



# Efficiency in the Market Structure of the Banking Sector in Croatia

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**Abstract:** *The purpose of this paper was to determine the market structure of the banking sector in Croatia and the characteristics of its technical efficiency for the period from 2009 to 2022 by applying descriptive statistics and data envelopment analysis (DEA). It was determined that the banking sector in Croatia is characterized by a relatively high and persistent technical efficiency of an oligopolistic market structure with a trend of growing consolidation. On average, managers use resources efficiently and are successful in exploiting economies of scale, with scale efficiency surpassing pure technical efficiency. The aforementioned efficiencies generally grow and are achieved more frequently with the increase in the size of banks, i.e., credit institutions. The results imply that small banks could increase efficiency by more rational use of inputs, and, assuming growing returns to scale, by exploiting economies of scale through internal growth or further sector consolidation.*

## 1. INTRODUCTION

Different characteristics of individual market structures determine differences in their economic efficiency in general, and technical efficiency specifically. Technical efficiency (TE) or input efficiency is achieved when companies combine inputs in a way that minimizes the costs of a certain amount of output (Pindyck & Rubinfeld, 2005) or achieve maximum output with available inputs (Primorac & Troškot, 2005). Technical efficiency includes scale efficiency (SE) and pure technical efficiency (PTE). Pure technical efficiency reflects (in)efficiency of operation, whereas scale efficiency reflects operating conditions (Cooper et al., 2007). In other words, the first refers to the manager's ability to use resources, and the second refers to utilizing scale economies by operating at the point where the efficiency frontier manifests the characteristics of constant returns to scale (Sufian, 2011).

Given that the banking sector is the backbone of financial markets in Central and Eastern European (CEE) countries, its efficiency influences their costs of financial intermediation as well as the general stability of the financial system (Novický & Drožď, 2018). As a result, there is a growing number of studies on the efficiency of the banking system in the aforementioned countries (Andrieş & Ursu, 2016; Belke et al., 2016; Cevik et al., 2016; Diallo, 2018; Erina & Erins, 2020; Kozak & Wierzbowska, 2019; Kutsomanoli-Filippaki et al., 2009; Řepková, 2014; Roghanian et al., 2012; Stavárek, 2006; Yildirim & Philippatos, 2007; among others), in Croatia (Davidović et al., 2019; Gardijan Kedžo & Tuškan Sjauš, 2021; Hunjak & Jakovčević, 2003; Jemrić & Vujčić, 2002; Jurčević & Žaja, 2013; Peša et al., 2021; Primorac & Troškot, 2005; Tuškan & Stojanović, 2016; Učkar & Petrović, 2021; among others), but of course also wider. Domestic studies (Gardijan Kedžo & Tuškan Sjauš, 2021; Jemrić & Vujčić, 2002; Peša et al., 2021; Tuškan Sjauš, 2020; Učkar & Petrović, 2021) indicate that the banking sector's efficiency

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generally grew from the 1990s to the present, and that larger banks are more efficient than small or medium-sized ones. At the same time, scientific and practical considerations point to an oligopolistic market structure (Tipurić et al., 2002), i.e., high concentration (Tuškan Sjauš & Zubanović, 2021) of the Croatian banking industry.

The general goal of the paper is derived from the introductory consideration of the paper's subject, and it consists of the analysis and identification of the market structure of the banking sector in Croatia and the characteristics of its technical efficiency from 2009 to 2022, using descriptive statistical analysis and the DEA method. Based on the empirical findings so far, the specific goals derived from the stated general goal have been shaped into the following hypotheses:

**Hypothesis One:** The banking sector in Croatia has an oligopolistic market structure in the period from 2009 to 2022.

**Hypothesis Two:** The market structure of the banking sector in Croatia is technically efficient in the period from 2009 to 2022.

**Hypothesis Three:** The levels and accomplishments of complete technical efficiency of credit institutions in the banking sector in Croatia increased with their size in the period from 2009 to 2022.

