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The Efficiency of Indonesian Commercial Banks: Does the Banking Industry Competition Matter?

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Abstract: This study examines the effect of banking industry competition on the efficiency of commercial banks in Indonesia from 2010 to 2019. First, using data envelopment analysis (DEA), the results showed that the commercial banks in Indonesia are moderately efficient. Second, this study uses H-statistics, obtained through the Panzar–Rosse model, to measure the level of competition. The results showed that the banking industry competition in Indonesia is a monopolistic market. In addition, this study also analysed other factors affecting bank efficiency, namely non-performing loans (NPL), loan to deposit ratio (LDR), capital adequacy ratio (CAR), bank size, and economic growth. This study used the Tobit estimation method to analyse the effect of competition and other variables. The results showed that tighter competition in the banking industry reduces the commercial banks' efficiency. The results of this study support the competition-inefficiency hypothesis. Other variables such as CAR, LDR, and economic growth had a significant effect on bank efficiency. Meanwhile, the NPL variable and bank size had no significant effect.

Keywords: efficiency; competition; commercial banks; competition-inefficiency hypothesis

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1. Introduction

Indonesia is a bank-based economy, where banks play a major role in the financial system's sustainability and become the main source of funding. Countries' capital markets for bank-based economies are still emerging [1]. Therefore, banks act as intermediary institutions that collect excess funds and distribute them in the form of loans [2]. In developing countries, banks become the main channel of capital flows and significantly contribute to economic activities [3].

Creating good economic stability requires a healthy, effective, and efficient banking system. Otherwise, bank credit will not be allocated appropriately, so the bank's credit portfolio cannot encourage overall economic growth [4]. Therefore, the banking industry must run in a healthy, stable, and efficient manner to create a more equitable and sustainable economic growth [5].

Banking efficiency is an important indicator for analysing bank performance and becomes a tool to review the effectiveness of monetary policy implemented by a country [6]. Banking efficiency also has a major impact on a country's economy [2]. According to [3], banks make a significant contribution to economic activity, so banking efficiency is a critical success factor in increasing the effectiveness and resilience of the financial system. According to the World Bank, Return on Assets (ROA) is one indicator that reflects banking efficiency. In Indonesia, the level of banking efficiency is low. Based on the World Bank data, Indonesian banking ROA from 2010 to 2017 was at 1 to 2 percent, so improvement strategies are needed.

There are internal and external factors affecting banking efficiency. Internal factors consist of bank business activities. External factors include competition, market structure, and

economic conditions [5]. Competition has a positive effect on efficiency, but its instability can also have a negative effect [7].

Based on data from Indonesia Financial Services Authority (OJK), the number of commercial banks in Indonesia has decreased continuously from 2010 to 2019 due to, among others, mergers or acquisitions. This is in line with OJK Regulation Number 12/POJK.03/2020 concerning the consolidation of commercial banks.

The relationship between competition and efficiency within the banking industry is complex [8]. There are two opposing hypotheses about the relationship between competition and banking efficiency: the competition-efficiency hypothesis and the competition-inefficiency hypothesis [9]. The competition-efficiency hypothesis postulates a positive relationship between industrial competition and banking efficiency [9]. Ref. [10] argues that higher competition encourages banks to specialise and focus on certain types of loans or certain groups of borrowers. The competition will also encourage bank managers to adopt new bank lending technology. With this, the processing cost and initial loan can be lowered, and borrowers can be better monitored.

In contrast, the competition-inefficiency hypothesis postulates a negative relationship between industrial competition and banking efficiency [9]. The relationships between customers and banks become less stable and shorter in a more competitive environment. They may switch quickly to other service providers [11].

Past studies have examined the relationship between banking industry competition and efficiency in Indonesia. Refs. [5,12] show that competition has a positive effect on banking efficiency. In contrast, ref. [6] shows that competition has a negative effect on banking efficiency. According to [13], banking efficiency is becoming more important due to higher competition in the banking industry and increasing customer satisfaction standards. Therefore, banking efficiency in Indonesia needs to be analysed further to identify the causes of efficiency changes and use the findings to make improvements.

Past studies on the effect of competition on banking efficiency have been extensive, such as by [3,9,14,15]. In Indonesia, studies analysing the link between competition and efficiency were conducted by [5,6,12]. However, the results were inconclusive. This study aims to provide new evidence by using analysing the effect of competition on efficiency using non-performing loans (NPL), capital adequacy ratio (CAR), loan to deposit ratio (LDR), bank size, and economic growth. The first step is to measure bank efficiency using the non-parametric data envelopment analysis (DEA) method. The next step is to determine the level of competition in the banking industry using a Panzar–Rosse model estimated by the ordinary least square (OLS) method and Tobit regression.

This study is novel as it uses a production approach to measuring banking efficiency. Previous studies conducted by [5,6] use an intermediation approach, while [12] uses the alternative profit efficiency approach. In addition, the combination of input and output variables to measure the level of bank efficiency in this study is also different from previous studies.

