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HOW EFFICIENT ARE BANKS IN CROATIA?

Abstract

Purpose: This paper measures the relative efficiency of commercial banks in the Republic of Croatia in a period of eleven years (2009-2019) by using the leading non-parametric Data Envelopment Analysis (DEA) methodology.

Methodology: In the selection of variables (inputs and outputs) and the DEA model, we have followed Banker et al. (2010).

Results: Based on the results obtained, we have found that the average efficiency of the Croatian banking sector in the observed period is 92%. The highest (96%) and the lowest (90%) mean efficiency score were achieved in 2009 and in 2017, respectively. In addition, we have analyzed several banks that show significant changes in the efficiency scores, and provided targets for improvement of their efficiency.

Conclusion: Croatia is a developing country characterized by a bank-based financial system and this study shows that its banking system is highly efficient, but certain relatively inefficient banks should improve their efficiency. Therefore, our findings provide valuable information for regulators, policymakers and bank management in order to take proper actions to maintain the stability of the key players in the financial system in Croatia.

Keywords: Banking sector, relative efficiency, DEA, BCC, targets for improvement

1. Introduction

Banks play a key role in the stability of the financial system, especially in developing countries, where the financial system is bank-based. In the Republic of Croatia, banks had a share of almost 70% of the total assets of the financial sector in 2018. Due to their crucial role in the stability of the financial system as a whole, it is important to measure their efficiency. There are parametric and non-parametric approaches to measuring banking efficiency in the literature, and in this paper, we have focused on the leading non-parametric Data Envelopment Analysis (DEA) methodology. DEA can handle more than one output and provide information for efficiency scores, sources and the amount of inefficiency, as well as targets for improvement of the identified relatively inefficient DMUs. In this paper, we measure the relative efficiency of 20 commercial banks in Croatia active in the financial market in the period between 2009 and 2019 by using the Banker-Charnes-Cooper (BCC) DEA model (Banker et al., 1984). In the selection of variables and the DEA model we follow Banker et al. (2010). The data for the variables used in research are extracted manually from the Croatian National Bank Bulletin and official financial reports of the banks. We present

results for the mean efficiency of each bank, detailed analyses of several banks that show significant changes in the efficiency, and targets for improvement of their efficiency, as well as the mean efficiency score of the whole Croatian banking system by year.

A significant role of the banking sector in the economic development of any country is the reason why it is considered the backbone of every country's economy (Fotova Čiković & Cvetkoska, 2017). Banks are vital financial intermediaries of any national economy, and especially important in bank-based systems since their management and efficiency play an important role in the banking sector, especially due to processes of globalization and internationalization, as well as the sensitivity of activities between interest groups (Tomičić et al., 2012). Namely, one of the main specifics of banks is a large number of stakeholders with different interests, such as shareholders and managers (whose relations and communication are crucial for "good" corporate governance), deponents and bank creditors (as the most specific stakeholders), as well as employees, the country and the broader community, whose interests are represented by various supervisory and regulatory bodies and judicial authorities (Trifunović, 2009). The efficiency and performance of the banking sector are crucial for the functioning of the financial system of a national economy as it impacts economic stability and growth. Therefore, it should come as no surprise that the measurement of bank efficiency has been of great interest to scholars, academics, practitioners and regulators (Andries & Ursu, 2016). Moreover, the efficiency of the banking sector in developing countries is even more important since the stakes of financial stability are higher.