Continuing from the introduction, the findings of the research are elaborated in the next chapters of the paper. Starting with the development and structural-business features of the banking sector in Croatia, the state and trend of its market structure are outlined in the second chapter. The third chapter introduces the methodological framework, and the fourth chapter gives the findings of the banking sector's technical efficiency in Croatia in connection to its identified market structure. The fifth chapter presents future research directions and the conclusion highlights the main findings and implications and discusses the contributions and limitations of the paper.

## 2. CROATIA'S BANKING SECTOR DEVELOPMENT AND STRUCTURAL-BUSINESS FEATURES

In the period from 2009 to 2022, there is a noticeable trend of consolidation of the banking sector, which is manifested by a decrease in the number of credit institutions (2009: 39; 2022: 22) and net entry rates, as well as an increase in the minimum efficient scale and the share of entities that meet it, especially in terms of number of employees (2009: 20.51%; 2021: 29.17%; 2022: 27.27%), which consequently results in the growth of market concentration (HHI 2009: 1,319.75, HHI 2012: 1,654.30). Although in the observed period all types of credit institutions recorded a decline in their number, the intensity of these declines varies. The credit institution structure by type illustrates banks' growing dominance, i.e., the fall in the role of savings banks and house savings banks in Croatia's banking industry over time. The foregoing is a direct result, first and foremost, of the expansion of financial markets and the introduction of new methods of meeting housing and other needs (Leko, 2012). As a result, 22 credit institutions existed in Croatia at the end of 2022, 21 of which were banks and one was a house savings bank, whereas no savings bank operated as of March 2018. The banking sector's size structure<sup>4</sup> was dominated by small credit institutions, i.e.,

<sup>4</sup> The size of banks is determined based on the share of their assets in the total assets of the banking sector. Small banks have a share of assets in the banking sector that is less than 1%, medium-sized banks have a share that is greater than 1% but less than 5%, and large banks have a share that is greater than 5%. (Šverko et al., 2012)

banks, whose number declined from 23 in 2009 to 13 in the most recent year, 2022, due to bankruptcies, liquidations, and mergers and takeovers. The number of medium-sized banks ranged from two (from 2018 to 2022) to four (2008; 2013; 2014), while the number of large banks stayed constant at six. Finally, in terms of credit institution ownership structure, foreign banks dominate throughout the period, although their proportion in the structure reduces over time (Hrvatska narodna banka [HNB], 2023a, 2023b). According to data from the end of 2022, 12 credit institutions are foreign-owned, while 10 are domestically owned, seven of which are privately owned and three of which are state-owned (Hrvatska narodna banka [HNB], 2023c).

The banking sector in Croatia in the observed period, but in the preceding periods, is also characterized by the linking of credit institutions into national (Croatian Banking Association (CBA) since 1999) and international (e.g., European Banking Federation (EBF) since 2013) associations and by the differentiation of substitutable services (Rupčić & Superina Gudelj, 2021), particularly driven by the progressive application of advanced information and communications technology (ICT). The rising usage of ICT, along with other variables, undoubtedly has an impact on the profitability of Croatia's banking sector. Profitability during the period in consideration, measured by Return on Assets (ROA) and Return on Equity (ROE), ranged from -1.14% and -9.00% in 2015 to 1.37% and 9.82% in 2019, with fourteen-year averages in the observed period of 0.75% and 5.41%. Banks and credit institutions mainly are generally deemed profitable if their ROA values are at least 1% and their ROE values are greater than 10% (Jurčević & Žaja, 2013). Accordingly, it can be concluded that on average the mentioned traditional requirements are not met. However, what is positive is that in the last five years, except for 2020, the ROA values are in line, and the ROE values are almost in line with the stated requirements.

Following the presented development and structural-business features, it can be concluded, according to Tipurić et al. (2002) and Tuškan Sjauš and Zubanović (2021), the existence and strengthening of the oligopolistic market structure of the banking sector in Croatia during the period from 2009 to 2022 and, accordingly, the hypothesis one is accepted.