This study contributes to empirical testing of the effect of competition on banking efficiency, which can be used as a reference in government policymaking related to competition regulation in the banking industry. This research can also be a reference for banks in formulating strategies to increase efficiency. In addition, this research can also be used as a reference for further research related to the effect of competition on banking efficiency in Indonesia.

2. Materials and Methods

In the banking industry, a bank's performance can also be measured through efficiency. An efficient bank can reach a maximum efficiency score of one, and an inefficient bank has an efficiency score close to zero [16]. There are two general approaches to assessing bank performance: the financial ratio approach and the frontier approach [17]. The frontier approach is divided into two categories: the parametric approach and the non-parametric approach. The parametric approach is specifically divided into three methods, namely

the stochastic frontier approach (SFA), the distribution-free approach (DFA), and the thick frontier approach (TFA). Meanwhile, the non-parametric approach is specifically divided into two methods, namely data envelopment analysis (DEA) and the free disposal hull (FDH) method [18].

For measuring bank efficiency, two approaches can be used to determine the input and output variables: the production approach and the intermediation approach [19]. In the production approach, the bank's function is described as a producer of deposit and credit account products. Meanwhile, in the intermediation approach, the function of the bank is described as an intermediary in collecting funds from customers and distributing these funds into loans [20].

Competition can affect bank efficiency [5]. Industry competition can occur due to differences in market forms [6]. Similar to other industries, the types of competition in the banking sector can be classified into the following categories: perfect, monopolistic, oligopoly, and monopoly competitions [18].

The measurement of banking industry competition is based on two different approaches, namely structural and non-structural approaches [21,22]. The structural approaches consist of the Herfindahl Hirschman Index (HHI) and n-bank concentration ratios such as CR5 [21,22]. Meanwhile, the non-structural approaches include the Lerner index and Panzar–Rosse H-statistics [22].

The relationship between competition and efficiency in the banking industry is still debatable, with two opinions circulating, namely the competition-efficiency hypothesis and the competition-inefficiency hypothesis [9]. The former argues that competition has a positive effect on banking efficiency [9]. The higher competition encourages banks to specialise and focus on certain types of loans or certain groups of borrowers and adopt new technology to lower processing fees and monitor borrowers [10]. The latter argues that competition will decrease bank efficiency [9]. Shorter and unstable relationships between customers and banks in a competitive market condition increase the tendency to switch to other service providers [3,11]. Finding new customers will increase the cost of collecting information and potential credit risk, which will increase the bank's operational costs [23].

Some empirical studies on the relationship between competition and banking efficiency support the competition-efficiency hypothesis [21,24,25], including in 15 Latin American countries from 2001 to 2008 [26]. Meanwhile, [27] found that banks facing a low, competitive environment tend to engage in risky activities, face more regulatory intervention, have higher loan losses, and experience default.

In contrast, other empirical studies, such as by [7,9,15,28], supported the competition-inefficiency hypothesis and showed the negative effect of competition on bank efficiency. The authors of [14] analysed the effect of competition on banking efficiency in six developing countries in Asia between 2005 and 2012. The results indicated that increased competition would reduce bank efficiency due to unstable relationships between customers and banks. A recent study by [3] also showed that competition has a negative effect on banking efficiency in the MENA region.

In Indonesia, [5] analysed 120 commercial banks in Indonesia from 2000 to 2012. Likewise, ref. [12] studied 107 commercial banks in Indonesia from 2008 to 2013. Both showed that competition has a positive effect on banking efficiency. However, ref. [6] analysed 19 commercial banks with the largest total asset ownership and total credit in 2008 and 2012 and found that competition had a negative effect on banking efficiency.

Other variables affecting bank efficiency are non-performing loans (NPL), capital adequacy ratio (CAR), LDR, bank size, and economic growth. Past studies have examined the effect of NPL on bank efficiency [9,14,29,30]. Ref. [29] found that NPL has a negative effect on bank efficiency because high credit risk indicates poor bank performance.

Meanwhile, capital positively affects bank efficiency [31,32]. High capital is an accessible source of funds for banks, so the selling price of credit will be more competitive. LDR is a benchmark that reflects the liquidity of a bank. Previous studies have shown that the liquidity aspect has a negative effect on bank efficiency [14,17,32]. When the bank

is illiquid, the bank must look for other sources of funds to overcome liquidity problems which will then increase input costs and reduce efficiency [14].

Bank size can also be a determinant of bank efficiency [9,14] reveal that large banks show higher efficiency because trust is also higher. In addition, large banks can reduce operational costs through economies of scale and economies of scope [9]. However, ref. [33] found a negative relationship between efficiency and bank size.

Lastly, economic growth is also a determinant of bank efficiency. According to [34], economic growth increases banking efficiency. High economic growth creates high demand in the financial sector [35]. In other words, the financial sector is growing as the demand for services from the growing real sector increases.

