MEASURING THE EFFICIENCY OF GOVERNMENT-OWNED BANKS DURING THE COVID-19 PANDEMIC IN THE EMERGING ECONOMY

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Abstract

This study aims to examine the technical efficiency of Indonesian government-owned banks, especially evaluating their performance during the COVID-19 pandemic. We used quarterly data ranging from the year 2019 to 2022 and a non-parametric approach known as a data envelopment analysis (DEA), and Tobit regression. Our findings show that Bank Rakyat Indonesia (BRI) and Bank Tabungan Nasional (BTN) are the most efficient and stable banks during the observation periods. In addition, the average efficiency trend shows a sharp decreasing trend in all banks from Q2 2020, the period when the COVID-19 pandemic began to spread in Indonesia. Furthermore, the Tobit regression result found that financial ratios — capital adequacy ratio (CAR), loan-to-deposit ratio (LDR), and return on assets (ROA) — have a significant positive impact to affect the efficiency level of the government-owned bank, whereas the bank's size was found insignificant (Susamto et al., 2023; Ikhwan & Riani, 2022). The paper contributes to the body of knowledge by specifically focusing on measuring the relative efficiency of government-owned banks in Indonesia in the most recent period in addition to existing, which represents the period before and during the pandemic crisis, which would fill the gaps in the available literature.

Keywords: Efficiency, Government-Owned Banks, DEA, Tobit Regression

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1. INTRODUCTION

Banking institutions are one of the financial sub-sectors that have a strategic role in economic activity. This is because of its function as a financial intermediary to collect and distribute public funds. Over the decades, banking institutions around the world have witnessed a substantial transformation underpinned by deregulation, globalization, and technological advancement (Baidya & Mitra, 2012). Indonesia is one of the countries that underwent a deregulation transition in 1998, with the implementation of the Pakto 88 policy (Winarti & Rinardi, 2020). This policy provided convenience for the banking industry in the form of relaxing regulations and ease of licensing for the banks' establishment, so as to form a healthy business climate and efficient banking conditions. The implications of this policy can be seen in the increasing number of banks in Indonesia. Bank Indonesia noted that in September 1988, there were only 108 commercial banks in Indonesia consisting of six government banks, 64 private banks, 27 village consultative bodies (*Badan Permusyawaratan Desa* — BPD), and 11 joint venture banks. Total commercial bank offices in that period were 1,359 units. However, after the deregulation, the number of bank offices has increased to 1,525 units. Until now, the number of commercial bank offices in Indonesia has reached 32,531 units consisting of four government banks, 68 private banks, 27 BPD, and 8 joint venture banks (Financial Services Authority, 2022). The emergence of this phenomenon has engendered heightened competitive dynamics within the Indonesian banking sector. The confluence of intensified competitive pressures, imminent challenges, and a more rigorous regulatory landscape has exerted a compelling impetus on banks to enhance their operational efficacy. Furthermore, the augmented presence of banks subsequent to the implementation of Pakto 88 is anticipated to amplify their role as intermediary institutions.

However, in the first quarter of 2020, the world was faced with the outbreak of the COVID-19 pandemic which affected almost all banking sectors around the world, including Indonesia. The impact of COVID-19 on the banking industry sector is generated by the large number of business owner clients who struggle to meet their bank obligations, hence increasing the ratio of non-performing loans (NPLs) (Ikhwan & Riani, 2022). This condition resulted in a slowdown in credit growth and led to a decline in banking profitability. The banking intermediation function in Indonesia experienced a declining trend during the pandemic, reflected in a decrease in loans disbursed by 2.41% year-on-year from 5,616,992 billion in the IV quarter of 2019 to 5,481,560 billion in the IV quarter of 2020. This weakening of the disbursed credit was accompanied by an increase in banking NPLs from 2.53% in the IV quarter of 2019, to 3.06% in the IV quarter of 2020 (Financial Services Authority, 2021). Furthermore, in terms of profitability growth, the average net profit/loss of banking companies has decreased from 123,940 billion in the III–IV quarter of 2019 to 42,048 billion in the I–II quarter of 2020 with a decrease in net profit/loss in Indonesian banks by -66.07% (Financial Services Authority, 2021). Despite these conditions, there are huge expectations that banks will not only survive in financial system disruptions but also become active contributors by supporting the government in reducing the negative effects of pandemic threats on the economy. The government-owned bank is expected to become one of the pillars of national economic growth. Based on Law No. 19 of 2003[1], government-owned banks have several roles including accelerating national economic growth and becoming a source of state revenue from non-tax revenues to fill the state treasury. The government-owned banks as one of the state-owned enterprises (*badan usaha milik negara* — BUMN) are expected to contribute more to the country's economy, especially in the case of the economic downturn due to the COVID-19 pandemic. Therefore, efficiency in banks, especially government-owned banks, needs to be done so that all inputs owned can produce the maximum possible output. In accordance with Mohan's (2005) perspective, the enhanced efficiency of a financial system in resource management and allocation correlates positively with its contribution to economic growth. Against this backdrop, pertinent inquiries arise regarding the efficiency with which government-owned banks in Indonesia deploy their resources. Furthermore, there is a need to ascertain which banks exhibit relatively greater efficiency in resource utilization amid the challenges posed by the pandemic. In addition, it is important to know what improvements must be made by the bank so that its performance becomes efficient. Thus, this paper aims to analyse the technical efficiency of Indonesian government-owned banks, especially evaluating their performance during the COVID-19 pandemic. Furthermore, the efficiency determinants were further analysed in order to find out the factors that affect efficiency achievement.

