Original scientific paper
UDC: 336.71:005.216.1(497.5)
https://doi.org/10.18045/zbefri.2021.2.349

Efficiency of banks in Croatia*

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Abstract

Croatian banking sector amounts to the majority of its financial sector. Therefore, it is necessary that Croatian banks operate efficiently. In the past two decades, the Croatian banking sector went through a consolidation process that steadily decreased the number of banks and allocated the majority of assets and market share to a few large banks. A simple definition of efficiency is cost minimization and profit maximization. Therefore, a bank is efficient when it strives to minimize its costs while maximizing its profits. This paper aims to estimate efficiency of Croatian banks using the DEA methodology within the period 2014-2019. In addition, the performance indicators (return on assets, return on equity) calculated for the same period aim at comparing performance indicators to efficiency results. The results indicate that larger banks are generally more efficient in operating on the frontier. And, in comparison to performance indicators, they achieve higher levels of returns on assets and equity. Furthermore, some small banks tend to be efficient, while the benefits of being a medium bank are inconclusive since the results reveal that some medium banks have below average efficiency. Overall, average efficiency improved in the observed period, which means that the consolidation process of financial institutions creates large and efficient banks.

Key words: *banking efficiency, Data Envelopment Analysis, financial consolidation, Croatian banking sector*

JEL classification: *G21, C61, C67*

* Received: 29-06-2021; accepted: 22-12-2021

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1. Introduction

Financial institution performance plays a crucial role in the economic growth and development of a country. Therefore, banks being the most prominent financial institutions must operate efficiently. Being efficient has several benefits for banks since it implies that they maximize profits, minimize costs, offer competitive financial products, are less prone to liquidity problems, and are less affected by economic downturns. Traditionally, the efficiency estimated by using simple ratios of accounting data (such as performance indicators: return on assets – ROA and return on equity – ROE) is available from financial statements. However, it is possible to use complex methods in efficiency estimation such as econometric models (Stochastic Frontier Approach – SFA) and non-parametric linear programming models (Data Envelopment Analysis – DEA) that evaluate if a decision-making unit (DMU) is operating on the frontier. In other words, DEA provides information on the efficiency of DMU's as well as, if a DMU is not operating on the frontier, on how inefficient it is. Both approaches have their advantages and disadvantages (see Učkar and Petrović, 2021), mainly the sample size (stochastic requirement) and the requirement for a priori assumptions on the form of the production function for the former, and the lack of addressing noise – increased sensibility to incorrect data for the latter.

In this paper, the DEA methodology implemented to estimate bank efficiency in Croatia covers the period of 2014-2019. The DEA, a non-parametric method, which through the usage of multiple-input and output variables, enables the comparison of relative efficiency among banks to assess the distance of each DMU (decision-making unit) to the frontier. This method is particularly suitable for efficiency estimation of the Croatian banking market that is a too-small sample to implement in other economic models. Namely, after a decades-long financial consolidation process, only 20 banks operate on the Croatian banking market. After gaining independence in the early 1990s, the Croatian economy, being in transition to a market-based economy started with an increase of small, privately-owned, and foreign banks, but then, for the past two decades, there has been a consistent decline in the number of banks, as well as the increase of market share of several large banks, making the market more competitive for new players. Today, Croatian banking market is predominantly foreign owned where the two largest banks operate with nearly half of total assets, and the four largest banks control more than 70% of total assets (Croatian National Bank, 2021). Therefore, it is accurate to define the Croatian banking market as highly consolidated.

The main goal of this paper is to estimate the efficiency of Croatian banks and evaluate the efficiency of the largest banks by comparing the attained efficiency results and performance indicators levels (ROA and ROE). With the main goal in mind, we propose the following research hypothesis:

H1: Large banks are more efficient than small or medium banks.

Efficiency can be defined as an optimization problem of profit maximization and/or cost minimization. In other words, efficiency can be defined in simple terms as *given a set amount of inputs, firms focus to produce the maximal amount of output/s (profit maximization); given a set amount outputs, firms focus on employing as little as possible of inputs (cost minimization).* Certainly, this is a strictly narrow definition of efficiency and it definitely neglects other important roles of banks in society. This wider view of banking efficiency through the lenses of Environmental, Social, and Governance (ESG), as well as, banks' Corporate Social Responsibility (CSR) is beyond the scope of this paper. Although, there is some empirical evidence that the relationship between banks' corporate social performance and financial performance could be positive, however more research is needed to corroborate this theory (see Soana, 2011). There are several reasons why should managers, investors, and other stakeholders be concerned with the efficiency of financial institutions, in our case banks. Firstly, the basic definition of efficiency mentioned above is in line with the theory of the firm. The theory of the firm is a microeconomic theory that postulates that firms are decision-making entities that maximize profits. Although there is valued criticism on the assumptions of this theory, see Coase (1995), Branch (1973), Machlup (1967), Cyert and Hedrick (1972), and Demsetz (1988), it is noteworthy that the given definition of efficiency is in line with the postulates of the theory of the firm (profit maximization and cost minimization). For example, Demsetz (1988: 143–144) states that, in the model of the theory of the firm, the only task management seems to focus on, is the selection of profit-maximizing quantities of inputs and outputs. The author further states that Knight's analysis of the firm "as an institution for efficient risk-sharing is based on risk aversion and costly knowledge", is an important conclusion in the case of financial institutions. Cyert and Hedrick (1972) argue that the environment determines the sole objective of the firm, that is, profit maximization because any other behavior of the firm will lead to its extinction. Jensen and Meckling (1976: 306–307) argue that the literature of economics references to "the theory of the firm" is, in reality, a theory of markets in which firms are important actors. The firm is a "black box" operated to meet the relevant marginal conditions with respect to inputs and outputs, thereby maximizing profits, or more accurately, present value. Branch (1973: 26) states that the market slowly recognizes the superior performance of firms, and it is in general difficult to, with a high degree of conviction, determine the performance of firms using the information available (accounting data, financial statements, public announcements, media coverage). However, as good results continue, the market will tend to value such firms more highly, thereby rewarding the earlier stockholders with higher stock prices generating a higher return. Furthermore, Coase (1995) states that there are several reasons that will determine the size of the firm. According to the author, the firm will grow larger as long as the costs of the organization are decreasing with size, and as long as the costs rise slower with the increase in the number of transactions. It is necessary to take into account that technological change – inventions that tend to bring factors of production nearer

together (inputs), by lessening spatial distribution, tend to increase the size of the firm.

For the stakeholders and the bank management, achieving the highest profits possible certainly is one of their priorities. The majority of their compensation is tied to the bonuses awarded after certain performance objectives are achieved. On the other hand, there are benefits in focusing on cost efficiency since a decrease in cost (inputs) will directly translate to an increase in profits, while the rise in income will first be affected by the cost increases of increased production and taxes before translating to the increase in profits. The compensation structure is put in place by investors – shareholders whose main goal is attaining ever so increasing returns from the investment in the firm (through dividends and capital gains) to motivate the management to maximize profits and minimize costs. Therefore, a bank that efficiently employs given inputs in the provision of financial services to its clients creates more value for its management and shareholders. Furthermore, there is empirical evidence that more efficient banks are less prone to problems in times of crisis. Efficient banks are better at allocating their resources and are less prone to failures. Greater stability of a bank means that the jobs of its employees will be less impaired during market turmoil and the longevity of the firm will not be questioned. Furthermore, since there is evidence that efficient banks are less prone to problems during turmoil, government regulatory and supervisory institutions may allow an efficient bank with better management, more room for leverage (Altunbas et al., 2007). Because of financial consolidation, the majority of assets and deposits are concentrated into a few large financial institutions (often called "*too big to fail*" (TBTF) because their peril would greatly increase systemic risk, endanger the stability of the financial system, and greatly affect the real economy). As shown during the last financial crisis of 2007, these institutions have been closely interconnected. Therefore, regulatory and supervisory institutions focus on the performance of TBTF institutions to ensure the overall stability of the financial system and the economy. However, increased efficiency can also benefit physical (private) and business (public) clients since more efficient banks will on one hand, as discussed before, be more stable and less prone to liquidity problems. On the other hand, efficient banks will be more competitive, have a higher market share, and offer more affordable financial services and new products using innovative technologies. Consequently, more affordable financial products and services will stimulate new investments and consumption, therefore, in the end, stimulating the economy as a whole.

This paper is structured in sections as follows: Section 2 focuses on a literature review on efficiency estimation of financial institutions based on empirical research. Efficiency analysis of financial institutions belongs to a vast field of empirical research, but there have been just a few studies that focus on the efficiency of Croatian financial institutions (see Jermić and Vujčić (2002), Jurčević and Žaja (2013) and Peša et al. (2021)). Section 3 presents the DEA methodology and

models used in this paper. In this paper, two input-oriented models using different approaches (intermediation and operating approach) are implemented by using CCR and BCC models. Section 4 presents empirical data and describes the banking sector in Croatia and the effects of bank consolidation. Furthermore, this section provides profitability indicators (ROA and ROE) and efficiency results for the observed period. Section 5 discusses the attained efficiency results and compares them with similar studies. Section 6 concludes and addresses topics for future research.