2.1. Data

This study uses panel data which is a combination of time series data (2010–2019) and cross section data (38 commercial banks listed on the Indonesia Stock Exchange (IDX)). The period of this research is 2010–2019. The research period begins in 2010 because, in that year, the Indonesian economy was recovering from the 2008 global financial crisis. The research period ended in 2019 because, in 2020, there was a COVID-19 pandemic, which had a large effect on the global economy. To avoid the convoluting effects of the global crises, this research period is from 2010 to 2019. The samples in this study were 38 out of 42 commercial banks in Indonesia listed on the Indonesia Stock Exchange (IDX). The use of this sample is based on data availability. The cross-section data used in this study are BRI, Bank Mandiri, BCA, BNI, BTN, Bank CIMB Niaga, Bank PAN, Bank OCBC NISP, Bank Danamon, BTPN, Bank Permata, Maybank, BPD West Java, Bank Mega, Bank Bukopin, Bank Mayapada Internasional, BPD East Java, Bank Woori Saudara Indonesia, Bank Sinarmas, Bank Victoria Internasional, BRI Agro, Bank QNB, Bank Capital, Bank China Construction, Bank Jtrust, Bank National Nobu, Bank Mestika Dharma, Bank MNC Internasional, Bank Bumi Arta, Bank Maspion, Bank IBK, Bank Ina Perdana, Bank Neo Commerce, Bank OKE, Bank Ganesha, Bank Jago, Bank of India, and Bank Harda Internasional.

This study used secondary data obtained from several available sources. This study used financial statement data of commercial banks in Indonesia from 2010 to 2019 to measure bank efficiency, the banking industry's competition level, the non-performing loan (NPL), the capital adequacy ratio (CAR), and the loan to deposit ratio (LDR) variables. Financial statement data is obtained from Indonesia Financial Services Authority (OJK), while the GDP growth rate is obtained from the World Bank. The descriptions of all variables in this study are presented in Table 1.

2.2. Research Methods

There were several quantitative methods used in this study. First, we calculated the efficiency score in banking industries using Data Envelopment Analysis (DEA). Second, we measured the competition level in banking industries using The Panzar and Rosse H-Statistics. Third, we estimate the impact of the competition level, some indicators of banking performances such NPL, CAR, LDR, bank size and the economic growth representing the macro-economic condition to the efficiency score of the banking industry in Indonesia.

2.2.1. Data Envelopment Analysis (DEA)

The non-parametric method of DEA seeks to obtain the value of the bank efficiency variable. The DEA method measures efficiency by using a linear programming technique from a set of similar decision-making units (DMUs), such as a group of banks in the same sector. The DEA method simultaneously uses several inputs and outputs to determine the efficiency value.

Table 1. Variable Descriptions and Formulas.

Variable	Description	Formula
Bank efficiency (EFF)	The level of bank efficiency is obtained through the data envelopment analysis (DEA) method	DEA
Banking competition (Compet)	The banking industry competition variable is estimated using a non-structural approach of the Panzar and Rosse H-Statistic model	The Panzar and Rosse H-Statistics
Non-Performing Loan (NPL)	NPL is a loan classified as substandard, doubtful and loss. It is measured by the ratio of non-current loans and total loans.	$\text{NPL} = \frac{\text{Non-current loans}}{\text{Total loans}} \times 100\%$
Capital Adequacy Ratio (CAR)	The measurement of a bank's available capital measured by the ratio of capital and risk weighted assets	$\text{CAR} = \frac{\text{Capital}}{\text{Risk Weighted Assets (RWA)}} \times 100\%$
Loan to Deposit Ratio (LDR)	The ratio of loan extended to third parties in Rupiah and foreign currencies, excluding loan to other banks, to third party funds covering demand deposits, savings, and time deposits in Rupiah and foreign currencies, excluding interbank funds.	$\text{LDR} = \frac{\text{Total credit}}{\text{Total third party funds}} \times 100\%$
Bank size (Size)	The ratio used to determine the size of the wealth owned by a bank. The size of a bank's wealth can be seen from the total assets it has.	$\text{Bank size} = \ln(\text{Total Aset})$
Economic growth (g)	GDP growth indicate the economic growth of a country	$\text{Economic growth} = \frac{\text{GDP}_t - \text{GDP}_{t-1}}{\text{GDP}_{t-1}} \times 100\%$

The DEA model basically has two categories, i.e., Charnes, Cooper and Rhodes (CCR) and Banker, Charnes and Cooper (BCC) [18]. The CCR model uses constant return to scale (CRS) assumption to calculate the efficiency score for each DMU as a ratio of output and input. Meanwhile, the BCC model assumes that the additional of input is not equal with the additional output, hence, we call it as variable return to scale (VRS).

The current literature on the DEA mostly uses VRS approach because the CRS seems to be not rational and only suitable if all banks are operated in the optimal scale [36]. Accordingly, we used the DEA model to obtain technical efficiency scores with a VRS and input-oriented approach.