### 3. METHODOLOGICAL FRAMEWORK FOR ANALYSING THE EFFICIENCY OF CROATIS'S BANKING SECTOR

Data Envelopment Analysis (DEA) is used to examine the technical efficiency of the banking sector's market structure in Croatia from 2009 to 2022. The method was chosen based on the rare analyses of banking efficiency in Croatia using the aforementioned method, which they carried out in their papers Jemrić and Vujčić (2002), Jurčević and Žaja (2013), Tuškan and Stojanović (2016), Davidović et al. (2019), Peša et al. (2021), Učkar and Petrović (2021), Tuškan Sjauš (2020) and Gardijan Kedžo and Tuškan Sjauš (2021).

In order to determine the TE, PTE, and SE for the banking sector in Croatia for each year, this paper, based on similar domestic (e.g., Gardijan Kedžo & Tuškan Sjauš, 2021; Jemrić & Vujčić, 2002; Peša et al., 2021; Tuškan Sjauš, 2020; Učkar & Petrović, 2021) and foreign studies (Řepková, 2014; Sufian, 2011; among others), both the Charnes-Cooper-Rhodes (CCR) and the Banker-Charnes-Cooper (BCC) input-directed models (CCR-I and BCC-I) were used. Both models were chosen precisely to enable the decomposition of TE into PTE and SE, and their focus on inputs was chosen because, although the banking market is not competitive, management in the banking sector has a greater ability to influence input minimization than output maximization (Učkar & Petrović, 2021). Therefore, the decision-making units (DMUs) included in the analysis

are (managers of) credit institutions (banks, savings banks, and housing savings banks) that operated in Croatia throughout certain years of the observed period.

Based on the literature review in the field of bank efficiency research, four equivalent approaches to identifying input and output dominate - the production, the intermediation, the added value and the operating or profit-oriented approach (Drake et al., 2006; Sufian, 2011). While the first two approaches apply the traditional microeconomic theory of the company to banking and differ only in the specification of banking activities, the last two approaches go a step further and modify the classical theory by incorporating some specific banking activities. The suitability of each approach varies depending on the circumstances (Sufian, 2011). Based on the fact that banks in Croatia are of a universal type and perform a variety of activities, as well as for practical reasons of ensuring comparability with previous studies (e.g., Jemrić & Vujčić, 2002; Jurčević & Žaja, 2013; Peša et al., 2021; Tuškan & Stojanović, 2016; Tuškan Sjauš, 2020; Učkar & Petrović, 2021), the inputs and outputs are determined using the operating approach. Following the operating approach's cost and income management perspective, each decision maker, i.e., credit institution has four inputs: (I1) interest costs, (I2) commission and fee costs, (I3) other non-interest costs, and (I4) general administrative costs and depreciation, and three outputs: (O1) interest income, (O2) commission and fee income, and (O3) other non-interest income.

Annual data on defined inputs and outputs of all credit institutions in Croatia during the observed period were used, which were extracted from the Croatian National Bank's Bulletin on Banks for individual years from 2010 to 2019 and from financial statements of credit institutions for years 2018 to 2022. The descriptive statistics of the input and output variables used to build the DEA model are available upon request.

#### 4. TECHNICAL EFFICIENCY OF THE CROATIA'S BANKING SECTOR

The results of applying the CCR-I model (Table 1), which assumes constant returns to scale, show that the banking sector's average annual global TE ranged from 0.8793 (2016) to 0.9725 (2022), with a fourteen-year average of 0.9283. As a result, the period's average relative inefficiency, that is average surplus of inputs in relation to the need for inputs when operating at the limit of efficiency, is 7.84%. Large banks have the highest average TE, whereas small banks have the lowest. The number of credit institutions operating on the efficiency limit, i.e., those that are technically efficient, as well as those whose TE is at or above the TE average, ranges from 15 (2016) to 24 (2011) and on average accounts for more than half (58, 65%) of the total number of credit institutions during the observed period. The size of credit institutions determines their representation in the set of technically efficient credit institutions. Based on fourteen-year averages, large banks dominate the set of technically efficient credit institutions (79.76%), followed by medium-sized banks (68.45%), and finally small banks (43.39%). Savings banks (72.22%) and housing savings banks (78.10%) have comparable participation rates. In terms of the coefficient of variation, the volatility of credit institutions in the covered period does not exceed 20%. The year 2016 was the most volatile (19.29%), characterized by the already mentioned, least favourable remaining efficiency indicators.