The Croatian financial market underwent substantial changes during this time frame. At the beginning of the foundation of Croatia's banking system in the early 1990s, there were many problems inherited from the socialist legacy in Croatia, but most of them were resolved over the years and it is safe to assume that this had a lot to do with the majority of bank assets becoming foreign-owned (Galac & Kraft, 2001). After proclaiming its independence in 1990, Croatia had to rebuild its banking system, establishing new standards of market-based banking practice (Jemrić & Vujčić, 2002). At the start of its transition from socialism to capitalism in 1990, Croatia had 26 state-owned banks. In an effort to promote competition, like many other transition countries, Croatia allowed relatively free entry into the banking market, which led to a credit boom, and thus, failure of many of those new banks in 1998 and 1999 (Kraft & Galac, 2007). By 1994, the total number of banks reached 49, and by 1997, there were 60 banks. However, during the banking crisis in 1998/1999, some 14 banks failed and stopped working. By the end of 2000, the number of banks went down to 43. Foreign bank entry and the intensification of competition resulted in an inevitable reduction in interest rates and prices of banking services, together with radical change in the market and the market scene. In the meantime, the banking sector has undergone mergers and acquisitions (M&A) trends, and consequently, the number of banks on the Croatian market continued to decrease as large banks acquired individual smaller banks (Tipurić et al., 2003). Over a period of 20 years, many domestic banks also became foreign banks. At the end of 2010, there were 32 banks in Croatia. The predictions of further M&A processes have come true especially among small and medium-sized banks (Kraft et al., 2002; Kraft & Galac, 2007; Tomičić et al., 2012; Croatian National Bank, 2018). The number of banks in the Republic of Croatia is decreasing, which can be considered as part of a general trend in the European Union, typical of a mature industry in the consolidation phase (due to the crisis, increased competition, challenges of technological change and new regulatory requirements) (Croatian Banking Association, 2020). In 2019, the Croatian banking sector consisted of 20 commercial banks, market concentration was very high and the share of assets of the first five banks, which oscillated at some 75% for a period of several years, increased to 81.4% in 2018, which means that the five largest banks control more than 80% of the total assets in the banking sector. The bank system is dominated by foreign-owned banks, whose share in the total bank assets in 2018 was around 90.2% (Croatian National Bank, 2019).

The Croatian financial system is a bank-based continental system, where banks play a crucial role in transferring funds to the economy by approving loans and enabling payments and are at the center of the financial system that includes other financial intermediaries (funds, leasing, etc.) (Croatian Banking Association, 2020). The banking sector can be considered a pillar of the national economy because of its vital role in the financing of economic activity (Kordić & Višković, 2018). In this paper, we

measure the relative efficiency of 20 commercial banks in Croatia that were active in the financial market in the period between 2009 and 2019 by using the non-parametric DEA methodology.

We have also analyzed the results of 7 commercial banks that show significant changes in the efficiency scores, and we also provide information on what each of these banks identified as relatively inefficient in 2019 needs to do to improve its efficiency.

The rest of the paper is organized in the following way. Section 2 gives a literature review of DEA in banking in Croatia. Section 3 describes the methodology used and data. Section 4 presents the results in a tabular and visual format, supported by their analysis, while Section 5 presents the conclusion.

2. Literature review

A bibliometric analysis of DEA in banking in the period between 1986 and 2019 is done by Cvetkoska & Savić (2021), where the authors analyze papers from the SCOPUS database. They have shown the distribution of DEA articles by year, identified the top journals and authors and the most cited papers, and provided text analytics to identify the interest of researchers in three periods (pre-2000, 2001-2010, and 2011-2019) by visualizing and analyzing keywords. They have also provided directions for future research in this area.

Neralić & Gardijan Kedžo (2019) have written a literature review published by authors from Croatia in the period from 1978 to 2018. In this paper, we focus on measuring the relative efficiency of Croatian commercial banks, hence we have surveyed DEA applications in the banking sector in Croatia and found 7 studies (Jemrić & Vujčić, 2002; Toçi, 2009; Jurčević & Mihelja Žaja, 2013; Tuškan & Stojanović, 2016; Kordić & Višković, 2018; Pavković et al., 2018, and Davidovic et al., 2019).

The author(s), period, variables and models used are presented in Table 1. On average, there are two authors per paper. The shortest period analyzed is 1 year (Kordić & Višković, 2018), while the longest period is 14 years (Pavković et al., 2018). The approach most frequently used in the selection of variables is the intermediation approach. In addition, the most frequently used model is the output-oriented BCC model.

Jemrić & Vujčić (2002) show that in the period 1995-2000, the Croatian financial system succeed-ed in equalizing the banks in terms of their technical efficiency, and after 1999 they recorded "a rapid catch-up towards the 'normal' levels of efficiency". They found foreign-owned banks to be on average more efficient compared to domestic banks, and new banks to be more efficient than old ones. The average efficiency of peer groups often had a U-shape, i.e. medium-sized banks were mostly less efficient. Smaller banks are globally efficient, but large banks are locally efficient.