Considering the risk of bias inherent in the intermediation approach, this study uses a production approach to select inputs and outputs. Additionally, the approach can determine the performance of the bank's intermediation function. According to production theory, the factors driving productivity are land, labour and capital. Operating costs can be considered as a proxy for land, physical capital expenditures, and conditions for dubious loans. Labour costs can be a proxy for labour. Interest expense can also be a proxy for the capital provided by the bank or by its depositors. Therefore, we utilize operating costs, labour costs and interest expenses as input variables. Meanwhile, interest income and non-interest are used as output variables. The use of input and output variables in this study is based on several references. Table 2 presents a list of input and output variables used in this study.

Table 2. Input and Output Variables.

Production Approach			
Variables	**Definition**	**Unit**	**References**
Input Variables			
Labour costs	The total cost incurred by bank for payment of workers' wages	Million rupiah	[19,32,36–38]
Other operating expenses	Total costs incurred by bank for operational, administrative, and other purposes	Million rupiah	[19,21,32,36,37]
Interest expenses	Total fees paid by the bank to third parties who collect funds in bank	Million rupiah	[19,21,38]
Output Variables			
Interest income	The income earned by the bank from interest payment from third parties	Million rupiah	[21,37,39]
Non-interest income	Income earned by the bank aside from interests	Million rupiah	[36–39]

In the intermediation approach, the function of the bank is described as an intermediary in collecting funds from customers and then channelling these funds into loans [20]. The intermediation approach is the right approach to determine the efficiency of banks as financial institutions that have an intermediation function [9]. In measuring efficiency with an intermediation approach, this study uses an output-oriented DEA method with the assumption of Variable Return to Scale (VRS). The input and output variables in the intermediation approach can be seen in the Table 3 below.

Table 3. Input and Output Variables in Intermediation Approach.

Intermediation Approach		
Variables	**Unit**	**References**
Input Variables		
Savings	Million rupiah	[31,32,40]
Current account	Million rupiah	[31,40]
Deposits	Million rupiah	[30–32,40–42]
Capital	Million rupiah	[32,41]
Output Variables		
Distributed credit	Million rupiah	[30–32,40–42]

2.2.2. The Panzar and Rosse H-Statistics

Due to its simplicity as following some prior studies such as [8,43–45], we used the Panzar and Rosse H-Statistics model to measure the competition level in banking industry. H-Statistics as an indicator of the level of competition is obtained from the amount of income elasticity influenced by input prices. The model used to estimate the level of competition is as follows:

$$ln(TR_{i,t}) = \alpha + \beta_1 lnW1_{i,t} + \beta_2 lnW2_{i,t} + \beta_3 lnW3_{i,t} + \beta_4 lnY1_{i,t} + \beta_5 lnY2_{i,t} + \beta_6 lnY3_{i,t} + \varepsilon_{i,t} \quad (1)$$

where:

TR: Ratio of total income to total assets
$W1$: Ratio of interest expense to total deposit
$W2$: Ratio of labour costs to total assets

$W3$: Ratio of operational costs to total assets
$Y1$: Ratio of equity to total assets
$Y2$: Ratio of credit to total assets
$Y3$: Natural logarithm of total assets

We prefer using the total income to the interest income in the dependent variable because the amount of non-interest income increased steadily in Indonesia. In addition, the industrial banking currently also does not only compete on the traditional activities but also on the non-interest income-based activities [46]. In term off independent variables, the Panzar and Rosse model proposed three main inputs in banking industries as a credit producer i.e., labour force, capital, and deposit. Furthermore, we used natural logarithm in the model to reduce the problem of multicollinearities and the heteroscedasticities.

The model is estimated for each period from 2010 to 2019 using cross-sectional data from 38 commercial banks in Indonesia using the OLS method. The level of industry competition is the total coefficient $\beta_1 + \beta_2 + \beta_3$ from the estimation results. The interpretation of the H-Statistics is described in Table 4.

Table 4. H-Statistics Interpretation.

H-Statistic	Industry Competition
$H \leq 0$	Monopoly and oligopoly
$0 < H < 1$	Monopolistic
$H = 1$	Perfect competition

Source: Tan [18]. Reprinted/adapted with permission from Elsevier, 2022.

2.2.3. Tobit, PLS, FEM, and REM Model

In determining the effect of the competition in the banking industry, NPL, CAR, LDR, bank size, and economic growth to the banking efficiency, we used the estimation results of the Tobit estimation model. Because we utilized the panel data, we also compare the Tobit estimation results with the pooled ordinary least square model (PLS), the fixed effects within-group model (FEM), and the random effects model (REM). The basic empirical model used in this study is as follows:

$$EFF_{i,t} = \alpha + \beta_1 Compet_{i,t} + \beta_2 NPL_{i,t} + \beta_3 CAR_{i,t} + \beta_4 LDR_{i,t} + \beta_5 Size_{i,t} + \beta_6 g_{i,t} + \varepsilon_{i,t} \quad (2)$$

where:

EFF: Banking efficiency
Compet: Competition or competition in the banking industry
NPL: Non-performing loans
CAR: Capital adequacy ratio
LDR: Loan to deposit ratio
Size: Bank size
g: Economic growth

In this study, the dependent variable was obtained from banking efficiency scores which ranged between 0.0000 and 1.0000. When the value of the dependent variable is between 0 and 1, the dependent variable must be changed before being estimated because the variable is a limited dependent variable [47]. This can be overcome by using a Tobit regression estimation model because I Tobit regression model has a limit given to the value of the dependent variable, so it is commonly known as the limited dependent variable regression model [37].