2. Literature review

Efficiency estimation in banking is an important field of study. Numerous empirical studies examine bank efficiency. Berger and Humphrey (1997) conducted surveys of over 100 studies on financial institution efficiency. These surveys have been common in the past twenty years and helped consolidate the vast number of studies and empirical knowledge obtained through them. More recently, Kaffash and Marra (2017) used a citation network for the analysis and qualitative investigation of 620 most relevant papers from 1985 to 2016 that provide an overview of the most recent applications and methodological advancements of the DEA methodology in financial services. The results for the three observed areas (banking, insurance industry, and money market funds) suggest that no obvious methodological preferences exist.

Stability and efficiency of financial institutions, predominantly banks, have become increasingly important since the financial and economic crisis of 2007. According to Berger and Bouwman (2013), not only is the bank's survival a central item to strategic decisions made by bank managers (and other stakeholders, investors), but also to decisions made by regulators who are concerned about the stability of the banking system. Furthermore, they investigate how capital affects bank performance during financial crises. Their findings corroborate the theory that capital helps to enhance the survival probability to small banks at all times, to medium and large banks preliminary during banking crises. Radić et al. (2012) study the role of liquidity risk and capital risk exposure in investment banking efficiency estimation. The results highlight that investment banks with higher liquidity risk are penalized in the case of cost efficiency but have an advantage in generating profits, while higher capital levels appear to increase cost efficiency and reduce profit efficiency (Radić et al. 2012: 83).

Acharya et al. (2011) examine four primary failures that contributed to the financial crisis of 2007 (excessive risk-taking, the regulatory focus on individual risk, financial derivatives externalities – individual firm failures, and runs on unregulated banking sector). Authors propose reforms to address these failures, such as proper

pricing of government guarantees regarding risk, proper pricing of systemic risk (internalization of costs of negative externalities imposed by individual firm's actions), greater transparency of over-the-counter (OTC) market for derivatives, and the implementations of liquidity requirements for financial institutions. Given the current state of financial regulation, it is possible to say that these proposed reforms have been to a degree addressed and implemented.

Assaf et al. (2019) examine how bank efficiency during ordinary times affects survival, risk, and profitability during subsequent financial crises. The findings provide insight into cost-efficiency. During normal times, cost-efficiency seems to reduce bank failure probabilities and during a financial crisis, it decreases risk and enhances profitability. On the other hand, the authors state that profit efficiency has limited benefits. Furthermore, results propose that cost efficiency is the most adequate for measuring management quality, while there is a possibility that enhanced profit efficiency is a consequence of temporary high returns from risky investments. Assaf et al. (2019) argue that these findings may steer policyholders, regulators, supervisors, and managers to concentrate on cost efficiency during normal times to assure better financial crisis performance in the future.

Jurčević and Žaja (2013) investigate the efficiency of banks and insurance companies in the period of the financial crisis in Croatia. The results suggest that competition during normal periods, or periods of expansion (economic boom), may positively affect the efficiency of financial institutions. Efficiency decreases at the beginning of the crisis, but by implementing saving activities and expense cuts as early as possible to prevent further losses during the crisis, efficiency remarkably recovers in the next period. Benazić and Radin (2015) study the quantitative impact of main Croatian macroeconomic variables on non-performing placements and off-sheet liabilities of Croatian banks. The econometric analysis suggests that the real GDP is the main driver of the non-performing placements and off-balance sheet liabilities in Croatia in the observed period (March 1997 – September 2013), while an increase in prices, unemployment, interest rate, and the depreciation of national currency increase non-performing placements and off-balance sheet liabilities in Croatia. Therefore, the authors conclude that key macroeconomic variables examined in their study are a major factor in banking and financial crises. Authors stress that effective bank management, increased financial regulation, and prudence from regulatory and supervisory institutions needs to recognize and quantify these effects to effectively mitigate future crises.

This discussion highlights the evidence of the well-researched topic of the efficiency of banks. Papers that focus on M&A activities of financial institutions generally corroborate the hypothesis that these activities can positively affect efficiency and the notion that larger institutions tend to be more efficient. DeYoung et al. (2009) provide a review of over 150 studies on financial institutions' mergers and acquisitions. The results of this review prove that, in general, North American

and European bank mergers result in efficiency improvements. González-Torres et al. (2020) systemically review the research on sustainability in mergers and acquisitions. Liargovas and Repousis (2011) study the effects of M&A on the performance of the Greek banking sector. Unlike other studies, the results imply that Greek M&A activities did not create wealth for the shareholders of the combined entity. Finally, Huizinga et al. (2001) studied the efficiency effects of bank mergers in Europe over the period 1994-1998. Their findings were in line with previously mentioned studies in the sense of scale and cost efficiency gains from banks M&A activities.

The versatility of the DEA methodology is visible in its implementation in other sectors such as in medicine where is used to measure hospital efficiency and in public finance where is used in measuring the efficiency of local and regional self-government units. For example, Rabar and Grbin (2019) study the regional efficiency in Croatia using fiscal indicators. Their results show that the number of employees is the main source of inefficiency for local and regional self-government units. Furthermore, there are numerous empirical studies on the effect of M&A activities on the efficiency of firms in other sectors, such as the telecommunications industry or energy providers. Salleh et al. (2013) study the efficiency of M&A in Malaysian telecommunication companies. Results suggest that larger telecommunication companies are generally more efficient than smaller ones. Chin et al. (2004) research the impact of mergers and acquisitions on IT governance structures. It is concluded that multinational corporations with decentralized organizational structures might adopt a centralized IT structure to take the advantage of the economies of scale. On the other hand, Majumdar et al. (2007) find that mergers of telecommunications firms have a negative impact on their efficiency. Çelen (2013) analyses the effects of M&A activities on the Turkish electricity distribution market. Using the SFA method to measure the efficiency of electricity distribution organizations before and after mergers, the author concludes that the mergers between electricity distribution organizations increased the efficiency levels. The empirical evidence presented stresses the importance of financial institutions' efficiency. In the following section, we outline the methodology used in measuring the efficiency of banks in Croatia in the period from 2014 until 2019.

3. Methodology

There are several approaches to measuring the efficiency of financial institutions. Učkar and Petrović (2021) state that models in efficiency estimation is equally divided between parametric (econometric) models such as stochastic frontier approach (SFA) and non-parametric models such as data envelopment analysis (DEA). Both of these widely used methods have their advantages and disadvantages. Ferrier and Lovell (1990) measure cost efficiency in banking using an econometric stochastic frontier

approach and a non-parametric linear programming approach on the same sample to examine the similarities and differences of the results. It is concluded that the results from both approaches in most parts are similar in the impact of scale, and allocative efficiency. The approaches are limited in providing information on the existence of economics of diversification. The DEA methodology is used in this paper for several reasons. First, the DEA is a non-parametric linear programming model that not only can be viewed as a measure of efficiency but is as well, a balanced benchmarking method. Furthermore, there are several issues that are needed to be addressed prior to implementing this method in efficiency analysis, such as the purpose, the choice, and ratio of input-output variables, model orientation, and what data the model uses, as Cook et al. (2014) state. These problems were addressed prior to implementing the DEA methodology on Croatian banks. As stated in Cook et al. (2014) the number of input/output variables should not exceed half of the DMUs in the sample (a consensus in the empirical literature is that the number of DMU's in the sample should exceed the number of input/output variables at least three times). In this paper, input-oriented models are used, since given the size of the Croatian financial sector the output quantities are presumed fixed, and it is recognized that decision makes (banks) have more control over their inputs.

Thanassoulis (1999) states that the production and the intermediation approaches in measuring efficiency are not exclusive but complementary, as well that DEA studies in banking are predominantly based on the production approach at the branch level. Furthermore, the author states that one of the new areas where DEA can contribute to efficiency analysis is the *assessment of effectiveness in minimizing financial risk at the branch level* (Thanassoulis, 1999: 10–11). DEA methodology is applied in this paper, specifically CCR and BCC models proposed respectively by Charnes et al. (1978) and Banker et al. (1984). Defining the input and output variables greatly affects the results of efficiency estimation. This study uses two approaches similar to Jermić and Vujčić (2002) and implements the intermediation and the operating approach. The intermediation approach defines input and output variables regarding a bank's intermediary services that allocate funds from monetary sufficient to monetary deficient entities. On the other hand, the operating approach ties inputs and output variables to banks' operations. Both approaches implement four input and two output variables for each bank (DMU).

For the intermediation approach input variables are (denoted as x_{ij} for every input i=1,…,4 and j=1,...,n; n=20 denotes each of 20 commercial banks):

- Input 1 (x_{1j}) – fixed and intangible assets (defined as net value after amortization where intangible assets predominantly refer to banks investments in software)
- Input 2 (x_{2j}) – number of employees
- Input 3 (x_{3j}) – total deposits received

– Input 4 (x_{4j}) – other liabilities (defined as the difference between total liabilities and deposits received)

The output variables for the intermediation approach are (denoted as y_{ij} for every input i=1,…,2 and j=1,...,n; n=20 denotes each of 20 commercial banks):

– Output 1 (y_{1j}) – total loans (defined as the total amount of approved loans)

– Output 2 (y_{2j}) – securities (defined as government and private securities)

For the operating approach input variables are (denoted as x_{ij} for every input i=1,…,4 and j=1,...,n; n=20 denotes each of 20 commercial banks):

– Input 1 (x_{1j}) – interest cost

– Input 2 (x_{2j}) – non-interest cost

– Input 3 (x_{3j}) – labor related administrative costs (defined as gross wages and other employee costs)

– Input 4 (x_{4j}) – other administrative costs (including amortization, advertising and representation)

The output variables for the intermediation approach are (denoted as y_{ij} for every input i=1,…,2 and j=1,...,n; n=20 denotes each of 20 commercial banks):

– Output 1 (y_{1j}) – interest income

– Output 2 (y_{2j}) – non-interest income (fees and commissions income)

The main advantages of the DEA methodology are its simplicity in implementation as well as that it does not require a formulation of a production function and the relationships (assumptions) between input and output variables. On the other hand, a different combination of input and output variables or applying different models will produce different efficiency results. However, the main disadvantage of the DEA method, which is a non-stochastic method, is not incorporating a random variable to address noise, and therefore, is particularly sensitive to inaccurate information. Furthermore, implementing DEA methodology to survey data can severely affect the quality of the efficiency results as the survey data tend to be, to a certain degree, inaccurate. It is necessary to address that the application of the DEA methodology is not aimed at the efficiency of one DMU (bank) but in general, the goal is to identify those DMUs that are below the "frontier", i.e., inefficient to some degree.