Toçi (2009) found out that the average efficiency of the whole sector increased from 0.728 in 2002 to 0.834 in 2003 and remained virtually relatively stable thereafter. Foreign banks steadily increased their intermediation efficiency, while domestic banks did not seem to succeed therein.

Jurčević & Mihelja Žaja (2013) obtained the lowest efficiency scores in 2008 (with only 10 efficient DMUs), but with visible lower values of efficiency already in 2007. As a result of the deteriorating position of the financial market, banks again recorded lower efficiency in 2010.

Based on the results of the Charnes-Cooper-Rhodes (CCR) model, Tuškan & Stojanović (2016) found that the lowest and the highest average relative efficiency were achieved in 2012 and in 2008, respectively. Furthermore, the BCC model shows the lowest average efficiency in 2009. In addition, DEA window analysis shows the lowest and the highest efficiency scores in 2008 and in 2011, respectively.

Kordić & Višković (2018) found 11 out of 24 banks to be overall technically efficient in 2016. Large banks showed greater efficiency than medium and small-sized banks. According to the BCC model, 12 banks were relative efficient. The domestic banks that were inefficient were forced to exit the market and the remaining domestic banks have gradually improved their efficiency over time. The authors found no statistically significant difference in regard to the ownership of banks.

Pavković et al. (2018) found large banks to be the most efficient bank group using the BCC model, while the "medium-sized banks appear most efficient using the CCR model". In addition, they found that "small-sized banks are the least efficient bank group in Croatia" due to their insufficient credit activity on the assets side and the fact that they rely more on deposits as a source of funding.

The most recent study on the Croatian banking sector using the DEA methodology is the study of Davidović et al. (2019), who have found that Croatian banks have largely benefited from the EU membership (through lower interest rates for intra-bank borrowings), and the efficiency score after the EU accession increased by about 45%. State-owned banks are constantly more efficient than privately owned banks. According to their study, the largest banks are also the most efficient ones.

In this paper, we have focused on measuring the relative efficiency of the Croatian banking sector after the global financial crisis in 2007-2009, and it incor-porates a timeline of 11 years (from 2009 to 2019). This study also offers valuable information and efficiency data for a period that has not yet been investigated in the Croatian banking sector (the time span 2016-2019). Furthermore, the only study on Croatian bank efficiency that is longer than this one is the study of Pavković et al. (2018), but they used different inputs and outputs in their model (deposits and total equity as inputs, and loans and fee and commission income as outputs). We have also identified outliers by using the Banker & Chang (2006) super-efficiency procedure and present valid results and targets for improvement of several banks identified as relatively inefficient in 2019.

Table 1 Literature review of banking studies with the application of DEA in Croatia

Author(s)	Period	Variables	Model
Jemrić & Vujčić, 2002	1995-2000	**Operating approach:** **Inputs:** interest and related costs, commissions for services, gross wages and other administration costs. **Outputs:** interest revenues, non-interest revenues **Intermediation approach:** **Inputs**: fixed assets and software, number of employees, total deposits received. **Outputs:** total loans extended and CNB bills and MoF treasury bills.	CCR and BCC models, input-oriented
Toçi, 2009	2002-2005	**Intermediation approach:** **Inputs:** deposits and total costs **Outputs:** loans net of provisions and total revenues	DEA (both CRS and VRS) and Malmquist Total Factor Productivity Change Index
Jurčević & Mihelja Žaja, 2013	2005-2010	**Intermediation approach:** **Inputs:** interest expenses, non-interest expenses, other expenses **Outputs:** interest income, non-interest income, other income from business activity	CCR and BCC models, output-oriented
Tuškan & Stojanović, 2016	2008-2012	**Profitability approach:** **Inputs:** interest expenses and total operating expenses **Outputs:** interest income, total operating income	CCR and BCC models, output-oriented
Kordić & Višković, 2018	2016	**Operating approach:** **Inputs:** interest costs, commission and fee costs, and general and administrative costs and amortization; **Outputs:** interest revenues and noninterest revenues, i.e. commission and fee revenues.	CCR and BCC models, input-oriented
Pavković et al., 2018	2004-2016	**Intermediation approach:** **Inputs**: deposits and total equity; **Outputs:** loans and fee and commission income.	CCR and BCC models, output-oriented
Davidović et al., 2019	2006-2015	**Intermediation approach:** **Inputs:** interest and non-interest expenses **Outputs:** interest and non-interest revenues	BCC output-oriented model and Andersen and Petersen super-efficiency model