The Tobit model is often utilized to analyse the determinants of banking technical efficiency. The Tobit model is known as a truncated or censored regression model, where the expected error is not equal to zero [38]. This aligns with the dependent variable used in

this study, namely the efficiency score which ranges between 0 and 1, so it can be censored. The general equation of the Tobit model is defined as follows [48]:

$$y^* = \beta_0 + x\beta + u,\ u|x \sim Normal(0, \sigma^2)$$
$$y = \max(0, y^*) \tag{3}$$

Equation (3) indicates that the observed variable, y, equals the latent dependent variable, y^*, when $y^* \geq 0$, and $y = 0$ when $y^* < 0$. Moreover, in a censored model, the upper censoring Tobit model is recommended [49]. The condition with the upper limit 1 such as the efficiency scores can be expressed as follows [50]:

$$y_i^* = x_i'\beta + u_i \tag{4}$$

$$y = \begin{cases} y^* \ \ if\ 0 < y^* < 1 \\ 0 \ \ if\ y^* < 0 \\ 1 \ \ if\ y^* > 1 \end{cases} \tag{5}$$

The Tobit model can sometimes be defined as censored from the bottom or up, that on the minus and plus sides.

We also used REM to estimate the panel random-effect model (REM) is used to perform a robustness test in analysing the effect of the independent variable on the dependent variable. The panel REM is a panel data regression model which assumes that the intercept of each cross-sectional unit is uncorrelated with the independent variables [44]. REM has two components of error terms, namely cross-section and time-series error terms [37]. In REM, the individual error components are uncorrelated with each other and are not autocorrelated across cross-section and time series units [42]. According to [37], REM used the generalised least square (GLS) method, meeting the classical assumptions. The GLS estimator of the REM parameters is more efficient than a simpler model [39].

There are several differences between the Fixed Effect Model (FEM) and the Random Effect Model (REM). In FEM, each cross-sectional unit has its own intercept value. Meanwhile, in REM, the intercept represents the mean value of all the (cross-sectional) intercepts, and the cross-section error component represents the (random) deviation of individual intercept from this mean value [42]. In addition, the individual effect in REM is uncorrelated with any of the independent variables in the model, while individual effect in FEM is allowed to be correlated with independent variables [48].

3. Results

3.1. Commercial Bank Efficiency in Indonesia

The commercial banks' efficiency value was obtained using the non-parametric DEA method. The resulting efficiency values range from 0 to 1. If the efficiency value is close to 1, the bank's efficiency level is high. Table 5 shows the average efficiency value of the 38 commercial banks in Indonesia from 2010 to 2019. According to Wasiaturrahma et al. [32], banks with efficiency values between 0.8 and 1 are categorised as efficient. Meanwhile, banks with efficiency values between 0.4 and 0.6 are categorised as inefficient. The average efficiency score of all commercial banks between 2010 and 2019 is 0.7123. This result indicates that commercial banks in Indonesia are categorized as moderately efficient. Nevertheless, the efficiency level of all sample banks increased steadily from 2010 to 2019. It also represents that the financial performance of commercial banks in Indonesia improved. In addition, if we compare the efficiency score between state-owned and private bank, the efficiency performance of state-owned banks was statistically better than the private banks both using the DEA production and intermediation approaches.

Table 5. The average efficiency value of all banks and number of efficient banks.

Period	Production Approach			Intermediation Approach		
	Overall	State-Owned Bank	Private Bank	Overall	State-Owned Bank	Private Bank
2010	0.4994	0.8120	0.4256	0.8697	0.9843	0.7551
2011	0.5361	0.8580	0.4679	0.8795	0.9881	0.7710
2012	0.5934	0.8879	0.5305	0.8999	0.9919	0.8080
2013	0.6824	0.9530	0.6229	0.9198	0.9974	0.8421
2014	0.7270	0.9618	0.6753	0.9395	0.9983	0.8808
2015	0.7402	0.9353	0.6982	0.9406	0.9978	0.8835
2016	0.7754	0.9321	0.7422	0.9400	0.9974	0.8826
2017	0.8169	0.9433	0.7903	0.9643	0.9978	0.9308
2018	0.8677	0.9475	0.8513	0.9712	0.9978	0.9447
2019	0.8785	0.9226	0.8672	0.9791	0.9981	0.9600
Average	0.7117	0.9153	0.6671	0.9304	0.9949	0.8659

3.2. Banking Industry Competition in Indonesia

Table 6 shows the results of the H-Statistics calculation for the banking industry in Indonesia from 2010 to 2019. The H-Statistic value is obtained from the regression of the Panzar–Rosse model in Equation (1). The model is estimated every year. The H-Statistic value is obtained from the sum of β_1, β_2, and β_3.

Table 6. H-Statistic Value.