The efficiency measurement of the government-owned bank has been carried out by several previous researchers (Baidya & Mitra, 2012; Bhatia & Mahendru, 2016; Gunawan & Utiyati, 2013; Nasution et al., 2020). The present article will contribute to the body of knowledge by specifically focusing on measuring the relative efficiency of government-owned banks in Indonesia in the most recent period, from the I quarter of 2019 to the II quarter of 2022. This observation represents the period before and during the pandemic crisis, which would fill the gaps in the available literature. Furthermore, this study continues the suggestion from previous research by extending the analysis to find the determinant that affects the efficiency based.

The remainder of this paper is structured as follows. Section 2 explores the relevant literature while Section 3 describes the methodological part. Section 4 presents the findings and discusses the results. Finally, we offer a conclusion and policy implications in Section 5.

2. LITERATURE REVIEW

2.1. Government-owned bank's efficiency

The banking sector plays a pivotal role as the foremost institution serving as an intermediary and a source of funding, particularly in the context of developing countries (Fase & Abma, 2003). Banks function as crucial entities for the collection and distribution of social funds that contribute to the realization of national development objectives,

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[1] https://www.btn.co.id/-/media/User-Defined/ACGS/Part-E/E311-Excerpt-of-Law-No-19-Of-2003-Indonesia-StateOwned-Entities-Chapter-28.pdf?la=id

thereby enhancing national stability and fostering equitable development, ultimately leading to an elevation in living standards. Based on their ownership, banking in Indonesia consists of state-owned banks, private-owned banks (national and foreign), cooperative-owned banks, and joint venture banks. As a bank whose majority shares are owned by the state, a government-owned bank is an important institution whose performance must always be monitored. Government-owned banks are expected to become alternatives in accelerating national growth, especially in the economic downturn due to the pandemic crisis. For government-owned banks to exist, have competitiveness, and not be liquidated, they need to maintain their financial efficiency. Devi and Firmansyah (2020) claimed that in order for an institution to remain stable in its operations and preserve its financial performance, it must have high efficiency. Efficiency in the context of the bank will show the bank's capacity to optimize output while utilizing already available resources.

The assessment of a bank's efficiency can be conducted through two distinct approaches: the ratio approach and the frontier approach. The ratio approach, characterized by its ease of calculation, involves comparing operational costs to operational income, often referred to as the BOPO (*biaya operasional dan pendapatan operasional*) ratio. This method stands as the most widely adopted means by banks to gauge their operational efficiency. However, it is crucial to acknowledge the limitations of the BOPO ratio, as highlighted by Piliang and Wakil (2008) and Qurniawati (2014), given that it omits consideration of bank output, thereby falling short of accurately representing the comprehensive conditions of the bank. To overcome the ratio approach's shortcomings, a frontier approach was then developed to measure the company's performance in terms of efficiency. This approach is able to capture the relation between input and output to analyze the efficiency value with various measurement methods. The frontier approach can be explained by the production frontier line. This line elucidates the connection between the inputs and outputs within the production process, as posited by Bauer et al. (1998). This relationship is graphically represented by the production frontier line, delineating the maximum achievable output attainable through the judicious utilization of each input. Technical efficiency, in this context, pertains specifically to the adept conversion of inputs into outputs. It is imperative to note that this concept exclusively addresses the technical interplay between inputs and outputs. Figure 1 visually represents the production frontier line.

Figure 1. Production frontier curve
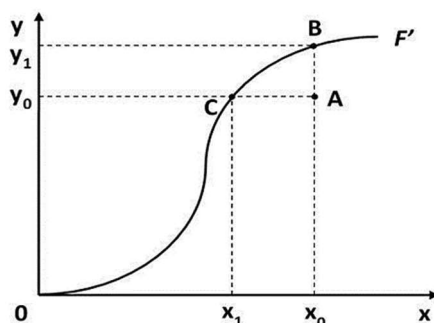
Source: Authors' illustration.

2.2. Efficiency concept

Farrell (1957) delineates efficiency into two integral components: technical efficiency and allocative efficiency. Technical efficiency is characterized by a business unit's proficiency in maximizing output with a given set of inputs. On the other hand, allocative efficiency pertains to a company's adeptness in employing inputs in the most cost-effective manner possible. The amalgamation of these two forms of efficiency yields economic efficiency. A company achieves economic efficiency when it can curtail production costs to generate a specific output while adhering to prevailing technological norms and market price levels (Ascarya & Yumanita, 2008).

Efficiency measurement tools encompass both parametric and non-parametric approaches. The parametric methodology utilizes stochastic econometrics to mitigate the impact of disturbances on inefficiency. Among the parametric econometric approaches are the stochastic frontier approach (SFA), the thick frontier approach (TFA), and the distribution-free approach (DFA). These approaches diverge in their assumptions regarding the shape of the efficient frontier, the treatment of random errors, and the distributions presumed for inefficiencies and random errors. Conversely, the non-parametric linear programming method for efficiency measurement adopts a non-stochastic perspective and tends to conflate disturbance with inefficiency (Ascarya & Yumanita, 2008). This method compares efficiency to other observed units through population-based discovery and observation.

The assessment of the efficiency of financial institutions, such as banks, involves deriving insights from their operational activities. There are three primary theories governing the input-output relationship of banks. The production (or operational) approach and the intermediation approach are grounded in the classical microeconomic theory of the firm. In contrast, the modern (or assets) approach builds upon the modified classical theory of the firm, incorporating distinctive features of banks' operations, including risk management and information processing. Furthermore, this approach accounts for the presence of asymmetric information, crucial elements in delineating the role of financial intermediaries (Freixas & Rochet, 1997).