Source: Authors

3. Methodology and data

In the selection of the DEA model, we follow Banker et al. (2010) and use the output-oriented BCC DEA model. This model is one of the most frequently used models in the DEA literature, as well as in the analysis of banking efficiency in Croatia.

The envelopment form of the model used is given in (1) - (5), (Cooper et al., 2007):

$$\text{(BCC - Oo)} \quad \max_{\eta_B,\lambda} \eta_B \tag{1}$$

$$\text{subject to } X\lambda \leq x_0 \tag{2}$$

$$\eta_B y_o - Y\lambda \leq 0 \tag{3}$$

$$e\lambda = 1 \tag{4}$$

$$\lambda \geq 0 , \tag{5}$$

where η_B is a scalar. The input data for DMUj (j=1,…,n) are (x_{1j}, x_{2j}, …,x_{mj}), and the output data are (y_{1j}, y_{2j}, …,y_{sj}); the data set is given by two matrices X and Y, where X is the input data matrix, and Y is the output data matrix, λ is a column vector and all its elements are non-negative, while e is a row vector and all its elements are equal to 1 (Cooper et al., 2007, p. 22, pp. 91-92; Cvetkoska & Barišić, 2017, pp. 33-34). The DMU is BCC efficient if the efficiency score is equal to 1 (100%) and its slacks are equal to 0. For more information about the BCC DEA model, see Banker et al. (1984) and Cooper et al. (2007, pp. 90-94).

Additionally, in the selection of the variables (inputs and outputs) for the DEA model we follow Banker et al. (2010). We use two inputs, i.e. interest expenses and other operating expenses (fee and commission expenses, administrative costs and depreciation and other expenses), and two outputs, i.e. interest revenue and other operating revenues (fee and commission revenue and other revenues). We have collected the data manually from the Croatian National Bank Bulletin and official financial reports of the banks. Our sample consists of 20 commercial banks in Croatia, active in its financial market in the period 2009-2019. We have excluded from the sample banks that have been merged or acquired during the analyzed period. The summary statistics for the inputs and outputs used in the research study is given in Table 2.

Table 2 Summary statistics of inputs and outputs (in 000 HRK)

	Interest Expense	Other Operating Expense	Interest Revenue	Other Operating Revenue
Mean	348,857	445,679	833,699	270,013
Standard Error	44,226	40,761	89,851	27,954
Median	65,609	83,823	130,822	39,754
Standard Deviation	655,976	604,578	1,332,713	414,621
Kurtosis	7.91	1.73	3.98	2.95
Skewness	2.80	1.56	2.11	1.81
Range	3,271,583	3,010,262	5,724,342	2,201,372
Minimum	1,878	14,896	10,910	4,437
Maximum	3,273,461	3,025,158	5,735,252	2,205,809
No. of observations	220	220	220	220

Source: Authors' calculations

4. Results and discussion

After running the BCC DEA model in the MaxDEA software we have obtained the efficiency scores for each bank in the observed period. Based on our analysis of the results obtained, we have noticed unusual results for one bank, i.e. Samoborska banka d.d., which was identified as relatively efficient over the whole observed period, but this bank operated with losses from 2013 to 2018.