3.1. The CCR model

Charnes et al. (1978) proposed a model that assumes constant returns to scale (CRS) and produces results on total (global) technical efficiency. Efficiency in this model is obtained as the ratio of weighted outputs to weighted inputs for each DMU.

To estimate relative efficiency of a DMU it is necessary to solve the following fractional programming problem (for a more detailed look on DEA methodology see Cooper et al., 2007) in (1) to (4) to obtain values for the input "weights" (vi) where i = 1,…, m and the output "weights" (ur) where r = 1,…, s. The programing model takes a fractional form:

$$\max_{u,v} \theta\,(u, v) = \frac{u_1 y_{1j} + u_2 y_{2j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + v_2 x_{2j} + \cdots + v_m x_{mj}} = \frac{\sum_{r=1}^{s} u_{r0}}{\sum_{i=1}^{m} v_i x_{i0}} \tag{1}$$

subject to

$$\frac{u_1 y_{1j} + \cdots + u_s y_{sj}}{v_1 x_{1j} + \cdots + v_m x_{mj}} = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, \text{ where } j = 1,\ldots, n \tag{2}$$

$$u_r \geq 0, \text{ r} = 1,\ldots, \text{s} \tag{3}$$

$$v_i \geq 0, \text{ i} = 1,\ldots, \text{m} \tag{4}$$

The fractional programming model from (1) to (4) has an infinite number of solutions. If some (u^*, v^*) is optimal, then for each positive scalar c, (cu^*, cv^*) is also optimal. Using the transformation in (5) it is possible to select a representative solution (u, v) for which we define the weighted sum of input variables equal to 1.

$$\sum_{i=1}^{m} v_i\, x_{i0} = 1 \tag{5}$$

The optimal solution from (5) simplifies the fractional programming problem from (1) to (4) into a linear programming problem for each DMU. The CCR model now can be written as:

$$\max_{u,v} z_0 = \mu_1 y_{1o} + \cdots + \mu_s y_{so} = \sum_{r=1}^{s} \mu_r y_{r0} \tag{6}$$

subject to

$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} v_i\, x_{ij} \leq 0, j = 1, \ldots, n \tag{7}$$

$$\sum_{i=1}^{m} v_i \, x_{i0} = 1 \tag{8}$$

$u_r \geq 0$, r = 1,…, s (9)

$v_i \geq 0$, i = 1,…, m (10)

The dual of the linear programming problem (6) to (10) for each DMU can be written as:

$$\min_{\lambda} z_0 = \Theta_0 \tag{11}$$

subject to

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, r = 1, \dots, s \tag{12}$$

$$\Theta_0 x_{i0} - \sum_{j=1}^{n} \lambda_j \, x_{ij} \geq 0, i = 1, \dots, m \tag{13}$$

$\lambda_j \geq 0$, j = 1,…, n (14)

where θ_0 is a scalar and its value denotes the efficiency score for the i-th DMU, and λ_j is a Nx1vector of constants.

3.2. The BCC model

In retrospect to the CCR model which implies constant returns to scale Banker et al. (1984) develop a model that allows variable returns to scale (VRS) by adding a convexity condition for λ_j in the model (11) to (14). The convexity condition is achieved by setting the sum of components of the vector λ_j to one. This gives us the following model:

$$\min_{\lambda} z_0 = \Theta_0 \tag{15}$$

subject to

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0}, r = 1, \dots, s \tag{16}$$

$$\Theta_0 x_{i0} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0, i = 1, \ldots, m \quad (17)$$

$$\sum_{j=1}^{n} \lambda_j = 1 \quad (18)$$

$$\lambda_j \geq 0, \text{ j} = 1, \ldots, \text{ n} \quad (19)$$

The model (15) to (19) is now called the input oriented BCC model. Contrary to the CCR model, it provides information on pure technical efficiency since it allows for variable returns to scale (VRS). The following section deals with empirical data and analysis.

4. Empirical data and analysis

This section presents summary statistics of sample data and deals with the idiosyncrasies of the Croatian banking market. Furthermore, this section provides the results for the ROA and ROE financial indicators and efficiency results using the DEA methodology. Efficiency is estimated on a sample of 20 (currently operating) Croatian banks within the period 2014-2019. Therefore, this sample of 20 Croatian banks represents the whole Croatian banking market in the observed period. It provides evidence of the financial consolidation process that has taken part in Croatia for the past two decades. All the data in the observed period were acquired from the end-of-year financial statements of Croatian commercial banks, used for calculating the financial indicators and the input and output variables. More specifically, for the intermediation approach, we use banks' balance sheets information, and for the operating approach, we use banks' income statements information. Table 1 presents summary statistics for the input and output variables of the sample in the observed period from 2014 until 2019.

Table 1: Summary statistics of the sample variables (2014-2019)

	Min	Max	Average	Standard deviation	Coefficient of variation
Intermediation approach					
Fixed and intangible assets	13,503,708	1,438,271,497	261,048,719	360,074,867	1.3793
Number of employees	50	4,233	904	1,177	1.3026
Total deposits	391,017,661	96,913,294,854	15,004,595,704	22,893,227,308	1.5257
Liabilities	3,135,406	13,560,150,682	1,259,441,687	2,332,643,518	1.8521
Total loans	156,017,539	77,680,302,162	12,267,088,580	19,652,532,687	1.6021
Securities	398,500	11,931,344,900	2,514,186,470	3,186,046,368	1.2672
Operating approach					
Interest expenses	1,877,652	3,217,174,982	222,330,511	488,410,751	2.1968
Non-interest expenses	831,562	454,614,232	66,702,151	104,978,349	1.5738
Labor related administrative costs	6,570,045	886,786,766	173,597,830	243,269,583	1.4013
Other administrative costs	4,193,225	779,996,463	166,026,053	218,744,382	1.3175
Interest income	10,909,662	5,776,662,123	714,594,059	1,160,310,633	1.6237
Non-interest income	4,082,342	1,304,807,762	222,939,430	336,558,002	1.5096

Source: Author's calculations, using financial statements data, all values in HKR except "Number of employees"

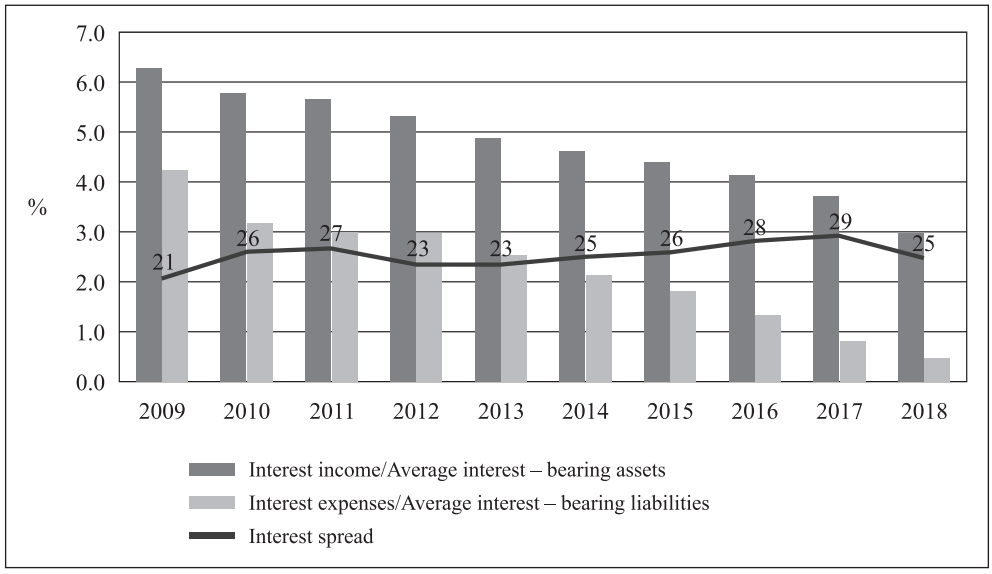
4.1. Idiosyncrasies of the banking sector in Croatia

Banks have a prominent role in the Croatian financial system. Ever since gaining its independence in 1990, by adapting its planned economy to a market-based economy, a great number of commercial banks got established. However, in the past 30 years, the consolidation process of the banking sector has taken place, arguably since the early 1990s, as stated by Jermić and Vujčić (2002). In the period from 2011, the number of banks continuously decreased from 32 commercial banks, from which 17 were foreign, 13 were domestic and 2 were state-owned, to 20 banks in 2020, which 11 are foreign, 7 are domestic and 2 are state-owned (Croatian National Bank, 2021). Total assets of the Croatian banking system, in the period from 2011 until the third quarter of 2020 show incremental growth, totaling HRK 445,7 billion. As stated before, the Croatian banking system is predominantly foreign-owned, with more than 90% of total assets attributed to foreign-owned banks (Croatian National Bank, 2021). The current state of the banking market is a consequence of several acquisitions and mergers, as well as several bankruptcy proceedings in this short period. Banks that operate in the Croatian banking market

can be classified into large (total assets above HRK 40 billion), medium (total assets between HRK 40 and HRK 10 billion), and small (total assets below HRK 10 billion). Taking into account this classification, on the market operate 4 large, 4 medium-sized, and 12 small banks. Therefore, the consolidation process produces a high concentration of total assets in a few banks, which dominate the banking market, making it extremely competitive for new banks entering the market.