The production approach conceptualizes banking operations as the generation of services for both depositors and borrowers through the utilization of all available production resources, including labor and physical capital. In contrast, the intermediation approach defines banking operations as the intermediary function that transforms funds borrowed from depositors (surplus spending units) into funds lent to borrowers (deficit spending units). Concurrently, the asset approach, also known as the "modern approach", seeks to augment the preceding two approaches by incorporating risk management, information processing, and governance considerations into the classical theory of the firm. This integration aims to provide a more comprehensive understanding of banking operations and their role in the financial landscape.

2.3. Prior literature

Several previous works of literature on government-owned bank efficiency have been conducted with various case studies and observation periods. Some of these studies compared the bank's performance based on its ownership, including government-owned banks, private-owned banks, and foreign banks (Altunbas et al., 2001; Karas et al., 2010; Kumar & Kar, 2022; Mohan, 2005). In addition, some others compared the performance among the government-owned banks (Baidya & Mitra, 2012; Bhatia & Mahendru, 2016; Singh & Bansal, 2016; Gunawan & Utiyati, 2013; Nasution et al., 2020; Sulistyono, 2014).

Most of the previous literature that compares the government bank efficiency found that the government-owned bank tends to become the most efficient compared to others. Mohan and Ray (2004) conducted a comparative analysis of the performance of public and private sector banks in India, employing the revenue-maximization approach data envelopment analysis (DEA). Their findings revealed that public sector banks (PSBs) in India exhibit significantly superior efficiency compared to private sector banks. The study suggests that the heightened performance of public sector banks can be predominantly attributed to their higher levels of technical efficiency rather than superior allocative efficiency. In a similar vein, Karas et al. (2010) sought to investigate the relationship between bank efficiency and ownership, focusing on the case of Russia. Their study disclosed that domestic private banks demonstrated lower efficiency levels than domestic public banks, with foreign banks emerging as the most efficient entities in the context of Russia's banking sector.

Altunbas et al. (2001) conducted an investigation into bank ownership and its impact on efficiency, focusing on the case of Germany. The study revealed that all categories of bank ownership experienced significant economies of scale. Moreover, the inefficiency measures employed in this study indicated that both public and mutual banks of all sizes exhibited lower costs and higher profit advantages compared to private banks. In a separate study, Kumar and Kar (2022) undertook an examination and comparison of efficiency levels between public and private sector banks in India. Using two-stage network data envelopment analysis (NDEA), the research reinforced previous findings, highlighting that public sector banks demonstrated a higher level of intermediation efficiency than their private sector counterparts. Additionally, this study identified factors influencing intermediation efficiency, including bank size, return on assets (ROA), ownership structure, and market share.

Furthermore, some other studies compared the performance among government-owned banks, and most of the literature in this field is in the case of India (Baidya & Mitra, 2012; Bhatia & Mahendru, 2016; Singh & Bansal, 2016). Baidya and Mitra (2012) evaluated the technical efficiency of 26 public sector banks in India between 2009 to 2010 and found that only 23% of these samples were considered efficient. This study also found that the more labor-intensive the banks, the more inefficient banks' performance. In addition, Bhatia and Mahendru (2016) continued to analyze the 26 PSBs with 2007–2008 to 2011–2012

as the observation periods. The result found that there was a declining performance in PSB efficiency in 2011–2012 compared to 2007–2008 and suggested banks optimize their operation's scale and adopt technological innovation to maximize the efficiency scores. Then, Singh and Bansal (2016) investigated and compared the efficiency of PSBs during the deregulation period from 2001–2002 to 2012–2013 and found its determinants. This study found that banks that have higher profitability, lower non-performing assets, and larger size are more technically efficient. In addition, some of these studies compared the bank's performance based on its ownership, including government-owned banks, private-owned banks, and foreign banks (Al-Dwiry et al., 2022; Altunbas et al., 2001; Karas et al., 2010; Kostyuk et al., 2014; Kumar & Kar, 2022; Marashdeh et al., 2021; Mohan, 2005).

In addition, Mateev and Bachvarov (2020) found that the ownership structure did not have a significant influence on the financial performance of Islamic banks in the Middle East and North Africa (MENA) region. In their study, the effect of foreign ownership was negative but not statistically significant, indicating that foreign ownership did not strongly impact the financial performance of these banks. Furthermore, the effect of government ownership, while somewhat significant, was also negative and only had a marginal impact on the financial performance of Islamic banks in the MENA region. In summary, their research suggests that ownership structure, whether foreign or government, did not play a substantial role in shaping the financial performance of Islamic banks in the MENA region as of the time of their study.

According to Doan et al. (2018), their research findings align with the notion that state-owned banks tend to be less efficient and less profitable when compared to privately owned banks. This could be attributed to the fact that banks under government control are more susceptible to experiencing agency conflicts, particularly in economies that are still developing or in countries with weak legal and regulatory frameworks, as well as political corruption within the banking sector. In such environments, state-owned banks may face greater challenges in achieving operational efficiency and financial profitability due to the influence of various political and regulatory factors that can hinder their performance. Pan et al. (2023) conducted an examination of the influence of government ownership on earnings management in banks, aiming to discern the prevailing impact of competing political or agency interests. Utilizing ownership data for 171 Chinese commercial banks spanning the period from 2006 to 2018, the study identified a tendency towards increased accruals management in government-owned banks, particularly with the intent of suppressing reported earnings. This effect was observed to be more pronounced in banks with diminished influence from controlling shareholders, more concentrated ownership structures, and in provinces characterized by higher levels of development.