When running the BCC DEA model, if there is/ are no similar DMU(s) with which one DMU can be compared, the unit will be compared with itself and the BCC algorithm will show that the unit is relatively efficient. Cvetkoska & Savić (2017) used a two-phase approach to validate unusual results by setting weight restrictions in the DEA model by using the most popular multi-criteria method called the Analytic Hierarchy Process (AHP). In our case, we investigate whether there are outliers in our sample of banks by applying the super-efficiency procedure as proposed by Banker & Chang (2006). According to the results obtained, no feasible solu-

tion was found for Samoborska banka d.d. and no outliers were identified. Therefore, we have excluded only Samoborska banka d.d. from the analysis and re-run the output-oriented BCC DEA model. In this section, we present the results that refer to the sample of 19 commercial banks in Croatia.

The mean efficiency score for each bank in the observed period of 11 years is presented in Table 3. The mean efficiency score for the whole observed period is 92%. Four banks are relatively efficient in the whole analyzed period, and those are Erste & Steiermaerkische Bank d.d., Hrvatska poštanska banka d.d., Privredna banka Zagreb d.d and Zagrebačka banka d.d., which are all part of the group of large banks consisting of banks with a market share above 5% (Šverko et al., 2012).

These findings are in line with Davidovic et al. (2019), who have found that Zagrebačka banka d.d. and Privredna banka Zagreb d.d. have maintained their unrivaled and outstanding efficiency positions over the years. Furthermore, 10 banks exhibit lower efficiency scores than the average efficiency of 92%.

Table 3 Mean efficiency scores for each bank in the observed period 2009-2019

| No.	Bank	Mean Efficiency Score
1	Addiko Bank d.d.	81%
2	Agram banka d.d.	87%
3	Banka Kovanica d.d.	91%
4	Croatia banka d.d.	77%
5	Erste & Steiermaerkische Bank d.d.	100%
6	Hrvatska poštanska banka d.d.	100%
7	Imex banka d.d.	91%
8	Istarska kreditna banka Umag d.d.	99%
9	J&T banka d.d.	82%
10	Karlovačka banka d.d.	87%
11	KentBank d.d.	91%
12	OTP banka d.d.	95%
13	Partner banka d.d.	92%
14	Podravska banka d.d.	86%
15	Privredna banka Zagreb d.d.	100%
16	Raiffeisenbank Austria d.d.	99%
17	Sberbank d.d.	91%
18	Slatinska banka d.d.	97%
19	Zagrebačka banka d.d.	100%

Source: Authors' calculations

The annual mean efficiency score of the whole Croatian banking system is calculated as an average of the efficiency scores for each bank in the current year. The mean efficiency of the Croatian banking sector in the analyzed period 2009-2019 is shown in Figure 1 by years as a line chart. According to this chart, the highest and the lowest efficiency score in the banking sector were recorded in 2009 (96%) and in 2017 (90%), respectively. A sharp fall in efficiency from 2009 to 2011 can be explained by the global financial crisis, which diminished the efficiency of the Croatian banks. In the case of a small open economy like the Republic of Croatia, the impact of the crisis comes from abroad in the form of smaller capital (in)flows and weaker export demand (Bokan et al., 2009). According to Davidović et al. (2019), as a result of an external shock, the banks in Croatia have noted slightly decreasing expenses, yet on the other hand, they have accumulated proportionally less revenue due to skyrocketing non-performing loans (NPL) during the crisis period.

In addition, even though 11 banks were relatively efficient in 2017, three banks showed the lowest efficiency in 2017, and these are Croatia banka d.d., KentBank d.d. and Podravska banka d.d. These are all small banks with a market share 0.56%-0.82%. Their inefficiency results could be explained by their size as well as the extraordinary crisis of the largest concern in Croatia, which was reflected in the banking market in general, as well as in credit operations of corporate clients of these banks and their impairment provisioning expenses.