Although the results of the local PTE analysis revealed by the BCC-I model (Table 2) based on the assumption of variable returns to scale inherently show higher levels of efficiency, the main findings are consistent with those of the CCR-I model. From 2009 to 2022, the banking sector's average annual local PTE fluctuated between 0.8997 (2015) and 0.9972 (2022), with a

fourteen-year average of 0.9505. In comparison to operations at the efficiency limit, this implies that the period's average relative inefficiency or the average excess of inputs is 5.31%. On average, the largest PTE is achieved by large banks, and the smallest by small banks. Except in 2015 (48.48%), the number of credit institutions operating on the efficiency frontier, characterized by PTE, is larger than 50%, with a period average of 2/3 (66.95%). This figure, as well as the number of credit institutions with PTEs equal to or higher than the PTE average, fluctuates between 16 (2015) and 26 (2011). As with TE, the presence of efficient credit institutions is highest in the large bank group (fourteen-year average: 90.48%), followed by medium-sized banks (fourteen-year average: 82.14%), and lowest in the small bank group (fourteen-year average 50.33%). Savings banks and housing savings banks are represented by 88.89% and 84.29% of their total number. Considering the elimination of SE effects, PTE volatility is consistently lower than TE volatility, implying that more credit institutions are closer to the average PTE than to the average TE. The highest PTE volatility was recorded in 2014 when it was 14.47%.

Finally, the findings of the SE analyses (Table 3), as a quotient of TE and PTE, identify the movement of the average SE of the banking sector in the examined period in the range of 0.9573 (2016) and 0.9876 (2017) and, correspondingly, with a high temporal average of 0.9758. Large banks achieve the greatest average SE ratings, whereas small banks achieve the lowest. Higher SE values compared to PTE, along with other measures, imply that the SE impact, while not by much, outperforms the local PTE effect in determining the total, that is, the global TE. Specifically, compared to the achievement of economies of scale and reaching the optimum point characterized by constant returns to scale, the average relative inefficiency in the covered period is only 2.48%. Although SE is generally more favourable, compared to TE and PTE, it is achieved by a smaller number of credit institutions. Specifically, from 43.59% to 79.17% of them, depending on the year, that is, on average 58.27% in total, 49.46% in the category of small banks, 66.67% in the group of medium-sized banks, and 73.81% large banks. And the frequencies of savings banks (44.44%) and housing savings banks (63.81%) are consistently lower. Parallel with TE and PTE, the variability of SE is in overall the lowest, with a maximum of 15.25% in 2016.

In all observed years, two credit institutions achieve full TE, full PTE, and therefore full SE: Hrvatska poštanska banka d. d. and Zagrebačka banka d.d. Accordingly, these credit institutions are considered absolutely technically efficient. Similarly, for the period from 2009 to 2018, [Gardijan Kedžo and Tuškan Sjauš \(2021\)](#) detected the dominance of Erste&Steiermärkische Bank d. d. and Zagrebačka banka d.d. Furthermore, the temporal trends of TE, PTE, and SE are broadly consistent with one another, as well as with the movements of ROA and ROE during the observed period. The above points to the agreement between the results of the efficiency evaluation using the non-parametric DEA method and traditional (profit) efficiency measures.

Based on the presented results of the analysis of the technical efficiency of the banking sector in Croatia for the period from 2009 to 2022, hypotheses two and three are accepted. Also, the results are consistent with the findings of [Peša et al. \(2021\)](#) and [Učkar and Petrović \(2021\)](#), and in the context of hypothesis two, to a greater extent, with the findings of [Gardijan Kedžo and Tuškan Sjauš \(2021\)](#), and in the context of hypothesis three, predominantly with the findings of [Jemrić and Vujčić \(2002\)](#).