Year	H-Statistic
2010	0.5610
2011	0.7684
2012	0.5600
2013	0.7184
2014	0.6458
2015	0.6027
2016	0.7102
2017	0.6475
2018	0.3487
2019	0.3511
Average	0.5913

The value of H-Statistics ranges between 0 and 1, indicating that the Indonesian banking industry is monopolistic competition. This result is in line with the prior research concluded that the banking industry competition in Indonesia was monopolistic competition [5,51]. Under monopolistic competition, there are many banks in the market, but not as many as in a perfectly competitive market. The products offered are similar but not identical [47]. This is what Indonesian banking is like: the number of commercial banks is large, but each bank has its product diversification or uniqueness.

3.3. Data Descriptive Analysis

Table 7 shows a statistical description of each variable used in this study: the number of observations in the study, the average value, standard deviation, the minimum value, and the maximum value.

Table 7. The Data Descriptive Analysis.

Variable	Unit	n	Mean	Min.	Max.	SD.
Efficiency	Index	380	0.7125	0.035	1.000	0.2949
Competition	Index	380	0.5791	0.388	0.730	0.0966
NPL	Percent	380	2.8248	0.000	24.840	2.4137
CAR	Percent	380	83.8680	1.980	171.320	15.036
LDR	Percent	380	22.1810	9.410	489.500	26.652
Bank size	Percent	380	16.9740	11.790	21.020	1.9691
Economic growth	Percent	380	5.4040	4.880	6.1700	0.4875

3.4. Estimation Results

This study used the Tobit, PLS, FEM, and REM methods to analyse the effect of the independent variables on the dependent variable. Using both the DEA production and intermediation approach, the model recommended among PLS, FEM, and REM was FEM. This was because although Breusch and Pagan Lagrangian multiplier test recommended REM to PLS and Chow test suggested FEM to PLS, but finally Hausman test choose FEM to REM. In addition, the estimation results show a prob > chi of 0.0000, where the value is less than α 1%, indicating that the variables of competition level, NPL, CAR, LDR, bank size, and economic growth simultaneously have a significant effect on the efficiency of commercial banks in Indonesia. In summary, the results are presented in Table 8.

Table 8 shows that the banking industry competition consistently had a significant negative effect on the efficiency of commercial banks both using the production and intermediation approach in Indonesia from 2010 to 2019. This result is in accordance with the research hypothesis, which assumes that competition has a significant negative effect on banking efficiency. Furthermore, NPL generally does not significantly affect bank efficiency during the study period although the PLS model indicated the positive impact in alpha 5%. This result accordingly is opposite of the research hypothesis assuming that NPL has a significant negative effect on bank efficiency.

The LDR has a significant negative effect on the efficiency of commercial banks in Indonesia during the study period with a 5% significance level in the DEA production approach only. This is in accordance with the research hypothesis assuming that LDR has a negative effect on bank efficiency. Conversely, the CAR variable commonly had a significant positive effect on the efficiency of commercial banks in Indonesia from 2010 to 2019 with a 5% significance level. This result is in accordance with the research hypothesis assuming that CAR has a significant positive effect on banking efficiency.

Generally, bank size has no significant effect on the efficiency of commercial banks in Indonesia during the study period. However, the PLS model suggested that the bank size has a negative impact to the efficiency of the bank both using the DEA production and intermediation approach. This result is the opposite of the research hypothesis assuming that bank size has a significant positive effect on bank efficiency. Surprisingly, the economic growth has a significant negative effect on the efficiency of commercial banks in Indonesia during the study period with a significance level of 1%, which is the opposite of the research hypothesis assuming that economic growth has a significant positive effect on banking efficiency.

From Table 9, we can assert that the impact of the competition level on the private bank efficiency is more significant than the state-owned banks. This shows that business competition in private banking is more intense than in state-owned banks. The more intense the business competition, the worse the bank's performance in generating income and carrying out its intermediation role. In addition, the performance of private banks also was more influenced by the economic growth negatively compared to the state-owned banks.

Table 8. The Estimation Results.

