.

This paper is not without limitations. Namely, the authors have explored all the relevant scientific databases in order to identify all the published relevant work in this field. However, there is a possibility that not all published work regarding bank efficiency with DEA in the Western Balkans has been presented in this review.

In future work, the authors will focus on an empirical study incorporating all of the banking sectors in these six Western Balkan countries to reveal how has the COVID-19 pandemic reflected in the banks' efficiency in these countries. This would represent a major scientific contribution to this research field, since there has not been a published study regarding the efficiency of the banking sectors of the six Western Balkan countries, and there has not been a study comparing the impact the COVID-19 pandemics had on the efficiency and performance of these countries' banking systems.

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