However, there is still a lack of literature that evaluates the efficiency of government-owned banks in the case of Indonesia (Gunawan & Utiyati, 2013; Nasution et al., 2020; Sulistyono, 2014). Gunawan and Utiyati's (2013) study aimed to identify whether

there were any differences in the government's bank efficiency during the 2008–2011 period using the intermediation approach — DEA. This study found that all the government banks achieved maximum efficiency scores of 100% during the observation period. This study also found that a bank's scale is positively related to the bank's efficiency. Then, Sulistiyono (2015) measured the Indonesian BUMN bank efficiency during the 2006, 2007, and 2013 periods using DEA. This study found a declining efficiency trend in 2007 indicating the prime mortgage effect on banking performance in Indonesia. Based on the potential improvement analysis, this study found that total credit is the main source of inefficiency in overall BUMN bank. In addition, Nasution et al. (2020) analyzed the efficiency of BUMN bank and its determinants using DEA and panel regression. The DEA result of this study indicated that Bank Rakyat Indonesia (BRI) is the most efficient bank. In addition, panel regression results showed that loan-to-deposit ratio (LDR), Pegawai Daerah Dengan Perjanjian Kerja (PDPK), ROA, exchange rate, and gross domestic product (GDP) growth were positively correlated to the bank's efficiency achievement.

3. METHODOLOGY

3.1. Data envelopment analysis

The assessment of banks' efficiency using both parametric and non-parametric approaches has garnered significant attention in recent decades. Among the various methodologies employed, DEA stands out as the most frequently utilized method. DEA, a nonparametric and stochastic approach, gauges the efficiency of decision-making units (DMUs) relative to similar counterparts, positioning all DMUs on or below the efficiency frontier. The nonparametric nature of DEA eliminates the need for assumptions about the production function. Additionally, DEA constructs the production function based on observed data, minimizing the impact of misspecification. Originating with Charnes et al. (1978) and subsequently extended by Banker et al. (1984), DEA facilitates the examination of relative efficiency based on multiple inputs and outputs. Moreover, it enables an analysis of potential improvement, offering insights into how a DMU can enhance its performance to attain efficiency.

The initial step in employing DEA is the careful selection of appropriate input and output variables. Once the variables for a group of DMUs are identified, the next phase involves constructing the production possibility set, denoted as Ω, within which these DMUs operate. This set encompasses all feasible input and output vectors associated with the entities under consideration.

$$\Omega = \{(x,y) \in \mathfrak{R}_+^{m+s} \ I \ x \ can \ produce \ y\} \quad (1)$$

Continuing from the previous statement, the input set, denoted as $L(y)$, represents the subset of all input vectors $x \in \mathfrak{R}_+^{m+s}$. Simultaneously, the production set $P(x)$ is defined as the subset of all output vectors $y \in \mathfrak{R}_+^{m+s}$ that can be obtained from the input vector x. Therefore, the input and output sets are explicitly defined as follows.

Then, an input set $L(y)$ is the subset of all input vectors $x \in \mathfrak{R}_+^{m+s}$, and a production set $P(x)$ is the subset of all output vectors $y \in \mathfrak{R}_+^{m+s}$, which are obtained from x. The input and output sets are therefore defined respectively as:

$$\begin{aligned} L(y) &= \{x \ I \ (x,y) \in \Omega\} \\ \text{or} \qquad\qquad & \qquad\qquad (2) \\ L(y) &= \{x \ I \ y \in P(x)\} \end{aligned}$$

$$\begin{aligned} P(x) &= \{x \ I \ (x,y) \in \Omega\} \\ \text{or} \qquad\qquad & \qquad\qquad (3) \\ P(x) &= \{x \ I \ y \in P(y)\} \end{aligned}$$

Suppose that n banks producing s outputs $(Y_i, i = 1, 2, .., s)$ with m inputs $(X_i, i = 1, 2, .., m)$. The shadow output and input prices are $(\mu_r, r = 1, 2, …, s)$ and $(v_i, i = 1, 2, .., m)$. So, for the unit K they use the input bundle $X_k = (X_{k1}, X_{k2}, …, X_{km})$ to produce $Y_k = (Y_{k1,} Y_{k2,}, …, Y_{km})$. The linear "fractional" programming problems are set up as:

$$max \ AP_k = \frac{\mu Y_k}{v Y_k} = \frac{\sum_{i=1}^{s} \mu_{rk} Y_{rk}}{\sum_{i=1}^{m} v_{ik} x_{ik}} \quad (4)$$

Two frequently employed DEA models are the Charnes, Cooper, and Rhodes (CCR) model (Charnes et al., 1978) and the Banker, Charnes, and Cooper (BCC) model (Banker et al., 1984), as outlined by Coelli (1996). The primary distinction between these models lies in their treatment of return to scale (RTS). The CCR model operates under the assumption of constant return to scale (CRS), implying that the changes in input values are proportional to the increase in certain output. This aligns with the fixed production function concept of CRS, where an additional input of x times results in an additional output of x times. Conversely, the BCC model allows for a variable return to scale (VRS), acknowledging that each DMU functions with a varying scale of production. Whereas the BCC model assumes that changes in the output created by DMU are proportional to the proportional change in the input. This is consistent with the VRS assumption, which states that not all inputs result in the same outcome. The VRS model presupposes that the ratio of input increment to output increase is distinct. Therefore, the addition of x inputs does not result in an x-fold increase in output, which may be smaller or bigger. DEA measurement in the banking context can be described by the following figure:

Figure 2. DEA model on banking
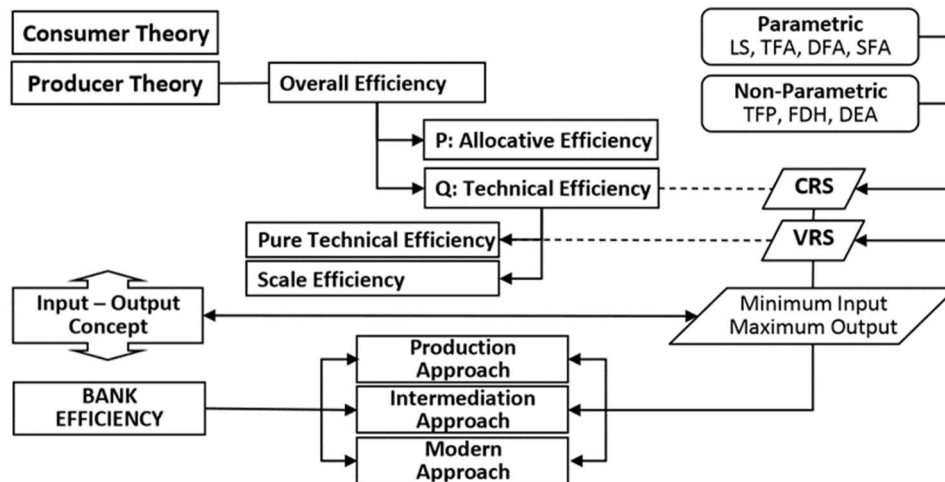
Source: Authors' illustration.

This study focuses on examining and analyzing the efficiency level of four government-owned banks in Indonesia namely BRI, Bank Mandiri, Bank Negara Indonesia (BNI), and Bank Tabungan Nasional (BTN) from the first quarter of 2019 to the second quarter of 2022. These four banks were selected for a few important reasons. These banks often played a vital role in Indonesia's financial system. Thus, assessing their efficiency helps policymakers and regulators understand how well these institutions are utilizing resources and contributing to economic development during the pandemic crisis. In addition, by analyzing these banks over the pandemic crisis periods, the study can assess their resilience to economic shocks and their ability to absorb potential losses without causing systemic disruptions. This is to ensure its financial stability. On the other hand, by analyzing the efficiency of government-owned banks in comparison to private banks, it can provide insights into the competitiveness of the financial sector during the pandemic crisis periods. It helps to determine whether government-owned banks are operating on a level playing field with their private counterparts. DEA with the intermediation approach is considered to be used in this study to examine a bank's efficiency. According to Ascarya and Yumanita (2008), the intermediation model is more appropriate for banking since it considers banks as intermediary entities. Consequently, this concept describes banking's activity as a mediator in converting money from a third party into money lent to borrowers (Ascarya & Yumanita, 2008). Hence, the intermediation approach becomes the main basis for selecting the variables used in this study. The input variables used are fixed assets, labor costs, and third-party funds, whereas the output variables are total financing and operational income. Data related to input and output variables were obtained from the financial reports of government-owned banks on the Financial Services Authority (*Otoritas Jasa Keuangan* — OJK) website (https://www.ojk.go.id/). Table 1 provides the definition and references of the variable of variables used in this study.

Alternatively, other methods of analysis could be deployed as well to measure the banking performance known as panel regression, sometimes referred to as panel data analysis or longitudinal data analysis. It is a statistical technique commonly employed in the fields of econometrics and social sciences for the examination of data that encompasses both cross-sectional and time-series components. In the context of panel regression analysis, the dataset comprises observations gathered from several entities, such as people, businesses, or nations, across numerous time periods. The use of cross-sectional and time-series data in tandem enables a more thorough and insightful analysis by including both individual heterogeneity and time-related effects.

Furthermore, Table 2 provides the statistical description of the variables used in this study.

Table 1. DEA variables definitions (Part 1)

Variables	Definition	References
Input variables		
Fixed assets	Assets owned by the bank and used in operational activities	Abbas et al. (2016), Lutfi and Sutyano (2019), Rani and Kassim (2020), Rusydiana and As-Salafiyah (2021), Widiarti et al. (2015)
Third-party funds	Savings from the public collected by banks in the form of demand deposits, savings, and time deposits	Abbas et al. (2016), Lutfi and Sutyano (2019), Rani and Kassim (2020), Řepková (2015), Rusydiana and As-Salafiyah (2021), Shawtari et al. (2018), Widiarti et al. (2015)
Labor costs	Wages and benefits paid to bank employees before deducting income tax and other deductions	Lutfi and Sutyano (2019), Rani and Kassim (2020), Řepková (2015), Rusydiana and As-Salafiyah (2021), Shawtari et al. (2018), Widiarti et al. (2015)

Table 1. DEA variables definitions (Part 2)

Variables	Definition	References
Output variables		
Loan	Provision of money or bills, based on a loan agreement between the bank and another party which requires the borrower to pay off the debt after a certain period by giving interest	Abbas et al. (2016), Lutfi and Sutyano (2019), Rani and Kassim (2020), Řepková (2015), Rusydiana and As-Salafiyah (2021), Shawtari et al. (2018), Widiarti et al. (2015)
Operational income	Income in rupiah and foreign currency earned by banks in the form of interest and non-interest operating income	Lutfi and Sutyano (2019), Rani and Kassim (2020), Řepková (2015), Rusydiana and As-Salafiyah (2021), Shawtari et al. (2018), Widiarti et al. (2015)

Note: This table indicates the extraction of variable information and the source from which it is extracted.
Source: Authors' compilation.

Table 2. Statistical description of input and output variables

DMU		Fixed asset	Third-party funds	Labor cost	Operational income	Loans
BRI	Mean	44.213.139	1.027.757.386	15.310.029	90.006.132	894.365.668
	Max	48.931.381	1.128.248.717	29.960.850	159.262.740	1.003.615.576
	Min	36.688.229	890.901.785	5.148.773	37.727.442	804.356.813
Mandiri	Mean	55.094.137	889.818.698	8.050.356	60.971.333	779.196.983
	Max	59.258.961	1.041.352.609	15.188.121	108.645.435	891.122.770
	Min	47.002.367	672.094.494	3.017.147	26.431.361	684.530.093
BNI	Mean	36.364.609	627.096.888	5.381.442	38.605.784	552.186.551
	Max	40.109.413	729.547.155	10.493.379	72.425.531	616.605.643
	Min	33.091.785	537.821.992	2.038.068	15.249.961	490.803.207
BTN	Mean	8.951.868	244.868.519	1.660.653	16.413.933	235.153.063
	Max	9.559.428	298.378.993	3.003.434	28.863.479	248.895.667
	Min	8.108.086	131.135.068	681.168	6.605.487	227.959.190

Note: This table shows the descriptive statistics of the input and output variables used for the analysis purpose. The information consists of mean, maximum, and minimum values.
Source: Authors' compilation.