In Croatia, nearly half (48.1 % in Q3 2020) of all assets in the banking sector is attributed to the two largest banks (Zagrebačka Banka, Privredna Banka Zagreb), while more than 70% of total assets can be attributed to the four largest banks (Zagrebačka Banka, Privredna Banka Zagreb, Erste&Steiermärkische Banka, and OTP Banka) in Croatia (Croatian National Bank, 2021). Furthermore, in the period from 2009 until 2018 interest spread has remained somewhat stable, averaging around 2.5 percentage points (Figure 1), showing a substantial decline in 2018 (of 0.4 percentage points) after a period of marginal growth from 2013.

Figure 1: Interest spread in the period from 2009 until 2018

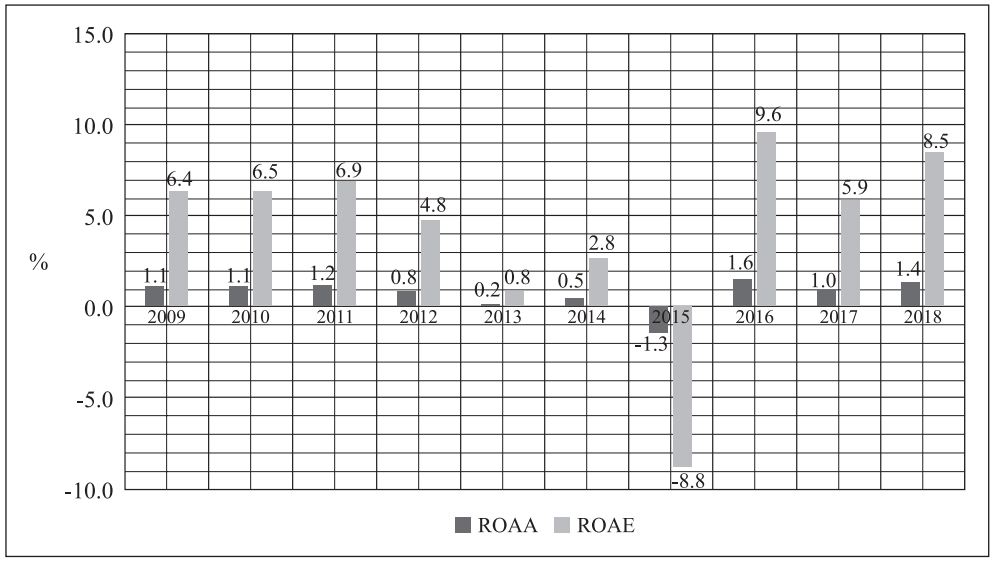


Source: Author's work using CNB data (2019) https://www.hnb.hr/en/analyses-and-publications/regular-publications/banks-bulletin (29.3.2021)

Even if interest spread is relatively stable, it is obvious that both ratios of interest income and interest expenses have steadily declined in the observed period, which follows from a steady decline of interest rates on the Croatian market. It is unclear if the consolidation process will continue in the future, but the question arises, are larger banks more or less efficient than medium and small banks. Findings from

Jermić and Vujčić (2002) show that the most efficient banks are either the smallest or the largest banks, while their results are unclear for medium banks. Financial indicators are often used in simple performance-efficiency estimation, notably performance indicators such as return on assets (ROA) and return on equity (ROE) are often considered as a measure of profitability for the banking system. Average performance indicators in the period from 2009 until 2018 are shown in Figure 2.

Figure 2: Bank return on average assets (ROAA) and return on average equity (ROAE) from 2009 until 2018



Source: Author's work using CNB data (2019) https://www.hnb.hr/en/analyses-and-publications/regular-publications/banks-bulletin (29.3.2021)

On average, ROAA is around 0.8%, while ROAE is around 4.3%. Both indicators are lower than it is theoretically required for banks to be considered efficient (see Jurčević and Žaja, 2013: 207), but in the last observed year, the indicators grew 2.6 percentage points and 0.4 percentage points respectively.

Return on assets and return on equity are presented in more detail in the following tables (Table 2 and Table 3) in the observed period from 2014 until 2019. Return on assets is calculated as a ratio of profit before taxes and average assets. The required data can be easily acquired from financial statements. Traditionally, ROA values of at least 1% percent or above are considered efficient, but investors would appreciate even higher levels of ROA, which would mean that bank management creates more profits from fewer assets implying higher profit efficiency (Jurčević and Žaja, 2013: 207). On the other hand, higher ROA values could mean that banks enter into

riskier investments that offer higher returns. From Table 2 it is visible that the four biggest banks by total assets (denoted by * in the table) in general provide higher ROA values, especially the two biggest banks Zagrebačka Banka and Privredna Banka Zagreb on average attain ROA values higher than 1% implying that bigger banks are more efficient.

Table 2: Return on assets (ROA) of Croatian banks from 2014 until 2019

Bank	2014	2015	2016	2017	2018	2019	Average	S.D.
Addiko bank	-0.45%	-9.13%	0.34%	0.72%	0.95%	0.88%	-1.11%	3.61%
Agram banka	-0.89%	0.22%	0.39%	0.60%	0.78%	1.05%	0.35%	0.62%
Banka Kovanica	-1.17%	0.92%	0.04%	0.45%	0.97%	1.22%	0.40%	0.80%
Croatia banka	0.17%	0.07%	0.09%	-1.11%	-0.92%	-1.17%	-0.48%	0.59%
Erste& Steiermarkische Bank*	0.44%	-2.08%	1.44%	1.43%	1.73%	1.47%	0.74%	1.33%
Hrvatska poštanska banka	-3.67%	0.72%	0.83%	0.06%	0.90%	0.42%	-0.12%	1.61%
Imex Banka	0.87%	-2.12%	-0.27%	-0.76%	-0.81%	0.20%	-0.48%	0.93%
Istarska kreditna banka Umag	0.50%	0.52%	0.84%	0.97%	0.84%	1.02%	0.78%	0.20%
J&T banka	-0.88%	-3.36%	-5.42%	-2.16%	0.07%	0.19%	-1.93%	1.99%
Karlovačka banka	0.32%	-0.78%	-0.29%	0.27%	0.73%	1.19%	0.24%	0.64%
KentBank	-0.93%	0.31%	0.47%	0.25%	0.33%	0.81%	0.21%	0.54%
OTP banka*	1.04%	-0.94%	0.96%	0.37%	0.69%	1.66%	0.63%	0.80%
Partner banka	0.11%	0.12%	0.74%	0.49%	0.77%	2.30%	0.76%	0.74%
Podravska banka	-0.57%	0.12%	1.11%	0.52%	0.43%	0.77%	0.39%	0.53%
Privredna banka Zagreb*	1.20%	0.30%	2.80%	2.27%	1.86%	2.52%	1.82%	0.85%
Raiffeisenbank Austria	1.16%	-0.99%	1.87%	1.51%	0.75%	1.31%	0.93%	0.93%
Samoborska banka	-0.16%	-1.62%	-1.97%	-1.49%	0.22%	0.72%	-0.72%	1.02%
Sberbank	0.40%	-2.46%	0.73%	-1.74%	0.90%	1.05%	-0.19%	1.38%
Slatinska banka	0.07%	-0.71%	-0.08%	0.08%	0.41%	0.26%	0.00%	0.36%
Zagrebačka banka*	1.44%	-0.64%	2.01%	0.97%	1.96%	1.58%	1.22%	0.90%

Source: Author's calculations using financial statements data; * denotes 4 largest banks by total assets

Similarly, return on equity is calculated as a profit ratio before taxes and average total bank equity. For a bank to be deemed efficient, it is necessary that its ROE values exceed at least 10%, while ROE levels above 15% demonstrate exceptional efficiency,

meaning that banks management produces higher profits while employing less total equity (Jurčević and Žaja, 2013: 207). From Table 3 it is obvious that the two largest banks on average achieve the highest ROE values, while this is not true for the third and fourth-largest banks. Higher returns on equity also have medium (Raiffeisenbank Austria) and small banks (Istarska kreditna banka Umag). It is necessary to note that ROE indicators in the observed period show higher volatility (standard deviation) than ROA indicators.