**Table 1.** Summary results of the application of the CCR-I model for the TE analysis of the banking sector in Croatia for the period 2009–2022

| measure  | 2009   | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   | 2020   | 2021   | 2022   | average |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| average efficiency                                 | 0,9250 | 0,9221 | 0,9339 | 0,9151 | 0,9145 | 0,8839 | 0,8806 | 0,8793 | 0,9482 | 0,9425 | 0,9369 | 0,9707 | 0,9717 | 0,9725 | 0,9283  |
| standard deviation                                 | 0,0915 | 0,1209 | 0,1133 | 0,1177 | 0,1368 | 0,1451 | 0,1258 | 0,1696 | 0,0788 | 0,0920 | 0,1093 | 0,0580 | 0,0727 | 0,0814 | 0,1081  |
| coefficient of variation (%)                       | 9,89   | 13,11  | 12,13  | 12,86  | 14,96  | 16,42  | 14,28  | 19,29  | 8,31   | 9,77   | 11,67  | 5,98   | 7,48   | 8,37   | 11,75   |
| maximum  | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000  |
| minimum  | 0,5705 | 0,5500 | 0,5884 | 0,5749 | 0,5217 | 0,5496 | 0,6383 | 0,1895 | 0,7085 | 0,7099 | 0,6468 | 0,7696 | 0,7196 | 0,6139 | 0,5965  |
| number of DMUs                                     | 39     | 38     | 37     | 36     | 35     | 33     | 33     | 31     | 29     | 25     | 24     | 24     | 23     | 22     | 30,64   |
| number of effective DMUs                           | 17     | 21     | 24     | 19     | 18     | 16     | 16     | 15     | 16     | 16     | 16     | 16     | 19     | 16     | 17,50   |
| %  | 43,59  | 55,26  | 64,86  | 52,78  | 51,43  | 48,48  | 48,48  | 48,39  | 55,17  | 64,00  | 66,67  | 66,67  | 82,61  | 72,73  | 58,65   |
| small  | 8      | 9      | 12     | 8      | 6      | 4      | 4      | 5      | 6      | 5      | 6      | 8      | 9      | 10     | 7,14    |
| %  | 34,78  | 39,13  | 54,55  | 38,10  | 31,58  | 23,53  | 22,22  | 31,25  | 40,00  | 38,46  | 46,15  | 61,54  | 69,23  | 76,92  | 43,39   |
| medium   | 1      | 2      | 2      | 1      | 3      | 2      | 2      | 3      | 2      | 1      | 2      | 1      | 2      | 2      | 1,86    |
| %  | 33,33  | 66,67  | 66,67  | 33,33  | 75,00  | 50,00  | 66,67  | 100,00 | 66,67  | 50,00  | 100,00 | 50,00  | 100,00 | 100,00 | 68,45   |
| large  | 3      | 5      | 5      | 5      | 4      | 5      | 5      | 5      | 5      | 6      | 6      | 5      | 5      | 3      | 4,79    |
| %  | 50,00  | 83,33  | 83,33  | 83,33  | 66,67  | 83,33  | 83,33  | 83,33  | 83,33  | 100,00 | 100,00 | 83,33  | 83,33  | 50,00  | 79,76   |
| savings banks                                      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0,50    |
| %  | 50,00  | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 0,00   | 0,00   |        |        |        |        |        | 72,22   |
| housing savings banks                              | 4      | 4      | 4      | 4      | 4      | 4      | 4      | 2      | 3      | 4      | 2      | 2      | 3      | 1      | 3,21    |
| %  | 80,00  | 80,00  | 80,00  | 80,00  | 80,00  | 80,00  | 80,00  | 40,00  | 60,00  | 100,00 | 66,67  | 66,67  | 100,00 | 100,00 | 78,10   |
| number of DMUs with efficiency at or above average | 21     | 26     | 27     | 23     | 24     | 19     | 17     | 17     | 20     | 17     | 18     | 17     | 20     | 17     | 20,21   |
| number of inefficient DMUs                         | 22     | 17     | 13     | 17     | 17     | 17     | 17     | 16     | 13     | 9      | 8      | 8      | 5      | 6      | 13,21   |
| average inefficiency                               | 0,0811 | 0,0845 | 0,0707 | 0,0927 | 0,0935 | 0,1313 | 0,1356 | 0,1373 | 0,0547 | 0,0610 | 0,0674 | 0,0302 | 0,0291 | 0,0283 | 0,0784  |