Based on the statistical description above, Mandiri is the bank with the highest average of fixed assets, while BRI has the highest in other variables namely third-party funds, labour cost, operational income, and loans. Table 2 also depicts that BTN is the government-owned bank with the lowest amount of input and output variables compared to the others.

3.2. Tobit regression

The second stage of the study employs Tobit regression, a methodology endorsed by Hoff (2007) as generally adequate for various circumstances. The Tobit method, introduced by James Tobin in 1958 for analyzing the relationship between a limited number of dependent variables and independent factors (Gujarati & Porter, 2008), was initially developed to assess car-buying expenditures by American households. The use of ordinary least squares (OLS) estimation in such cases is complicated, particularly when some households do not make a car purchase, resulting in zero expenditure. OLS estimation in this context is likely to yield values close to zero and statistically insignificant. Tobin (1958) addressed this issue, and the Tobit regression model, based on maximum likelihood estimation (MLE), emerged as a more accurate alternative compared to OLS, particularly when dealing with censored data (Gujarati, 2008). In this study, Tobit regression is applied to explore the determinants of the efficiency value, the dependent variable, which ranges from 0 to 1. Independent variables include factors such as capital adequacy ratio (*CAR*), financial performance (*ROA*), and deposit ratio (*LDR/FDR*), along with the bank's size (*SIZE*). The Tobit regression model is implemented using panel data, and the formulation for the study is as follows:

$$Y_t = \beta_0 + \beta_1 SIZE + \beta_2 CAR + \beta_3 ROA + \beta_4 LDR + \mu \qquad (5)$$

Table 3. Tobit variables' definitions

Tobit variable	Definition	References	Source
Efficiency	Relative efficiency scores obtained from DEA result	MaxDEA 8	MaxDEA 8
SIZE	Bank's total asset	Eyceyurt Batir et al. (2017), Goswami et al. (2019), Lutfi and Sutyano (2019), Majdina et al. (2019), Nasution et al. (2020), Řepková (2015), Widiarti et al. (2015)	Financial statement — OJK website
CAR	The ratio of risky capital to the risk-weighted asset	Lutfi and Sutyano (2019), Majdina et al. (2019), Nasution et al. (2020), Widiarti et al. (2015)	Bank financial ratio — OJK's website
ROA	The ratio of annualized earnings before taxes to the asset's average	Eyceyurt Batir et al. (2017), Goswami et al. (2019), Majdina et al. (2019), Nasution et al. (2020), Řepková (2015)	Bank financial ratio — OJK website
LDR	The ratio of loan to the deposit/third-party funds	Goswami et al. (2019), Lutfi and Sutyano (2019), Nasution et al. (2020), Řepková (2015), Widiarti et al. (2015)	Bank financial ratio — OJK website

Note: This table shows the variables' definitions and sources of variables' extraction with the literature support.
Source: Authors' compilation.

4. RESULTS AND DISCUSSION

4.1. DEA result

Table 4 represents the efficiency of four government-owned banks in Indonesia from the first quarter of 2020 to the second quarter of 2022. The result represented by an efficiency score between 0 and 1.

A score of 1 signifies the bank's optimal management of its input and output variables. Deviations from a score of 1 indicate that the bank is either inefficient or not optimally managing its input and output variables. Following is a table displaying the efficiency scores obtained following data processing with MaxDEA 8.

Table 4. Efficiency result

|	Period													
	Before pandemic					*During pandemic*								
DMU	*Q1 2019*	*Q2 2019*	*Q3 2019*	*Q4 2019*	*Q1 2020*	*Q2 2020*	*Q3 2020*	*Q4 2020*	*Q1 2021*	*Q2 2021*	*Q3 2021*	*Q4 2021*	*Q1 2022*	*Q2 2022*
BNI	0.92	0.91	0.95	0.94	1	0.89	0.84	0.83	0.94	0.85	0.82	0.77	0.92	0.88
BRI	1	1	1	1	1	0.94	0.94	0.97	0.96	0.94	0.92	1	1	1
BTN	1	1	1	0.97	1	0.96	0.96	1	0.98	0.96	0.95	0.97	1	1
Mandiri	1	1	1	0.93	1	0.89	0.86	0.86	0.93	0.92	0.88	0.85	1	1

Source: Authors' compilation.

BRI and BTN are the most efficient banks with average efficiency scores of 0.98 during the observation periods, followed by Mandiri (0.94) and BNI (0.89). This finding was consistent with Nasution et al. (2020), where BRI was the most efficient bank during the 2008–2018 period, and different from Nugraha (2013) who found that Bank Mandiri was the most efficient in the 2007–2010 period. Furthermore, the average efficiency trend shows a sharp decreasing trend in all banks, starting from Q2 2020. All government-owned banks were able to achieve efficient performance in Q1 2020 but experienced a downward trend in the following periods. In addition, in the pre-pandemic period, 70% of banks were able to achieve maximum efficiency values, but during the pandemic period, the number of efficient banks decreased to 22%. This is indicating due to the influence of the COVID-19 that began to spread in Indonesia in March 2020, which had a domino effect on banking performance.