Figure 1 Mean efficiency scores for the banking sector in Croatia in the period 2009-2019
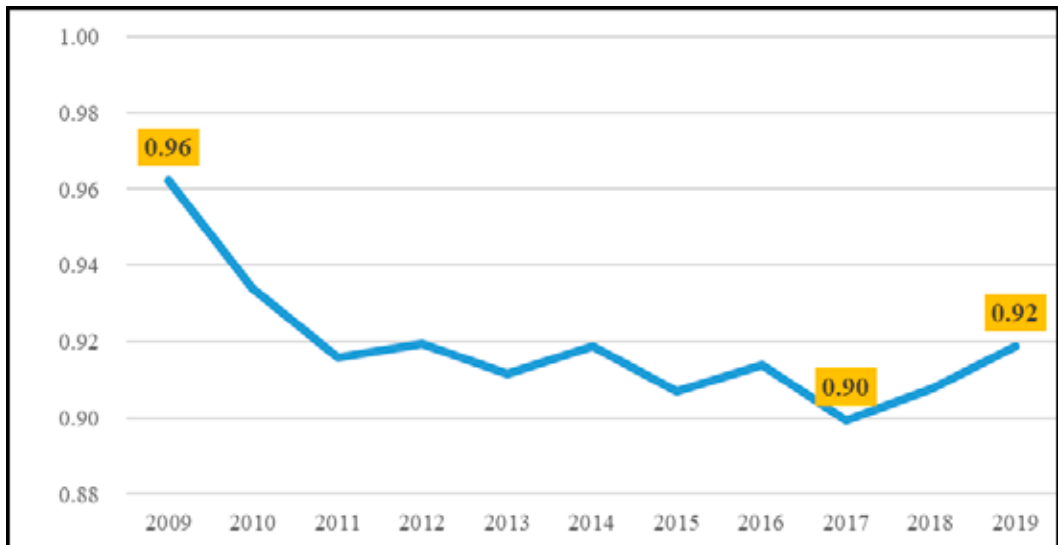
Source: Authors' calculations

In Figure 2, we present a line chart for the efficiency scores of 7 banks (Banka Kovanica d.d., Croatia banka d.d., Imex banka d.d., J&T banka d.d., Karlovačka banka d.d., KentBank d.d. and Partner banka d.d.) that show significant changes in their efficiency over time. What can be drawn as a conclusion from their efficiency scores is that it seems that these seven banks have regrouped into two groups. Namely, Banka Kovanica d.d., J&T banka d.d. and Karlovačka banka d.d. were relatively inefficient by 2014, 2017, and 2016, respectively, and thereafter they were relatively efficient. Unlike them, the group consisting of Imex banka d.d., KentBank d.d. and Partner banka d.d. were relatively efficient up to 2016, when their efficiency started to decrease. Croatia banka d.d. was relatively inefficient in the whole observed period.

Banka Kovanica d.d. experienced a decrease in efficiency as a result of the global crisis, but to a lesser extent (from 80% in 2009 to 69% in 2011, when it started to increase its efficiency to 93% in 2013, and started to be efficient from 2014 to 2019). This is a

rather untypical result for a bank with a 0.3% market share and a member of the group comprising small banks. This rise in efficiency and maintaining efficiency for five years can be explained by their business performance improvement (ROE - 13.4% in 2019), a high capital adequacy ratio (18.0% in 2019) and prudent investment policy and effective uncollected debt recovery policy of the bank as well as further automation of company processes to optimize back and middle office functions.

Croatia banka d.d. recorded 86.14% efficiency in 2009 and experienced a rather dramatic fall to 73% in 2013. It increased efficiency to 82-85% from 2014 to 2016, but its efficiency started to decline once again in the period 2017-2019, ending the year 2019 with a score of 69%. This can be explained with impairment of loans and advances to customers as well as the process of consolidation of the liquidity structure at the level of the entire bank. Croatia banka d.d. was the least efficient bank in the whole observed period and it is fully (100%) owned by the state.

Imex banka d.d. recorded some rather untypical scores of efficiency, which are contrary to the banks analyzed earlier. Namely, it recorded an efficiency score of 100% in the whole post-crisis period, and its efficiency started to decline from 87% in 2016 to 71% in 2019. These efficiency scores could be explained with the new business strategy of the bank from 2015-2020, which defines its orientation towards citizens, craftsmen, small and medium-sized enterprises with a focus on an individual approach to the client and the quality and speed of service as the main advantages. The essence of the changed business model refers to the reduction of the bank risk profile and the reduction of concentration risk with primary orientation and emphasis on the growth of the citizen portfolio. Their strategic goals were to increase the share of retail loans in the total loan portfolio and increase the number of clients with a loan or deposit and eventually increase the number of products per client. By analyzing the balance sheets of Imex banka d.d., it is evident that the bank used to achieve growth of profit by 2011, when it started to decrease gains and record losses. The efficiency scores imply that the effects of the new business model do not bring the desired effect.