Source: Own calculations

Table 2. Summary results of the application of the BCC-I model for the PTE analysis of the banking sector in Croatia for the period 2009–2022

| measure  | 2009   | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   | 2020   | 2021   | 2022   | average |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| average efficiency                                 | 0,9487 | 0,9411 | 0,9479 | 0,9347 | 0,9372 | 0,9021 | 0,8997 | 0,9201 | 0,9596 | 0,9703 | 0,9708 | 0,9904 | 0,9877 | 0,9972 | 0,9505  |
| standard deviation                                 | 0,0652 | 0,0925 | 0,0951 | 0,0999 | 0,1121 | 0,1305 | 0,1097 | 0,1074 | 0,0700 | 0,0590 | 0,0648 | 0,0395 | 0,0420 | 0,0106 | 0,0784  |
| coefficient of variation (%)                       | 6,87   | 9,82   | 10,03  | 10,69  | 11,97  | 14,47  | 12,19  | 11,68  | 7,29   | 6,08   | 6,68   | 3,98   | 4,26   | 1,06   | 8,36    |
| maximum  | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000  |
| minimum  | 0,7851 | 0,7074 | 0,6670 | 0,6292 | 0,5650 | 0,5768 | 0,6505 | 0,7081 | 0,7280 | 0,7589 | 0,7728 | 0,8040 | 0,8015 | 0,9501 | 0,7217  |
| number of DMUs                                     | 39     | 38     | 37     | 36     | 35     | 33     | 33     | 31     | 29     | 25     | 24     | 24     | 24     | 22     | 30,71   |
| number of effective DMUs                           | 20     | 23     | 26     | 21     | 19     | 17     | 16     | 18     | 19     | 18     | 19     | 22     | 21     | 20     | 19,93   |
| %  | 51,28  | 60,53  | 70,27  | 58,33  | 54,29  | 51,52  | 48,48  | 58,06  | 63,33  | 72,00  | 79,17  | 91,67  | 87,50  | 90,91  | 66,95   |
| small  | 7      | 12     | 13     | 10     | 6      | 4      | 4      | 6      | 7      | 6      | 8      | 11     | 10     | 11     | 8,21    |
| %  | 30,43  | 52,17  | 59,09  | 47,62  | 31,58  | 23,53  | 22,22  | 37,50  | 46,67  | 46,15  | 61,54  | 84,62  | 76,92  | 84,62  | 50,33   |
| medium   | 2      | 1      | 3      | 1      | 3      | 3      | 2      | 3      | 3      | 2      | 2      | 2      | 2      | 2      | 2,21    |
| %  | 66,67  | 33,33  | 100,00 | 33,33  | 75,00  | 75,00  | 66,67  | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 82,14   |
| large  | 5      | 5      | 5      | 5      | 5      | 5      | 5      | 5      | 6      | 6      | 6      | 6      | 6      | 6      | 5,43    |
| %  | 83,33  | 83,33  | 83,33  | 83,33  | 83,33  | 83,33  | 83,33  | 83,33  | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 90,48   |
| savings banks                                      | 2      | 1      | 1      | 1      | 1      | 1      | 1      | 1      | 0      | 0      | 0      | 0      | 0      | 0      | 0,64    |
| %  | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 0,00   |        |        |        |        |        | 88,89   |
| housing savings banks                              | 4      | 4      | 4      | 4      | 4      | 4      | 4      | 3      | 3      | 4      | 3      | 3      | 3      | 1      | 3,43    |
| %  | 80,00  | 80,00  | 80,00  | 80,00  | 80,00  | 80,00  | 80,00  | 60,00  | 60,00  | 100,00 | 100,00 | 100,00 | 100,00 | 100,00 | 84,29   |
| number of DMUs with efficiency at or above average | 23     | 26     | 27     | 24     | 26     | 20     | 16     | 19     | 22     | 19     | 19     | 22     | 21     | 20     | 21,71   |
| number of inefficient DMUs                         | 19     | 15     | 11     | 15     | 16     | 16     | 17     | 13     | 10     | 7      | 5      | 2      | 3      | 2      | 10,79   |
| average inefficiency                               | 0,0541 | 0,0625 | 0,0550 | 0,0698 | 0,0670 | 0,1085 | 0,1115 | 0,0868 | 0,0421 | 0,0306 | 0,0301 | 0,0097 | 0,0124 | 0,0028 | 0,0531  |