Table 3: Return on equity (ROE) of Croatian banks from 2014 until 2019

Bank	2014	2015	2016	2017	2018	2019	Average	S.D.
Addiko bank	-2.68%	-66.86%	3.08%	5.62%	6.54%	5.40%	-8.15%	26.43%
Agram banka	-14.25%	3.05%	4.61%	6.45%	7.67%	9.83%	2.89%	7.96%
Banka Kovanica	-13.44%	10.17%	0.39%	4.65%	9.92%	12.71%	4.07%	8.82%
Croatia banka	2.57%	1.18%	1.43%	-18.30%	-15.62%	-21.06%	-8.30%	10.16%
Erste& Steiermarkische Bank*	3.70%	-18.63%	12.91%	11.70%	13.72%	11.35%	5.79%	11.40%
Hrvatska poštanska banka	-75.43%	9.65%	8.24%	0.66%	9.48%	4.35%	-7.18%	30.69%
Imex Banka	11.24%	-28.00%	-3.66%	-10.43%	-11.49%	2.79%	-6.59%	12.33%
Istarska kreditna banka Umag	5.63%	5.93%	9.80%	11.06%	9.54%	11.38%	8.89%	2.29%
J&T banka	-9.63%	-33.60%	-50.53%	-20.03%	0.62%	1.55%	-18.60%	18.72%
Karlovačka banka	4.07%	-11.61%	-4.93%	4.31%	10.85%	16.67%	3.22%	9.38%
KentBank	-6.69%	2.15%	3.95%	2.38%	3.25%	7.98%	2.17%	4.41%
OTP banka*	9.45%	-8.64%	8.71%	1.91%	3.91%	11.77%	4.52%	6.77%
Partner banka	0.98%	1.10%	6.90%	4.76%	7.60%	20.73%	7.01%	6.64%
Podravska banka	-4.55%	0.92%	8.98%	4.03%	3.25%	5.86%	3.08%	4.21%
Privredna banka Zagreb*	7.07%	1.82%	16.41%	12.63%	10.57%	14.89%	10.56%	4.93%
Raiffeisenbank Austria	7.53%	-7.01%	13.78%	10.65%	5.48%	9.78%	6.70%	6.65%
Samoborska banka	-0.94%	-9.80%	-13.34%	-11.29%	1.77%	5.83%	-4.63%	7.20%
Sberbank	2.85%	-18.56%	5.52%	-13.11%	7.37%	9.35%	-1.10%	10.72%
Slatinska banka	0.54%	-6.23%	-0.70%	0.76%	3.98%	2.38%	0.12%	3.20%
Zagrebačka banka*	9.01%	-4.25%	13.60%	6.25%	13.14%	11.11%	8.15%	6.07%

Source: author's calculations using financial statements data; * denotes 4 largest banks by total assets

Returning to the question of the effect of consolidation on efficiency, Ferguson (2002) states that, in general, high levels of mergers and acquisitions of financial firms (M&A) occurred during the 1990s. Financial consolidation contributed to the creation of a significant number of large and thus complex financial institutions. Furthermore, Ferguson (2002) states that the most important forces encouraging financial consolidation are improvements in information technology, financial deregulation, globalization of financial and nonfinancial markets, and increased shareholder pressure for financial performance. However, even if the study determined that consolidation has the potential to improve operating efficiency, it concludes that efficiency gains are low.

Similarly, Berger et al. (2001) studied efficiency barriers on the cross-border consolidation of financial institutions within Europe, such as distance, cultural and language differences, currency, and regulatory and supervisory frameworks. Generally speaking, financial consolidation is more common domestically than internationally across European nations. Authors corroborate that there is substantial potential for efficiency gains from the financial institutions' consolidation. Urio and Tanna (2012), conduct a more focused study of the effects of consolidation on the efficiency of financial institutions in Europe. The review of empirical studies on consolidation of financial markets that began in the 1980s until the early 2000s demonstrates that most studies find evidence of efficiency improvements from mergers and acquisitions in varying degrees. A similar study is provided by Amel et al. (2004), their findings are in line with studies above, in the sense, that in general, the expectations of the impact of M&A on financial institutions (consolidation of the financial market), mainly banks, will to some degree positively affect efficiency. Furthermore, it corroborates the theory that in general, larger banks are on average more efficient, and that is one of the reasons to support the continuation of the consolidation process of financial markets in the future.

4.2. Efficiency results

In the past sections, the methodology used in this paper, as well as, the idiosyncrasies of the Croatian banking sector were established. Using the DEA methodology, this study investigates the efficiency of Croatian banks in the period from 2014 until 2019. The results are presented in the following tables. Table 4 presents efficiency results for the intermediation approach (input-oriented) CCR DEA model that assumes constant returns to scale (CRS). The input-oriented model is used to express the potential decrease (savings) of inputs in achieving technical efficiency (performing on the frontier). In a competitive market, management has more influence and greater possibility to influence the use of inputs (decrease in inputs = savings = cost minimization) in the banking process than affecting the increase of output (profit maximization), therefore the input orientation is chosen. Through the observed period, on average, the efficiency of Croatian banks improved

by two percentage points. The worst year was 2015, when only eight banks were efficient, while nine banks were less efficient than average. As predicted from past studies and microeconomic theory, seven banks that are by assets the largest banks in Croatia are continuously efficient for the observed period. In 2019, thirteen banks are on the frontier, four large, three medium-sized, and five small banks.

More closely, the largest banks (denoted by * in Table 4) are efficient throughout the observed period, as stated from previous research (Jermic and Vujčić, 2002), in general, small and large banks are efficient, while the benefits of being a medium bank are not entirely clear. Observing for volatility, in general, the efficiency of banks in the observed period is above or below 16 percentage points in 2015 (most volatile year).

Table 4: Efficiency of Croatian banks from 2014 until 2019 – Intermediation approach (CCR model)

Bank	2014	2015	2016	2017	2018	2019	Average
Addiko bank	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Agram banka	100.00%	64.74%	73.06%	100.00%	100.00%	100.00%	89.63%
Banka Kovanica	100.00%	86.70%	93.30%	89.29%	100.00%	100.00%	94.88%
Croatia banka	83.89%	66.67%	78.22%	86.92%	100.00%	92.22%	84.65%
Erste&Steiermarkische Bank*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Hrvatska poštanska banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Imex Banka	74.64%	62.78%	86.59%	92.22%	56.86%	90.95%	77.34%
Istarska kreditna banka Umag	100.00%	59.64%	80.70%	100.00%	100.00%	100.00%	90.06%
J&T banka	81.60%	63.36%	76.69%	94.07%	87.71%	90.20%	82.27%
Karlovačka banka	83.58%	60.06%	94.93%	92.84%	94.77%	97.56%	87.29%
KentBank	100.00%	100.00%	100.00%	100.00%	100.00%	89.24%	98.21%
OTP banka*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Partner banka	74.75%	71.72%	82.63%	100.00%	100.00%	100.00%	88.18%
Podravska banka	98.38%	61.87%	80.10%	100.00%	100.00%	100.00%	90.06%
Privredna banka Zagreb*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Raiffeisenbank Austria	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Samoborska banka	100.00%	91.73%	100.00%	68.20%	64.54%	64.62%	81.52%
Sberbank	88.34%	82.46%	94.18%	100.00%	100.00%	100.00%	94.16%
Slatinska banka	81.45%	71.60%	79.50%	76.91%	80.68%	85.89%	79.34%
Zagrebačka banka*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Average	93.33%	82.17%	91.00%	95.02%	94.23%	95.53%	91.88%
Standard Deviation	9.33%	16.67%	9.74%	8.61%	12.26%	8.40%	7.69%

Source: author's calculations using financial statements data; *denotes 4 largest banks by total assets

Table 5 presents efficiency results for the intermediation approach (input-oriented) BCC DEA model that assumes variable returns to scale (VRS). In general, efficiency results are higher by the nature of the model, but the main findings are in line with the results from the CCR model (Table 4).

Table 5: Efficiency of Croatian banks from 2014 until 2019 – Intermediation approach (BCC model)

Bank	2014	2015	2016	2017	2018	2019	Average
Addiko bank	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Agram banka	100.00%	100.00%	73.26%	100.00%	100.00%	100.00%	95.54%
Banka Kovanica	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Croatia banka	90.19%	90.82%	78.39%	87.44%	100.00%	99.37%	91.04%
Erste&Steiermarkische Bank*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Hrvatska poštanska banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Imex Banka	77.73%	66.06%	88.72%	94.82%	58.75%	98.09%	80.70%
Istarska kreditna banka Umag	100.00%	99.84%	81.69%	100.00%	100.00%	100.00%	96.92%
J&T banka	100.00%	65.35%	80.70%	100.00%	100.00%	100.00%	91.01%
Karlovačka banka	87.62%	64.36%	97.20%	100.00%	100.00%	100.00%	91.53%
KentBank	100.00%	100.00%	100.00%	100.00%	100.00%	89.93%	98.32%
OTP banka*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Partner banka	74.97%	72.16%	85.23%	100.00%	100.00%	100.00%	88.73%
Podravska banka	100.00%	87.82%	100.00%	100.00%	100.00%	100.00%	97.97%
Privredna banka Zagreb*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Raiffeisenbank Austria	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Samoborska banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Sberbank	90.49%	89.11%	94.89%	100.00%	100.00%	100.00%	95.75%
Slatinska banka	84.04%	81.49%	84.71%	93.23%	98.27%	98.04%	89.96%
Zagrebačka banka*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Average	95.25%	90.85%	93.24%	98.77%	97.85%	99.27%	95.87%
Standard Deviation	7.96%	13.07%	8.91%	3.17%	8.98%	2.22%	7.38%

Source: author's calculations using financial statements data; *denotes 4 largest banks by total assets

The results show that larger banks are efficient in the observed period, and their overall efficiency improved by four percentage points. In general, these findings are in line with performance indicators ROA and ROE observed earlier (Tables 2 and 3) giving evidence that larger banks, in general, provide higher returns on assets and

equity. As stated before, the BCC model allows variable returns to scale and provides information on pure technical efficiency. Similar to the CCR model, average efficiency improves through the observed period while using the BCC model (Table 5).