Figure 3 shows the efficiency trend during the observation period in the form of a graph. The graph depicts that BTN and BRI have the most stable efficiency trend compared to other government-owned banks. This illustrates that the occurrence of the COVID-19 pandemic did not have a significant impact on both banks, while it affected the efficiency-stability of Mandiri and BNI.

Figure 3. Efficiency trend of the government-owned bank in Indonesia
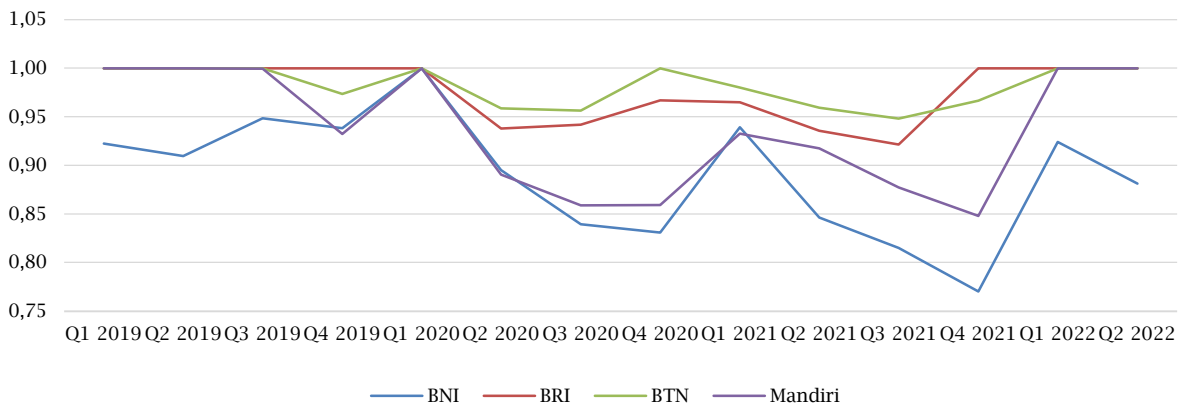
Source: Authors' compilation.

4.2. Potential improvement

In addition to measuring efficiency scores, DEA also facilitates the assessment of potential improvement, enabling the identification of the primary sources of inefficiency and pinpointing the variables that each bank should optimize. The potential improvement analysis involves a comparison between the projected values and the actual or current data, employing the input and output approach. Table 5 presents the results of the potential improvement, highlighting the areas that each bank should consider for enhancement to improve their efficiency levels in the future.

Table 5. Potential improvement result

DMU	Approach	Fixed asset	Third-party funds	Labor cost	Operational income	Loans
BNI	Input	-0.72	-2.73	-2.96	3.94	0.00
	Output	0.00	-1.88	-2.02	4.09	0.63
	Average	**-0.36**	**-2.30**	**-2.49**	**4.01**	**0.31**
BRI	Input	-2.37	-3.17	-6.37	3.67	0.00
	Output	-0.01	-0.58	-3.28	5.47	2.02
	Average	**-1.19**	**-1.87**	**-4.83**	**4.57**	**1.01**
Mandiri	Input	-3.76	-4.98	-5.86	2.67	0.07
	Output	-0.83	-0.31	-1.53	5.73	2.96
	Average	**-2.29**	**-2.64**	**-3.70**	**4.20**	**1.51**
BTN	Input	-1.19	-6.23	-1.60	0.41	0.08
	Output	-0.08	-5.11	-0.69	0.71	0.71
	Average	**-0.64**	**-5.67**	**-1.15**	**0.56**	**0.40**

Source: Authors' compilation.

Based on Table 5, it is known that the third-party fund is the main source of inefficiency for BTN, operational income for Mandiri and BNI, and labor cost caused inefficiency for BRI the most. Government-owned banks need to adjust their input and output variables, either by decreasing the among of input variables or increasing the output variable by the percentage shown in Table 3. For instance, Mandiri needs to find a strategy to reduce its fixed assets by 2.29%, third-party funds by 2.64%, labor costs by 3.7%, and increase the amount of operational income by 4.20%, and loans by 1.51%. The amount of operating income has become the main source of inefficiency for Mandiri and BTN. This means that both banks suggested finding other strategies to improve their income. It can be done by maximizing their loan productively and minimizing the NPL by being more selective in providing loans so that the expected income becomes more optimal. BTN suggested decreasing its third-party fund's amount to increase efficiency achievement. However, decreasing third-party funds doesn't literally mean that BTN is necessary to limit the amount of their deposit because of its role as an intermediary institution. It can be done by optimizing the use of

their third-party funds effectively in producing more income and loans to the customers. Furthermore, labour cost as an input variable causes the highest inefficiency score on Bank BRI. This is due to its largest scale, resulting largest labor cost compared to other government-owned banks. Based on the potential improvement analysis, BRI suggested reducing its labour cost by 4.38% to achieve an efficient performance. It can be done by optimizing their cost or providing stimulus to improve the performance of existing labour so that they could be more productive in producing output.

4.3. Discussion of Tobit regression results

The analysis then extended to identify which factors may influence the efficiency level using the Tobit regression model. The result depicts that the financial ratios (*CAR, LDR,* and *ROA*) significantly influence the efficiency scores, while the *SIZE* variable failed to explain the efficiency achievement. Table 6 represents the overall findings of the Tobit estimation in this study:

Table 6. Tobit regression result

Variable	Coefficient	Prob.
SIZE	-7.61E-11	0.0644*
CAR	0.011393	0.0403**
LDR	0.003689	0.0001***
ROA	0.046751	0.0015**

*Note: This table shows the Tobit regression and the signs *, **, and *** denote significance at 10%, 5%, and 1%, respectively.*
Source: Authors' illustration.