Independent Variables	Production Approach				Intermediation Approach			
	Tobit	**REM**	**FEM**	**PLS**	**Tobit**	**REM**	**FEM**	**PLS**
Competition	−0.5007 *** (0.0917)	−0.4856 *** (0.0943)	−0.6082 *** (0.0936)	−0.4648 *** (0.1382)	−0.1655 *** (0.0547)	−0.1595 *** (0.0554)	−0.2278 *** (0.0555)	−0.1522 * (0.0908)
NPL	−0.0006 (0,0043)	−0.0021 (0.0044)	0.0024 (0.0042)	−0.0245 *** (0.0054)	0.0042 * (0.0026)	0.0039 (0.0026)	0.0056 ** (0.0025)	−0.0671 * (o.0035)
LDR	−0.0019 ** (0.0008)	−0.0018 ** (0.0008)	−0.0019 *** (0.0008)	−0.0001 (0.0008)	0.0001 (0.0002)	0.0002 (0.0002)	−0.0003 (0.0002)	0.0003 (0.0005)
CAR	0.0009 ** (0.0003)	0.001 ** (0.0003)	0.0001 (0.0004)	0.0021 *** 0.0005	0.0005 (0.0005)	0.0004 (0.0005)	0.0006 (0.0005)	0.0010 ** (0.0003)
Bank Size	0.0002 (0.0184)	0.0149 (0.0139)	−0.1008 *** (0.0278)	0.0427 *** (0.0279)	0.0013 (0.0127)	0.0075 (0.0099)	−0.0589 *** (0.0165)	0.0399 *** (0.0045)
Economic Growth	−0.2056 *** (0.0221)	−0.1956 *** (0.0211)	−0.2757 *** (0.0264)	−0.1820 *** (0.0279)	−0.0873 *** (0.0138)	−0.0832 *** (0.0129)	−0.1284 *** (0.0157)	−0.0721 *** (0.0183)
Constant	2.2541 *** (0.4189)	1.9353 *** (0.3284)	4.4228 *** (0.6102)	1.2689 *** (0.2365)	1.3823 *** (0.2815)	1.2519 *** (0.2283)	2.6565 *** (0.3615)	0.7152 *** −1.553
Number of Observation	380	380	380	380	380	380	380	380
Number of Banks	38	38	38	38	38	38	38	38
Prob > chi	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: The brackets () indicate the standard error. Significance Level *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 9. The Efficiency Score of Production Approach between State-owned and Private Banks.

Independent Variables	State-Owned Banks				Private Banks			
	Tobit	**REM**	**FEM**	**PLS**	**Tobit**	**REM**	**FEM**	**PLS**
Competition	−0.0141 (0.0641)	0.2587 * (0.1376)	−0.0249 (0.0699)	0.2587 * (0.1376)	−0.5823 *** (0.0985)	−0.5685 *** (0.1015)	−0.6675 *** (0.1006)	−0.5592 *** (0.1481)
NPL	−0.0101 (0.0078)	−0.0109 (0.0174)	−0.0098 (0.0085)	−0.0109 (0.0174)	−0.0019 (0.0044)	−0.0034 (0.0045)	0.0012 (0.0044)	−0.0267 *** (0.0056)
LDR	0.0008 (0.0011)	0.0069 *** (0.0019)	0.0008 (0.0012)	0.0069 *** (0.0019)	−0.0018 ** (0.0008)	−0.0017 ** (0.0008)	−0.0018 ** (0.0008)	−0.0005 (0.0009)
CAR	−0.0011 (0.0028)	−0.0053 (0.0063)	−0.0009 (0.0031)	−0.0053 (0.0063)	0.0008 ** (0.0004)	0.0009 (0.0004)	0.0002 (0.0004)	0.0020 *** (0.0005)
Bank Size	−0.0410 (0.0257)	0.0849 ** (0.0377)	−0.0501 * (0.0291)	0.0849 ** (0.0377)	−0.0208 (0.0206)	−0.0059 (0.0162)	−0.1047 *** (0.0292)	0.0264 *** (0.0084)
Economic Growth	−0.0288 (0.0218)	0.0977 ** (0.0419)	−0.0342 (0.0238)	0.0977 ** (0.0419)	−0.2423 *** (0.0241)	−0.2326 *** (0.0231)	−0.3001 *** (0.0281)	−0.2214 *** (0.0299)
Constant	191.5270 *** (0.6536)	−190.1450 * (1.0840)	2.1280 *** (0.7235)	−190.1450 * (1.0840)	2.8110 *** (0.4563)	2.5025 *** (0.3709)	4.5737 *** (0.6296)	1.8331 *** (0.2632)
Number of Observation	380	380	380	380	380	380	380	380
Number of Banks	38	38	38	38	38	38	38	38
Prob > chi	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: The brackets () indicate the standard error. Significance Level *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4. Discussion

The estimation results showed that competition in the banking industry has a negative effect on the efficiency of commercial banks in Indonesia. The higher the competition, the lower the efficiency is. The result of this study aligns with studies by [2,3,9,14,40,41], which also found that industrial competition had a significant negative effect on the level of banking efficiency. In addition, its impact is higher in the private banks than the state-owned banks. This reflects that business competition in private banks is tighter than state-owned banks. It also can be influenced by the profile of their customer of private banks that are riskier because most of them work at the private sectors that are particularly more vulnerable to the influence of economic conditions.

This research supported the competition-inefficiency hypothesis. Therefore, banks need more costs to monitor and handle non-performing loans in a more competitive market [14]. As competition increases, a bank's screening and information gathering capacity may decrease due to withholding information about its borrowers. Thus, low-quality borrowers have more opportunities to obtain loans from banks. To prevent bad loans, banks need to spend more resources such as labour costs to monitor their borrowers. As a result, the efficiency score will decrease. This is because tighter competition encourages banks to lower credit requirements, which will lead to an increase in monitoring costs and a decline in efficiency [9]. In addition, when the level of competition is low, banks have higher market power, which allows banks to earn more profits and motivates banks to apply good practices in providing loans [47]. This precautionary principle can lead to the selection of banking activities that are less risky with lower monitoring costs, thereby increasing bank efficiency.