In 2014, fourteen banks were on the frontier, while six had below-average efficiency. On the other hand, in 2019, sixteen banks were on the frontier, and the average efficiency in the last observed year was 99.27%. The overall average efficiency of banks in the observed period amounted to 95.87%. Regarding volatility, the standard deviation was lower when compared to the results from the CCR model, meaning that more banks are closer to the average efficiency of 99.27% in 2019.

Regarding economies of scale (the decrease of average cost per unit of output with the increase in the scale, quantity, or magnitude of output being produced) Cooper et al. (2007: 152-154) state that scale efficiency can be easily obtained by observing the difference between CRS and VRS technical efficiency scores for a particular bank. The difference in efficiency scores would then indicate the scale inefficiency of a bank. Therefore, is possible to calculate scale efficiency as the ratio of CRS efficiency and VRS efficiency. Observing the efficiency results from Table 4 (CCR model – CRS) and Table 5 (BCC model – VRS) for the intermediation approach it can be concluded that all four banks classified as large by assets are scale efficient.

Furthermore, in Tables 6 and 7, the results for the CCR and BCC models using the operating approach (input-oriented) are presented. Since the operating approach incorporates different inputs and outputs, the efficiency results differ from the intermediation approach.

However, some results coincide with the two approaches that can provide interesting conclusions on the efficiency of banks. Using the operating approach on the CCR model the average efficiency decreased from 90.33% in 2014 to 89.76% in 2019, while the average efficiency for the period is 89.26%, which is lower than the efficiency for the intermediation approach (Table 4, 91.88%).

In 2014, twelve banks were efficient, with an average efficiency of 90.33%, while seven banks were below average efficient. In 2019, eleven banks were efficient, with an average efficiency of 89.76%. The main takeaway from the intermediation approach is still present, i.e., the largest banks are, in general, efficient in the observed period, except for the OTP Banka that is inefficient in 2017 (67.34%) and 2018 (65.84%). OTP Banka today is by assets the fourth largest bank in Croatia, but attained its large bank status by the acquisition of Splitska Banka by the end of 2018. Therefore, the inefficiency in 2017 and 2018 could be attributed to the acquisition process. Efficiency score recuperated in 2019 as OTP Banka is on the frontier.

Table 6: Efficiency of Croatian banks from 2014 until 2019 – Operating approach (CCR model)

Bank	2014	2015	2016	2017	2018	2019	Average
Addiko bank	100.00%	100.00%	100.00%	100.00%	100.00%	70.30%	95.05%
Agram banka	100.00%	82.02%	96.20%	100.00%	100.00%	100.00%	96.37%
Banka Kovanica	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Croatia banka	73.25%	82.16%	84.51%	71.51%	61.68%	66.73%	73.31%
Erste&Steiermarkische Bank*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Hrvatska poštanska banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Imex Banka	100.00%	100.00%	100.00%	95.18%	82.59%	73.39%	91.86%
Istarska kreditna banka Umag	98.20%	85.52%	94.95%	97.21%	100.00%	100.00%	95.98%
J&T banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Karlovačka banka	57.54%	71.23%	71.99%	84.44%	85.29%	88.02%	76.42%
KentBank	79.17%	82.17%	78.66%	80.86%	84.03%	91.62%	82.75%
OTP banka*	100.00%	100.00%	100.00%	67.34%	65.84%	100.00%	88.86%
Partner banka	82.92%	79.18%	87.13%	87.06%	100.00%	100.00%	89.38%
Podravska banka	68.89%	67.86%	74..53%	62.67%	65.43%	73.07%	68.74%
Privredna banka Zagreb*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Raiffeisenbank Austria	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Samoborska banka	70.20%	77.51%	70.79%	65.08%	68.90%	65.03%	69.59%
Sberbank	100.00%	100.00%	60.25%	72.91%	73.74%	80.33%	81.21%
Slatinska banka	76.52%	72.07%	67.59%	72.98%	77.69%	86.71%	75.59%
Zagrebačka banka*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Average	90.33%	89.99%	89.33%	87.86%	88.26%	89.76%	89.26%
Standard Deviation	13.76%	11.71%	13.31%	13.81%	14.15%	12.89%	13.27%

Source: author's calculations, using financial statements data; *denotes 4 largest banks by total assets

As some studies have discovered, the effects of M&A are not instantaneous, and it is possible that the acquisition effect on efficiency has just taken place and its full benefits will be notable in the future. Similar conclusions can be derived from Table 7 that uses the operating approach on the BCC model. The efficiency results are higher in retrospect to the CCR operating approach since BCC allows variable returns to scale. In 2014, fourteen banks were on the frontier with 94.44% average efficiency while six banks were below average efficiency. Average efficiency slightly declined in the observed period, in 2019, twelve banks were efficient, and six were below average efficient. Overall average efficiency for the observed period was 93.30%. Additionally, the key take away from the BCC model using the

operating approach is the same one from the intermediation approach. The largest banks in Croatia are in general efficient for the observed period (except in the case of OTP Banka that has identical inefficiency in 2017 and slightly higher efficiency (66.01%) in 2018 in comparison to the CCR model). Similar conclusions can be attributed to medium banks in both models; two banks (of four) are overall efficient in the observed period. Furthermore, addressing scale efficiency for the operating approach, while observing the efficiency results from Table 6 (CCR model – CRS) and Table 7 (BCC model – VRS) it can be noted that large banks are in general scale efficient, except for OTP Banka in 2018 where its scale efficiency score is 99,74% supposedly due to the before mentioned acquisition.

Table 7: Efficiency of Croatian banks from 2014 until 2019 – Operating approach (BCC model)

Bank	2014	2015	2016	2017	2018	2019	Average
Addiko bank	100.00%	100.00%	100.00%	100.00%	100.00%	71.26%	95.21%
Agram banka	100.00%	88.57%	100.00%	100.00%	100.00%	100.00%	98.10%
Banka Kovanica	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Croatia banka	77.50%	84.67%	88.92%	74.17%	64.28%	75.54%	77.51%
Erste&Steiermarkische Bank*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Hrvatska poštanska banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Imex Banka	100.00%	100.00%	100.00%	100.00%	88.43%	88.93%	96.23%
Istarska kreditna banka Umag	100.00%	99.14%	100.00%	100.00%	100.00%	100.00%	99.86%
J&T banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Karlovačka banka	65.18%	81.84%	82.94%	92.04%	91.25%	97.19%	85.07%
KentBank	93.85%	89.38%	86.37%	81.40%	84.57%	91.98%	87.93%
OTP banka*	100.00%	100.00%	100.00%	67.34%	66.01%	100.00%	88.89%
Partner banka	91.58%	86.13%	100.00%	89.55%	100.00%	100.00%	94.54%
Podravska banka	72.79%	72.13%	80.66%	66.80%	72.20%	77.00%	73.60%
Privredna banka Zagreb*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Raiffeisenbank Austria	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Samoborska banka	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Sberbank	100.00%	100.00%	61.98%	73.76%	75.33%	83.81%	82.48%
Slatinska banka	87.88%	84.64%	84.32%	82.84%	85.75%	94.56%	86.67%
Zagrebačka banka*	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Average	94.44%	94.33%	94.26%	91.40%	91.39%	94.01%	93.30%
Standard Deviation	10.24%	8.28%	10.01%	11.95%	12.21%	9.28%	10.33%

Source: author's calculations using financial statements data; *denotes 4 largest banks by total assets

5. Results and discussion

According to the results obtained in this study, the main conclusion is that the four largest banks have been fully efficient or achieved the above-average efficiency throughout the observed period, which is in line with the main hypothesis (H1) of this study. The results for medium and small banks are mixed. Jermić and Vujčić (2002) attain similar results nearly twenty years earlier. The results corroborate the theory that the consolidation process on the Croatian banking market positively affected banks' efficiency since our results show higher average efficiency than reported from Jermić and Vujčić (2002), and Jurčević and Žaja (2013). The 20 banks that operate in the Croatian banking market are, in general,efficient or close to full efficiency.

Irrelevant to the model, average efficiency in the observed period did improve, at the end of it, is close to or above 90%. It is still unclear if the consolidation process will continue, but following the findings from previous studies and efficiency results from this study, it is possible to conclude that the consolidation process of financial markets, in this case, banks, to some degree positively affects their efficiency. Therefore, it is possible to assume that inefficient banks will either fail or partake in future M&A with a larger bank, continuing the consolidation process of the Croatian financial market.