J&T banka d.d. experienced a dramatic fall in efficiency in the post-crisis period (from 83% in 2009 to 61% in 2013). However, it recorded an increase in efficiency since then and has restored efficiency since 2017. This increase is a result of a change in business strategies in 2017 and a shift of focus towards bigger corporate clients. As part of the change in strategy, J&T banka d.d. has optimized its business processes, altered its organizational structure and reduced the number of employees.

Karlovačka banka d.d. was relatively efficient in 2009. After that, it experienced a decrease in efficiency to 70% in 2011 and 74% in 2015, and restored its efficiency from 2016 by the end of the observed period, which was explained by its management by the exit of Croatia from recession in 2015.

KentBank d.d. was relatively efficient in the post-crisis period by 2016, when its efficiency score was 73% and 70% in 2017. Its efficiency increased in 2018 and 2019 (to 79% and 80%, respectively), but it remained relatively inefficient. This could be a result of the banking operation modernization process and business network expansion.

Partner banka d.d. showed rather untypical efficiency results, i.e. its efficiency score in 2009 was 98%, and after that, it was relatively efficient from 2010 to 2013 and in 2015, following a sharp decrease in efficiency from 91% in 2016 to 76% in 2017 and 71% in 2019. The decline in efficiency in 2017 cannot be attributed to the collapse of the Agrokor Group since the Management Board of Partner banka d.d. had previously made a decision on a gradual decrease the total exposure of the Bank to the Agrokor Group. The Management Board of Partner Banka d.d. stated in the 2017 Annual Report that they "increased placements and loans to more quality and more stable clients with reliable cash flows and high-quality collaterals since 2017 and in that way significantly decreased its credit risks, thus providing with new profitability" (Partner banka d.d., 2017).

The group of small banks in Croatia recorded lower efficiency scores than the group of large banks and these findings are consistent with previous research studies conducted by Kordić & Višković (2018), Pavković et al. (2018) and Davidović et al. (2019).

Most analysts question the sustainability of small banks and thereby announce possible further consolidation processes. The consolidation of small banks has long been cited as an inevitable scenario for the development of the banking sector (Šverko et al., 2012).

Figure 2 Efficiency scores over time for 7 commercial banks in Croatia
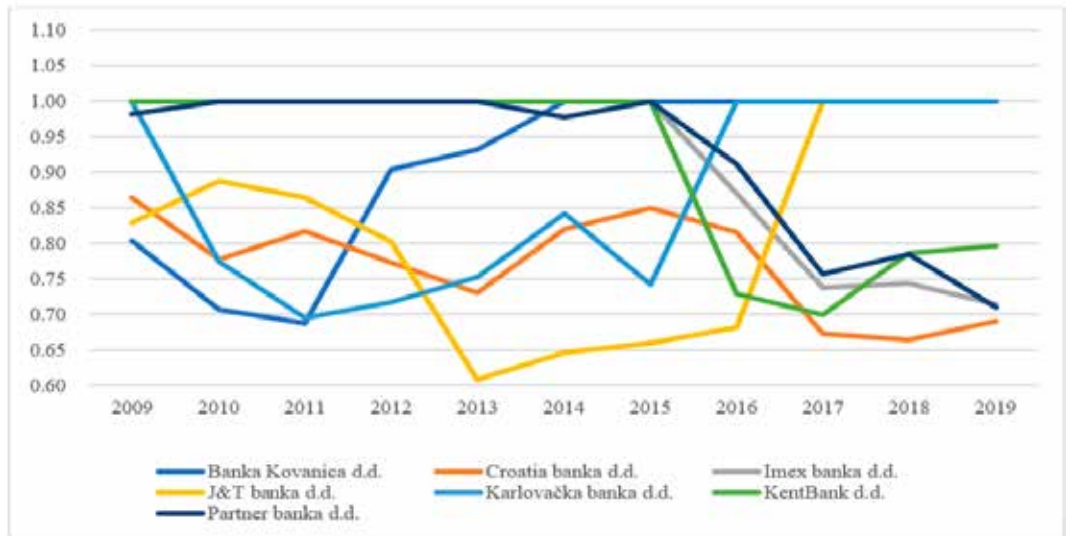
Source: Authors' calculations