The coefficient value of -7.61E-11 for the variable *SIZE* indicates a negative impact on efficiency. This finding aligns with the observations of Lutfi and Sutyano (2019), who identified a non-linear (quadratic or U-shaped) relationship between bank size and efficiency. In this context, an increase in asset size initially enhances bank efficiency, but beyond a certain point, further increases may lead to a decrease in efficiency. However, it is noteworthy that in the current study, the variable *SIZE* is not deemed statistically significant in influencing efficiency, as evidenced by its probability value of 0.0644, which exceeds the conventional significance threshold of 0.05. This lack of statistical significance suggests that, in the sample studied, the variable *SIZE* may not have a substantial impact on bank efficiency. It is important to recognize that the size of government-owned banks varies, and a larger banking size does not necessarily guarantee higher

efficiency. This is evident in the efficiency results presented in Table 2, where BTN, despite having one of the smallest sizes compared to other banks, exhibits among the highest average efficiency scores.

Additionally, the *CAR* serves as an indicator of a bank's capability to allocate funds in anticipation of potential defaults. Beyond its role in risk management, *CAR* is instrumental in furnishing resources for the development of new products, facilities, services, and overall expansion. Moreover, a robust *CAR* contributes to bolstering public confidence and instilling trust among creditors (Rose & Hudgins, 2013). As noted by Fatima (2014), a healthy bank is often characterized by a favorable capital balance. This equilibrium signifies that depositors are inclined to entrust their funds to the bank without necessitating a high rate of return, underlining the stability and credibility of the financial institution.

This study found that *CAR* has a significant positive impact on efficiency achievement. The more capital that is owned by the banks, the greater bank's efficiency. This result is relevant to Altunbas et al. (2007), Lutfi and Sutyano (2019), Majdina et al. (2019), and Widiarti et al. (2015), who also found that *CAR* has a positive and significant effect on bank efficiency level. The positive effect of *CAR* on bank efficiency suggests that the presence of excess capital will allow banks to boost lending without being excessively worried about not being able to cover the credit risk that occurs since they have enough capital to cover the risk. Consistently, the *ROA* exhibits a coefficient value of 0.046751, indicating a positive and statistically significant impact on banking efficiency. This finding suggests a direct relationship between *ROA* and efficiency, signifying an enhancement in efficiency as bank profitability increases. This aligns with previous research findings by Firdaus and Hosen (2013), Nasution et al. (2020), and Sufian and Shah Habibullah (2010), all of which observed a positive and significant correlation between *ROA* and efficiency. The implication is that banks with higher profit margins tend to be more efficient, as they demonstrate effective management of their assets. This management of assets may manifest as an improvement in credit quality, leading to a reduction in NPL, or an increase in loan volume. Lastly, *LDR* value is a ratio to assess the quality of a bank's liquidity and its intermediation performances. The higher *LDR* represents the better bank's performance in terms of its intermediation function. *LDR's* coefficient value of 0.03689 indicates that it significantly improves the efficiency of the bank. The result was consistent with studies by Lutfi and Sutyano (2019), Sathye (2003), and Sulaeman et al. (2019) which found a favorable relationship between the *LDR* and banking efficiency. The positive relationship between *LDR* and banking efficiency is due to the fact that higher *LDR* results in increased loan output, which raises interest income obtained by banks.

5. CONCLUSION

Bank efficiency can reflect bank performance by comparing the output obtained with the input owned by the bank. More efficient banks are expected to tend to get optimal profits, more loan funds, and can provide better service to their customers. The higher efficiency of a bank shows that the bank is able to manage the bank's resources to obtain large results. The government-owned bank needs to act efficiently as one of the BUMN which is expected to contribute more to the country's economy, especially in the case of the economic downturn due to the COVID-19 pandemic.

DEA results showed that BRI and BTN are the most efficient and stable banks during the observation periods. Furthermore, the average efficiency trend showed a sharp decreasing trend in all banks from Q2 2020, the period when the COVID-19 pandemic began to spread in Indonesia. Further analysis showed by Tobit regression result, which found that financial ratios (CAR, LDR, and ROA) have a significant impact to affect the efficiency level of the government-owned bank, whereas the bank's size was found insignificant. So, for the banks to achieve maximum efficiency levels in the future, they need to increase their CAR, LDR, and FDR.

The outcomes of the potential improvement analysis offer valuable insights for banks to assess their efficiency achievements. This information becomes instrumental for practitioners in government-owned banks as they can pinpoint the specific variables that should be prioritized for improvement and receive more attention. The analysis identifies the primary sources of inefficiency for each government-owned bank, guiding practitioners in refining their strategies. According to the potential improvement analysis, the third-party fund emerges as the primary source of inefficiency for BTN, while operational income plays a pivotal role for Mandiri and BNI. Additionally, labor cost is identified as the primary contributor to inefficiency for BRI. Armed with this knowledge, government-owned banks can strategically adjust their input and output variables. This adjustment may involve reducing the amount of input variables or increasing the output variable by the specified percentage in the potential improvement analysis. Such strategic adjustments are crucial for steering government-owned banks towards efficient performance in the future.

This study is not without its limitations, primarily associated with the observation periods and the selection of Tobit variables. The research is confined to data available until 2020, and therefore, future studies should consider extending the observation period to encompass the post-pandemic years, offering a more comprehensive understanding of the banking sector's efficiency dynamics in the evolving economic landscape. Furthermore, the research methodology could benefit from enhancements by incorporating additional methods and approaches to enrich the results and contribute to the existing literature. Diversifying the methodological toolkit may provide a more nuanced perspective on the factors influencing banking efficiency. Additionally, there is a potential avenue for future research to explore the efficiency determinants by integrating external variables such as GDP, economic growth, and inflation as independent variables. This inclusion could offer a broader and more holistic perspective, contributing to a comprehensive and nuanced understanding of the various factors influencing banking efficiency.

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