Source: Own calculations

**Table 3.** Summary results of the SE analysis of the banking sector in Croatia for the period 2009–2022

| measure  | 2009   | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   | 2016   | 2017   | 2018   | 2019   | 2020   | 2021   | 2022   | average |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| average efficiency                                 | 0,9738 | 0,9782 | 0,9850 | 0,9779 | 0,9725 | 0,9778 | 0,9773 | 0,9573 | 0,9876 | 0,9710 | 0,9636 | 0,9798 | 0,9836 | 0,9753 | 0,9758  |
| standard deviation                                 | 0,0553 | 0,0702 | 0,0624 | 0,0574 | 0,0583 | 0,0484 | 0,0492 | 0,1460 | 0,0248 | 0,0685 | 0,0795 | 0,0386 | 0,0585 | 0,0832 | 0,0643  |
| coefficient of variation (%)                       | 5,68   | 7,17   | 6,34   | 5,87   | 6,00   | 4,95   | 5,04   | 15,25  | 2,51   | 7,06   | 8,25   | 3,94   | 5,95   | 8,53   | 6,61    |
| maximum  | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1,0000  |
| minimum  | 0,6789 | 0,6268 | 0,6208 | 0,7249 | 0,7483 | 0,8369 | 0,8095 | 0,1895 | 0,8847 | 0,7099 | 0,6468 | 0,8406 | 0,7196 | 0,6139 | 0,6894  |
| number of DMUs                                     | 39     | 38     | 37     | 36     | 35     | 33     | 33     | 31     | 29     | 25     | 24     | 24     | 24     | 22     | 30,71   |
| number of effective DMUs                           | 17     | 21     | 24     | 19     | 18     | 16     | 16     | 15     | 16     | 16     | 16     | 16     | 19     | 16     | 17,50   |
| %  | 43,59  | 55,26  | 64,86  | 52,78  | 51,43  | 48,48  | 48,48  | 48,39  | 53,33  | 64,00  | 66,67  | 66,67  | 79,17  | 72,73  | 58,27   |
| small  | 7      | 14     | 15     | 14     | 6      | 7      | 4      | 5      | 6      | 5      | 6      | 8      | 9      | 11     | 8,36    |
| %  | 30,43  | 60,87  | 68,18  | 66,67  | 31,58  | 41,18  | 22,22  | 31,25  | 40,00  | 38,46  | 46,15  | 61,54  | 69,23  | 84,62  | 49,46   |
| medium   | 1      | 1      | 3      | 1      | 3      | 3      | 2      | 3      | 2      | 1      | 2      | 1      | 2      | 1      | 1,86    |
| %  | 33,33  | 33,33  | 100,00 | 33,33  | 75,00  | 75,00  | 66,67  | 100,00 | 66,67  | 50,00  | 100,00 | 50,00  | 100,00 | 50,00  | 66,67   |
| large  | 3      | 3      | 5      | 3      | 4      | 4      | 5      | 5      | 5      | 6      | 6      | 5      | 5      | 3      | 4,43    |
| %  | 50,00  | 50,00  | 83,33  | 50,00  | 66,67  | 66,67  | 83,33  | 83,33  | 83,33  | 100,00 | 100,00 | 83,33  | 83,33  | 50,00  | 73,81   |
| savings banks                                      | 2      | 1      | 0      | 0      | 1      | 0      | 1      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0,36    |
| %  | 100,00 | 100,00 | 0,00   | 0,00   | 100,00 | 0,00   | 100,00 | 0,00   | 0,00   |        |        |        |        |        | 44,44   |
| housing savings banks                              | 4      | 2      | 1      | 1      | 4      | 2      | 4      | 2      | 3      | 4      | 2      | 2      | 3      | 1      | 2,50    |
| %  | 80,00  | 40,00  | 20,00  | 20,00  | 80,00  | 40,00  | 80,00  | 40,00  | 60,00  | 100,00 | 66,67  | 66,67  | 100,00 | 100,00 | 63,81   |
| number of DMUs with efficiency at or above average | 29     | 33     | 31     | 30     | 27     | 27     | 28     | 26     | 20     | 20     | 17     | 16     | 21     | 19     | 24,57   |
| number of inefficient DMUs                         | 22     | 17     | 13     | 17     | 17     | 17     | 17     | 16     | 13     | 9      | 8      | 8      | 5      | 6      | 13,21   |
| average inefficiency                               | 0,0270 | 0,0223 | 0,0153 | 0,0226 | 0,0283 | 0,0227 | 0,0232 | 0,0446 | 0,0126 | 0,0299 | 0,0377 | 0,0206 | 0,0167 | 0,0253 | 0,0249  |