The estimation results showed that NPL has no significant effect on bank efficiency. The results of this study are supported by the results of research by [9,31,42] and Khan et al. [30] who found that NPL had no significant effect on bank efficiency. It means that the banks that have the higher NPL tend to be more in-efficient. Banks usually spend more budget for handling the credit risk, hence, they increase the credit interest rate to compensate the credit default.

CAR is a proxy for the bank's capital aspect. The estimation results showed that CAR has a positive effect on the efficiency of commercial banks in Indonesia. Moreover, its impact is also higher in the private bank. This result means that when the CAR ratio increases, the efficiency of commercial banks also increases. The results of this study align with the results of research by [17,32,42,52,53]. The results of this study imply that adequate capital is a critical success factor in banking efficiency. It means that the greater the capital owned by a bank, the more efficient the bank is [32]. When the CAR value increases due to higher capital and lower risk assets, the potential for achieving efficiency will also be higher. Moreover, this result is in line with [53], suggesting that a high CAR value indicates sufficient funds that can be used to anticipate risks and avoid bankruptcy. The authors of [52] argued that higher capital could reduce the probability of bankruptcy, increase the availability of information, and then increase bank efficiency.

The Tobit estimation results showed that LDR has a significant negative effect on the efficiency of commercial banks in Indonesia. If the LDR ratio increases, the efficiency of commercial banks will decrease. The results of this study are in line with the research results of [30,32,53], which found that LDR had a significant negative effect on the level of bank efficiency. LDR is a ratio used to indicate credit expansion and bank liquidity [17]. According to [32], a negative relationship between LDR and bank efficiency can occur if the characteristics of the credit disbursed by the bank are risky enough that it can have a negative impact on banking efficiency. The negative effect of LDR on efficiency was also supported by [53], stating that too many funds for liquidity purposes can lead to unproductivity. If these funds are distributed into credit, these funds will generate interest for the bank and will affect the bank's efficiency.

The Tobit estimation results show that bank size has no significant effect on bank efficiency. The results of this study are supported by [28,54], who did not find a significant

effect of bank size on efficiency. However, it does not mean that the banks should not have a target to increase their size, but they can focus on the efficiency matter so then their size will growth simultaneously as a bonus.

The Tobit estimation results show that economic growth has a significant negative effect on the efficiency of commercial banks in Indonesia. These results are supported by [14,34], which showed that a high level of economic growth would reduce bank efficiency. The high economic growth will increase the demand for financial services. It pressurises banks to control their inputs and thus become less efficient [48]. Moreover, banks in developing countries with rapid economic growth are less stable because they tend to relax their monitoring function [49]. This will increase the risk of bankruptcy and decrease efficiency. The negative relationship between economic growth and banking efficiency does not support the demand-following hypothesis, which explains that the financial sector develops due to increased demand for its services from the growing real sector. In other words, an increase in economic growth leads to an increase in the demand for financial services.

5. Conclusions

Based on the research results, several conclusions can be drawn. First, the level of competition in the banking industry as measured by Panzar–Rosse's H-Statistics model showed that the competition in the Indonesian banking industry is monopolistic, as indicated by the H-Statistics value, which ranges between 0 and 1 during the study period. Second, commercial banks in Indonesia have an average efficiency value of 0.7123, categorised as moderately efficient. Third, the level of competition has a significant negative effect on the efficiency of commercial banks in Indonesia from 2010 to 2019. The results of this study are in line with the competition-inefficiency hypothesis. Lastly, the CAR variable positively affects the bank's efficiency level. Meanwhile, LDR and GDP growth have a negative effect, whereas the NPL variable and bank size have no significant effect.

The result illustrates that industrial competition has a significant negative effect on the efficiency value of commercial banks in Indonesia. As such, Indonesia Financial Services Authority (OJK) can merge and acquire banks that are not yet efficient and simplify the requirements especially in the private banks that are more influenced by the competition level. In the future, OJK could also give incentives to make the merger process more efficient to realize the optimal number of bank targets. This study also illustrates that CAR has a positive and significant effect on the efficiency of commercial banks in Indonesia so that Bank Indonesia can increase the minimum CAR value for commercial banks in Indonesia.

This study has several limitations. First, this study only involves 38 commercial banks that have been listed on the IDX as a sample. Further research is expected not only to use a sample of banks that have been listed on the IDX but also to use a sample of all commercial banks in Indonesia. Second, this research does not use other proxies for efficiency and competition as a comparison. There are various measurement techniques of efficiency both the parametric approaches such as Stochastic Frontier Approach (SFA), Distribution-Free Approach (DFA), and Thick Frontier Approach (TFA), as well as the non-parametric approaches such as Free Disposal Hull (FDH). In addition, there are also some methods to measure the competition level such as the Lerner Index and the Boone Indicator. Further research will benefit from measuring the level of banking efficiency and competition using these approaches.

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