The attained results are also in line with a more recent study by Peša et al. (2021) that uses 15 different input and output combinations in the DEA input-oriented BCC model. The authors conclude that large banks in Croatia operate efficiently. Furthermore, Rhoades (1998) summarizes nine case studies on the efficiency effects of bank mergers that conclude with mixed results. Key findings of this study show that all summarized studies discovered significant cost-cutting objectives were achieved or surpassed fairly quickly. Four mergers showed clear efficiency gains relative to peers, and seven mergers exhibited an improvement in return on assets relative to peers. These results are in line with the attained results concerning the fourth largest bank in Croatia (OTP Banka) where its efficiency decreased during the acquisition process, but the bank regained full efficiency in the following year.

Empirical results from Al-Sharkas et al. (2008) indicate that mergers (i.e. financial consolidation) have improved the cost and profit efficiency of banks. Authors further elaborate that merged banks experience greater productivity growth compared to non-merged banks, as well as that mergers allow efficient banks to gain control of weaker banks – increasing input efficiency and taking advantage of opportunities created by improved technology. Similar results are visible on the Croatian market where M&A activities took place in the past three years, when small banks, faced with extinction, merged with medium and large banks. For example, the before mentioned acquisition of Splitska Banka by OTP Banka in 2018, the merger between Veneto and Privredna Banka Zagreb in 2018, and the

merger between Jadranska Banka and Hrvatska poštanska banka in 2019 (Peša et al., 2021: 222).

Additionally, Vander Vennet (1996) examined the performance effects of acquisitions and mergers between EC credit institutions in the period 1988-1993. The findings also corroborate the notion that M&A activities positively affect banks' performance in the case of cross-border acquisitions (the findings are not entirely positive for domestic acquisitions), which are common in the European banking industry. Some evidence on findings from Vander Vennet (1996) is also present in the Croatian banking market (series of cross-border acquisitions in the early 2000s). On the other hand, Sufian and Abdul Majid (2007) study the efficiency of financial institutions in Malaysia. The results suggest that efficiency is positively associated with bank capitalization and market share. As shown in this study, on the Croatian banking market, the largest banks that have the largest capitalization and market share are in general efficient. These results corroborate Sufian and Abdul Majid's (2007) findings.

Finally, Hughes et al. (1999) examine the net economic benefits from consolidation. Their findings provide evidence that consolidation offers, among other benefits, significant gains in bank financial performance. Furthermore, their results also corroborate the notion that larger banks achieve greater safety and improved efficiency, which is in line with the findings in this study. In general, the efficiency of the Croatian banking sector improved in the observed period, while large banks operate with full efficiency. Furthermore, the consolidation process on the Croatian banking market continued, and it is justified to assume that it will continue in the future.

6. Conclusions

The focus of this paper was the efficiency estimation of banks on the Croatian market. For this purpose, DEA methodology is employed on a sample of 20 operating banks within the period 2014- 2019. The attained results using the DEA methodology that are compared with financial indicators are in line with the main hypothesis (H1) in the sense that large banks are more efficient than small or medium banks in Croatia. Efficiency estimation of financial institutions is an important field of study whose empirical evidence was greatly expanded in the past decades. The Croatian banking market was formed in the early 1990s after adopting a capitalist economy. The banking market in the past two decades has shown clear signs of consolidation. Financial consolidation is a process that through mergers and acquisitions, as well as bank failures reduces the number of relevant market participants, while at the same time consolidating the majority of assets in a small number of large financial institutions. Several studies mentioned in this paper propose and corroborate the theory that large banks are more efficient. Our findings are in line with this theory

where, in general, the four largest banks on the Croatian banking market operate with an above-average efficiency of are on the frontier (fully efficient) in the observed period. In comparison to our efficiency results, performance indicators such as return on assets (ROA) and return on equity (ROE) are calculated since they represent a traditional measure of efficiency. Performance indicators are on average higher for the four largest banks in our sample, while being less volatile. Therefore, both efficiency estimated through a non-parametric method such as DEA and traditional performance indicators demonstrates that larger banks are in general more efficient. The results show that overall efficiency improved in the observed period according to the intermediation approach, while the operating approach showed a slight decline in average efficiency. Overall, regardless of the approach and the model, more than half of the observed banks operate efficiently, while average efficiency is near or above 90% regardless of the use of constant or variable returns to scale. Although this paper sheds some light on the efficiency of banks in Croatia, several questions remain unanswered that could be topics for future studies. Will the consolidation process continue on the Croatian banking market? Furthermore, is the combination of input and output variables used in this paper adequate for efficiency estimation of banks, or is there a more comprehensive combination? Additionally, keeping in mind the size of the sample (20 operating banks – DMU's), are there other methodologies suitable in efficiency estimation that would provide better insight into the state of efficiency of Croatian banks? Future studies could tackle the question of a wider definition of efficiency, incorporating more drivers for bank efficiency than just cost minimization and profit maximization, such as banks' role in society, in other words, their corporate social responsibility. Finally, how does the efficiency of Croatian banks compare to the efficiency of banks in the European Monetary Union (EMU)?

References

Acharya, V. V. et al. (2011) "Market failures and regulatory failures: Lessons from past and present financial crises", *ADBI Working Paper*, No. 264, pp. 1–37, http://hdl.handle.net/10419/53604.

Al-Sharkas, A. A., Hassan, M. K., Lawrence, S. (2008) "The impact of mergers and acquisitions on the efficiency of the US banking industry: further evidence", *Journal of Business Finance & Accounting*, Vol. 35, No. 1-2, pp. 50–70, https://doi.org/10.1111/j.1468-5957.2007.02059.x.

Altunbas, Y. et al. (2007) "Examining the relationships between capital, risk and efficiency in European banking", *European financial management*, Vol. 13, No. 1, pp. 49–70, https://doi.org/10.1111/j.1468-036X.2006.00285.x.

Amel, D. et al. (2004) "Consolidation and efficiency in the financial sector: A review of the international evidence", *Journal of Banking & Finance*, Vol. 28, No. 10, pp. 2493–2519, https://doi.org/10.1016/j.jbankfin.2003.10.013.

Assaf, A. G. et al. (2019) "Does efficiency help banks survive and thrive during financial crises?", *Journal of Banking & Finance*, Vol. 106, pp. 445–470, https://doi.org/10.1016/j.jbankfin.2019.07.013.

Banker, R. D., Charnes, A., Cooper, W. W. (1984) "Some models for estimating technical and scale inefficiencies in data envelopment analysis", *Management science*, Vol. 30, No. 9, pp. 1078–1092, http://dx.doi.org/10.1287/mnsc.30.9.1078.

Benazić, M., Radin, D. (2015) "Macroeconomic determinants of the non-performing placements and off-balance sheet liabilities of Croatian banks", *Organizacija,* Vol. 48, No. 2, pp. 75–87, https://doi.org/10.1515/orga-2015-0009.

Berger, A. N., Bouwman, C. H. (2013) "How does capital affect bank performance during financial crises?", *Journal of financial economics*, Vol. 109, No. 1, pp. 146–176, https://doi.org/10.1016/j.jfineco.2013.02.008.

Berger, A. N., Humphrey, D. B. (1997) "Efficiency of financial institutions: International survey and directions for future research", *European journal of operational research*, Vol. 98, No. 2, pp. 175–21, https://doi.org/10.1016/S0377-2217(96)00342-6.

Berger, A. N., De Young, R., Udell, G. F. (2001) "Efficiency barriers to the consolidation of the European financial services industry", *European Financial Management*, Vol. 7, No. 1, pp. 117–130, https://doi.org/10.1111/1468-036X.00147.

Branch, B. (1973) "Corporate objectives and market performance", *Financial Management*, Vol. 2, No. 2, pp. 24–29, https://www.jstor.org/stable/3665479.

Çelen, A. (2013) "The effect of merger and consolidation activities on the efficiency of electricity distribution regions in Turkey", *Energy policy*, Vol. 59, pp. 674–682, https://doi.org/10.1016/j.enpol.2013.04.024.

Charnes, A., Cooper, W. W., Rhodes, E. (1978) "Measuring the efficiency of decision making units", *European journal of operational research*, Vol. 2, No. 6, pp. 429–444, https://doi.org/10.1016/0377-2217(78)90138-8.

Chin, P. O., Brown, G. A., Hu, Q. (2004) "The impact of mergers & acquisitions on IT governance structures: A case study", *Journal of Global Information Management (JGIM)*, Vol. 12, No. 4, pp. 50–74, https://www.researchgate.net/publication/220500397_The_Impact_of_Mergers_Acquisitions_on_IT_Governance_Structures_A_Case_Study.

Coase, R. H. (1995) "The nature of the firm", In: *Estrin S., Marin A. (eds) Essential Readings in Economics,* Palgrave, London, pp. 37–54, https://doi.org/10.1007/978-1-349-24002-9_3.

Cook, W. D., Tone, K., Zhu, J. (2014) "Data envelopment analysis: Prior to choosing a model", *Omega,* Vol. 44, pp. 1–4, https://doi.org/10.1016/j.omega.2013.09.004.

Cooper, W. W., Seiford L. M., Tome K. (2007) *Data Envelopment Analysis, A Comprehensive Text with Models, Applications, References and DEA Solver Software.* Boston: Kluwer Academic Publishers. https://link.springer.com/book/10.1007/978-0-387-45283-8.

Croatian National Bank (2019) *Banks Bulletin No. 32 September 2019*, Zagreb: CNB, available online: https://www.hnb.hr/en/analyses-and-publications/regular-publications/banks-bulletin [accessed: 29.3.2021].