Four out of the seven banks analyzed, i.e. Croatia banka d.d., Imex banka d.d., KentBank d.d. and Partner banka d.d. were relatively inefficient in 2019. In Table 4, the authors present the benchmarks for those banks and their λ. As can be seen from this table, Banka Kovanica d.d. is a benchmark for all inefficient banks. Based on λ for Croatia banka d.d., we can see that in calculating the targets for its improvement, Slatinska banka d.d. will have the highest impact because it has the largest value for λ (0.8960) followed by Banka Kovanica d.d., OTP banka d.d. and Zagrebačka banka d.d.

Table 4 Benchmarks for four inefficient banks in 2019

Banks	Benchmarks with λ
Croatia banka d.d.	Banka Kovanica d.d. (0.0967); OTP banka d.d. (0.0045); Slatinska banka d.d. (0.8960); Zagrebačka banka d.d. (0.0028)
Imex banka d.d.	Banka Kovanica d.d. (0.5614); Istarska kreditna banka Umag d.d. (0.0805); Slatinska banka d.d. (0.3580)
KentBank d.d.	Banka Kovanica d.d. (0.7822); Istarska kreditna banka Umag d.d. (0.1932); OTP banka d.d. (0.0247)
Partner banka d.d.	Banka Kovanica d.d. (0.9485); Privredna banka Zagreb d.d. (0.0015); Slatinska banka d.d. (0.0500)

Source: Authors' calculations

In Table 5, we present the targets for improvement for the same four banks based on which they can achieve the efficient frontier and be relatively efficient. According to the calculations for the inputs and the outputs, we can see that the analyzed banks need to increase their outputs, while Partner banka d.d. also needs to decrease the input interest expense.

Table 5 Projection for four inefficient banks in 2019 to achieve the frontier in future

(in 000 HRK)

	Interest Expense	Projection	Other Operating Expense	Projection	Interest Revenue	Projection	Other Operating Revenue	Projection
Croatia banka d.d.	10,910	10,910	60,803	60,803	53,109	76,967	19,694	28,541
Imex banka d.d.	12,483	12,483	48,475	48,475	53,213	74,499	7,049	16,339
KentBank d.d.	15,443	15,443	77,607	77,607	88,839	111,511	7,175	26,813
Partner banka d.d.	16,540	15,782	47,311	47,311	60,793	85,720	8,975	12,655

Source: Authors' calculations

5. Conclusions

Banks play a vital role in the economy of each country and their importance is emphasized in developing countries, where the financial system is characterized as a bank-based system. Therefore, measuring their performance is important for maintaining the stability of the financial system.

In this paper, we measure the efficiency of commercial banks in Croatia in a period of 11 years (2009-2019) by using the leading non-parametric DEA methodology. In the selection of the variables and the DEA model, we have followed Banker et al. (2010).

Based on the results obtained, the average efficiency of the Croatian banking system is 92%. Four banks were relatively efficient in the analyzed period and they are as follows: Erste & Steiermaerkische Bank

d.d., Hrvatska poštanska banka d.d., Privredna banka Zagreb d.d. and Zagrebačka banka d.d. Croatia banka d.d. was identified as the least efficient bank with a mean efficiency score of 77% in the whole analyzed period. In addition, we have analyzed seven banks that show significant changes in the results in the observed period, and for those that were relatively inefficient in 2019, we provide benchmarks and targets for improvement (a decrease in inputs and/or an increase in outputs). By following these targets, relatively inefficient banks could improve their efficiency and be projected onto the efficient frontier.

In further research we plan to investigate the determinants of efficiency by using the DEA+OLS (ordinary least squares) procedure proposed in Banker & Natarajan (2008), which is also applied in the Korean banking sector (Banker et al., 2010).

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