Source: Own calculations



## 5. FUTURE RESEARCH DIRECTIONS

Given the extent of this paper, it is suggested to channel future research in the direction of analysing other dimensions of efficiency: dynamic efficiency, inherent in oligopoly and monopoly markets, and allocative and cost efficiency. Furthermore, it is suggested that future research take into account other limitations of this study, particularly the sensitivity of the results to the methodological approach (choice of method and input and output) and the absence of identification of the character of returns to scale. Also, this research can be extended temporally, sectorally and geographically, by analysing an even longer period in order to comparatively monitor changes in efficiency over time within the same and between different sectors in one or more countries. Finally, there are numerous possibilities for extending the research on the relation to market structure — efficiency — business and economic performance.

## 6. CONCLUSION

The banking sector is the backbone of financial markets and economies of CEE countries, including Croatia. Consequently, the efficiency of its market structure affects the performance of the financial and economic system in general. For this reason, the purpose of the paper was to determine the market structure of the banking sector in Croatia and the characteristics of its TE for the period from 2009 to 2022 using descriptive statistical analysis and the DEA method. Based on the descriptive analysis, consistent with hypothesis one, an oligopolistic market structure with characteristics of growing consolidation was established. The results of the technical efficiency analysis using the DEA method reveal the persistence of a relatively high average TE, as well as its components: PTE and SE. Full total TE (58.65 %), PTE (66.95 %) and SE (58.27 %) were achieved on average in the observed period by more than half of the credit institutions. It is concluded, following hypothesis two, that on average managers use bank resources efficiently and are more successful in exploiting economies of scale, which synergistically determines a relatively high average TE. At the same time, as assumed by hypothesis three, the aforementioned efficiencies generally grow and are achieved more frequently the larger the size of the bank, that is, the credit institution. Thus, large banks achieve the highest levels and most often achieve full PTE, SE and overall TE. The opposite is true for small banks. Additionally, the results of the analysis reveal relatively low to moderate volatility of average (in)efficiencies (TE, PTE and SE) and equal degrees of homogeneity between PTE and SE of credit institutions.

The findings imply that small banks in Croatia could increase efficiency by using inputs more rationally and assuming growing returns to scale, by exploiting economies of scale. With the aforementioned assumption, positive effects on efficiency can be achieved by changing the volume of operations through internal growth or further consolidation in the sector. The study suggests that to take advantage of cost advantages due to the use of economies of scale, efficient banks should absorb inefficient banks. In addition to the aforementioned implications aimed at improving static TE, long-term efficiency improvements can also result from innovative banks that develop and introduce new technologies.

Despite the detected limitations, this research is valuable because it stands out among the rare existing related studies in Croatia in its spatial and temporal coverage, covering the entire banking sector for the longest period. In this way, it contributes to existing studies on the efficiency of the banking sector in Croatia and beyond, while providing a foothold for future research. The practical contribution of the paper is in the implications of the research results for the bank's management, the central bank, the association of banks, the government, and other bodies in the financial market.

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