Croatian National Bank (2021) official data from *Standard Presentation Format*, Zagreb: CNB, available online: https://www.hnb.hr/en/analyses-and-publications/regular-publications/spf [accessed: 29.3.2021].

Cyert, R. M., Hedrick, C. L. (1972) "Theory of the firm: Past, present, and future; an interpretation", *Journal of Economic Literature*, Vol: 10, No. 2, pp. 398–412, https://www.jstor.org/stable/2721463.

Demsetz, H. (1988) "The theory of the firm revisited", *Journal of Law, Economics, & Organization,* Vol. 4, No. 1, pp. 141–161, https://www.jstor.org/stable/765018.

DeYoung, R., Evanoff, D. D., Molyneux, P. (2009) "Mergers and acquisitions of financial institutions: A review of the post-2000 literature", *Journal of Financial services research*, Vol. 36, No. 2-3, pp. 87–110, https://doi.org/10.1007/s10693-009-0066-7.

Ferguson, R. W. (2002) "Understanding financial consolidation", *Economic Policy Review*, Vol. 8, No. 1, pp. 209–213, http://faculty.msmc.edu/hossain/grad_bank_and_money_policy/understanding%20financial%20consolidation_ferguson.pdf.

Ferrier, G. D., Lovell, C. K. (1990) "Measuring cost efficiency in banking: Econometric and linear programming evidence" *Journal of econometrics*, Vol. 46, No. 1-2, pp. 229–245, https://doi.org/10.1016/0304-4076(90)90057-Z.

González-Torres, T., et al. (2020) "A systematic review of research on sustainability in mergers and acquisitions", *Sustainability*, Vol. 12, No. 2, pp. 513–530, https://doi.org/10.3390/su12020513.

Hughes, J. P. et al. (1999) "The dollars and sense of bank consolidation", *Journal of banking & finance*, Vol. 23, No. 2-4, pp. 291–324, https://doi.org/10.1016/S0378-4266(98)00088-0.

Huizinga, H. P., Nelissen, J., Vander Vennet, R. (2001) "Efficiency Effects of Bank Mergers and Acquisitions", *Tinbergen Institute Discussion Paper Series*, No. TI 01-088/3, pp. 1–41, https://repub.eur.nl/pub/6843.

Jemric, I., Vujcic, B. (2002) "Efficiency of banks in Croatia: A DEA approach" *Comparative Economic Studies*, Vol. 44, No. 2, pp. 169–193, https://doi.org/10.1057/ces.2002.13.

Jensen, M. C., Meckling, W. H. (1976) "Theory of the firm: Managerial behavior, agency costs and ownership structure" *Journal of financial economics*, Vol. 3, No. 4, pp. 305–360, https://doi.org/10.1016/0304-405X(76)90026-X.

Jurčević, B., Žaja, M. M. (2013) "Banks and insurance companies efficiency indicators in the period of financial crisis: The case of the Republic of Croatia" *Economic research-Ekonomska istraživanja*, Vol. 26, No. 1, pp. 203–224, https://doi.org/10.1080/1331677X.2013.11517598.

Kaffash, S., Marra, M. (2017) "Data envelopment analysis in financial services: a citations network analysis of banks, insurance companies and money market funds", *Annals of Operations Research*, Vol. 253, No. 1, pp. 307–344, https://doi.org/10.1007/s10479-016-2294-1.

Liargovas, P., Repousis, S. (2011) "The impact of mergers and acquisitions on the performance of the Greek banking sector: An event study approach", *International Journal of Economics and Finance*, Vol. 3, No. 2, pp. 89–100, https://www.ccsenet.org/journal/index.php/ijef/article/view/7096.

Machlup, F. (1967) "Theories of the firm: Marginalist, behavioral, managerial", *The American economic review*, Vol. 57, No. 1, pp. 1–33, https://www.jstor.org/stable/1815603.

Majumdar, S. K., Moussawi, R., Yaylacicegi, U. (2007) "Quest for efficiency: Assessing the impact of mergers on performance in the US telecommunications industry", Available at: SSRN 1008601, http://dx.doi.org/10.2139/ssrn.1008601.

Peša A., Maté M., Prvonožec S. (2021) "Measuring bank efficiency: Croatian banking sector research" in: *Proceedings of the 10th International Scientific Symposium Region, Entrepreneurship, and Development*, June 2021, Osijek, pp. 218–233, available at: http://www.efos.unios.hr/red/wp-content/uploads/sites/20/2021/06/RED-2021-Proceedings.pdf [accessed 28.6.2021].

Rabar, D., Grbin, A. (2019) "Analysis of the regional efficiency in Croatia using fiscal indicators – a nonparametric approach (in Croatian, original title: Analiza regionalne efikasnosti u Hrvatskoj korištenjem fiskalnih pokazatelja – neparametarski pristup)", *Ekonomski pregled*, Vol. 70, No. 4, pp. 627–649, https://doi.org/10.32910/ep.70.4.3.

Radić, N., Fiordelisi, F., Girardone, C. (2012) "Efficiency and risk-taking in pre-crisis investment banks", *Journal of Financial Services Research*, Vol. 41, No. 1-2, pp. 81–101, https://doi.org/10.1007/s10693-011-0111-1.

Rhoades, S. A. (1998) "The efficiency effects of bank mergers: An overview of case studies of nine mergers", *Journal of Banking & Finance*, Vol. 22, No. 3, pp. 273–291, https://doi.org/10.1016/S0378-4266(97)00053-8.

Salleh, W. A. et al. (2013) "The efficiency of mergers and acquisitions in Malaysia based telecommunication companies", *Asian Social Science*, Vol. 9, No. 2, pp. 12–23, https://www.ccsenet.org/journal/index.php/ass/article/view/24349.

Soana, M. G. (2011) "The relationship between corporate social performance and corporate financial performance in the banking sector", *Journal of business ethics*, Vol 104, No. 1, pp. 133–148, https://doi.org/10.1007/s10551-011-0894-x.

Sufian, F., Abdul Majid, M. Z. (2007) "Consolidation and efficiency: Evidence from non-bank financial institutions in Malaysia", *University Library of Munich, Germany*, MPRA Paper No. 12128, pp. 1–30, https://mpra.ub.uni-muenchen.de/id/eprint/12128.

Thanassoulis, E. (1999) "Data envelopment analysis and its use in banking", *Interfaces*, Vol. 29, No. 3, pp. 1–13, https://www.jstor.org/stable/25062482.

Učkar, D., Petrović, D. (2021) "Financial Institutions Efficiency: Theory, Methods And Empirical Evidence" in the *64th International Scientific Conference on Economic and Social Development Proceedings of Economic and Social Development,* 22 January 2021, Online Conference, *Varazdin Development and Entrepreneurship Agency (VADEA)*, pp. 63–77, available at: https://zbw.eu/econis-archiv/bitstream/11159/5129/1/1747805807.pdf#page=69 [accessed 28.6.2021].

Urio, H. N., Tanna, S. (2012) "Consolidation and Performance in the European Banking Industry" in Meryem Duygun Fethi and Chrysovalantis Gaganis and Fotios Pasiouras and Constantin Zopounidis (Eds). *Financial Services: Efficiency and Risk Management*, pp. 1–40.

Vander Vennet, R. (1996) "The effect of mergers and acquisitions on the efficiency and profitability of EC credit institutions", *Journal of Banking & Finance*, Vol. 20, No. 9, pp. 1531–1558, https://doi.org/10.1016/S0378-4266(96)00014-3.

Efikasnost banaka u Hrvatskoj

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Sažetak

Hrvatski bankarski sektor sačinjava većinu financijskog sektora. Stoga je neophodno da hrvatske banke posluju učinkovito. U posljednja dva desetljeća, hrvatski je bankarski sektor prošao kroz proces konsolidacije koji je postupno smanjivao broj banka, te većinu imovine i tržišnog udjela alocirao na nekoliko velikih banaka. Efikasnost se u užem smislu može definirati kao minimiziranje troškova i maksimiziranje profita. Stoga je banka učinkovita kada nastoji minimizirati svoje troškove, a istovremeno maksimizirati svoje profite. Svrha ovog rada je procijeniti efikasnost hrvatskih banaka koristeći se DEA metodologijom u razdoblju od 2014. do 2019. godine. Dodatno, u istom razdoblju izračunavaju se pokazatelji uspješnosti (profitabilnost imovine, profitabilnost kapitala) s ciljem usporedbe pokazatelja uspješnosti i rezultata efikasnosti. Rezultati ukazuju da su velike banke uglavnom efikasne (posluju na efikasnoj granici), te u usporedbi s pokazateljima uspješnosti, postižu veće razine profitabilnosti imovine i profitabilnosti kapitala. Nadalje, nekoliko malih banaka imaju tendenciju biti efikasne, dok koristi banaka srednje veličine nisu jasne s obzirom da rezultati otkrivaju kako nekoliko srednjih banaka ostvaruje ispodprosječnu efikasnost. Sveukupno gledano, u promatranom razdoblju prosječna se efikasnost povećala, što navodi da proces konsolidacije financijskih institucija stvara velike i efikasne banke.

Ključne riječi: *efikasnost banaka, analiza omeđivanja podataka, financijska konsolidacija, hrvatski bankarski sektor*

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