The Influence of Banking Regulation and Board Remuneration on Cost Efficiency of Indonesian Banks

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Abstract. This study examines the relationship between bank capital regulation, income diversification, market discipline, and board remuneration on cost efficiency of Indonesia banks during the 2013–2022 period. The sample consists of 77 Indonesian banks registered in Indonesian Financial Service Authority (OJK) as of February 2023. The Stochastic Frontier Analysis (SFA) was employed to estimate bank cost efficiency scores, and panel data regression was used to analyze the effects of independent variables on banks cost efficiency. The results showed that bank capital regulation, as measured by Capital Adequacy Ratio (CAR), lowered cost efficiency. Bank income diversification and market discipline, as measured by the use of a Big 4 auditor, have a negative but insignificant impact on bank efficiency. Finally, the Board's remuneration mechanism was proven to increase cost efficiency. The findings implies that Indonesia's banking industry should improve their policy regarding management's risk-taking behavior related to the use of bank capital for their interest. Additionally, this study suggests the Indonesian banking sector should reconsider income diversification strategy and, instead, start to focus on funding diversification to boost performance. Lastly, the Indonesian banking industry does not need to use a Big 4 auditor for assessing their information quality since they just give a lower bank cost efficiency compared to non-Big 4.

Keywords: *Bank regulation; CAR; income diversification; auditor; remuneration; efficiency*

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1. Introduction

Banking is one of the heavily regulated sectors among others in the world [1]. There is a historical background of banking in which banks can be bound by many rules. The trend of financial liberalization and several crisis phenomena in the financial world have become the main driving factors for governance reform in the banking industry.

In the late 1980s, banking in many developed and developing countries was highly controlled by the government [2]. They determine deposit and loan rates, regulate licenses for the entry of new foreign and domestic banks, and control the establishment of new bank branches. They also restrict foreign financial transactions [3, 4]. It was later realized that this could hamper banking performance because repressive financial policies resulted in poor bank operational performance in many developed and developing countries [2]. The idea of financial liberalization emerged to increase the banking system's efficiency and productivity.

Since the 1970s, efforts to liberalize finance have actually begun to be carried out by many developed countries with the United States as the initiator [5]. This effort continued to grow until it was followed by developed countries in Asia and Europe in the 1990s. The massive implementation of the idea of financial liberalization is due to its positive impact on banking efficiency [2]. Theoretically, financial liberalization is expected to increase bank efficiency [6]. Financial liberalization makes markets more competitive [7], thus stimulating banks to become more efficient through cost reduction, bank risk management improvement, and new financial instruments and services are offered [8].

However, empirically, financial liberalization does not always have a positive impact on banking. Research conducted in Korea by [9] showed that there was no positive relationship between bank reform in Korea and their efficiency. In Türkiye, [8] found that bank efficiency decreased after the liberalization program was carried out during the period 1970–1994. Then in Spain, [10] found that the deregulation program reduced bank productivity. The failure of financial liberalization then faced its peak when the crisis occurred in subprime mortgage lending, in 2007. In this case, intervention is necessary to control financial instability [11].

Efforts to make global banking regulations have been carried out since the 1970s through the Basel Committee, which produced the Basel Agreement that contains references and standard guidelines for global banking regulations to be applied throughout the world. In its development, the Basel Committee has produced three Basel agreements which revise each other. In general, there are three major points, namely minimum capital requirements, supervision from the formal sector, and supervision from the private sector. Although not binding, the Basel Agreement has

become a standard guideline for global banking regulations governing these three matters.

Although [2] and [1] stated that regulation disrupts bank operations, in fact not all banking regulations interfere with bank operations. There are at least three banking regulations that are always used to study their effect on bank efficiency, namely regulations related to capital, activity restriction, and enforcement of market discipline. In addition, [12] and [1] stated that increasingly stringent capital regulations can increase bank efficiency. In terms of policies related to bank activity restriction on bank efficiency, these studies implied a negative influence of restriction in activities on efficiency, where [1] used productive inefficiency, while [12] used technical efficiency. The restrictions that were analyzed by both studies were the degree to which banks may be involved in three activities: (1) any transactions in securities (underwriting, brokering, and dealing) and all mutual fund industry aspects, (2) real estate transaction activities, and (3) insurance underwriting and selling. Therefore, a business diversification strategy can be implemented to improve bank efficiency, as found by [13]. Finally, [14] found a positive relationship between market discipline enforcement on monitoring of bank efficiency. Moreover, there is agency theory, which states the existence of misalignment between the shareholders' interest and management in the company. In the banking context, this means it will disrupt banking performance. To overcome this, a remuneration package is a mechanism that can be used to mitigate this problem [15, 16].

A previous study of Indonesian bank cost efficiency had been conducted by [17]; however, they only estimated cost efficiency among Indonesian banks during the 1993–2000 period. They did not examine factors that determined banks' cost efficiency. The study, furthermore, passed the Asia economic crisis, and they compared how Indonesian banks' cost efficiency is before and after the crisis period. The study showed that average banks' cost efficiency during the research period was 70%, and the cost efficiency deteriorated from 80% before the crisis to only 53%. Thus, the Indonesian banking's cost efficiency worsened after the financial crisis occurred.

In terms of profitability, the Indonesia banking sector is attractive. The Indonesian banking industry is now the most profitable among ASEAN countries due to its highest Net Interest Margins (NIM) in the world [18]. By the end of 2022, Indonesia's NIM reached 4.68%, the second largest in ASEAN after Cambodia. However, [19] stated that a higher level of NIM indicates an inefficiency over the financial intermediary process by banks. It is confirmed in BCA's research regarding 2023 Indonesia banking outlook. By using Data Envelopment Analysis (DEA) method, it was found that Indonesia banks' efficiency ranking dropped from 2019 to 2022, from 58% to 47%. Even so, the Capital Adequacy Ratio (CAR) level of Indonesia's banking industry has continued to improve. The number is far above the minimum

requirement set by the Central Bank of Indonesia. The minimum requirement is 8% and the average CAR level of Indonesia's banking sector reached even above 20%. This means that all Indonesia's banking companies have strengthened their capital buffers strongly, so that they have lower risk of bankruptcy due to their high level of CAR.

In terms of remuneration mechanisms in Indonesia, the determination of its amount is structured by the Remuneration Committee through remuneration's structure and policy. According to Indonesia Financial Service Authority regulation number 45 in 2015 (POJK 45/POJK.03/2015), for commercial banks, board remuneration consists of fixed and variable components. The fixed is at least assessed by considering business scale, complexity, peer group, inflation, condition, and financial capabilities; the variable is calculated by considering two factors: performance and risk.

Based on those phenomena and previous studies, this study aims to analyze capital requirement policy, business diversification, market supervision of banks as well as board remuneration impact on cost efficiency. Previous studies, however, generally focus on the traditional bank performance measures such as return on assets, market to book value ratio, and profit margin. In addition, this study takes into account the Indonesian banking sector's cost efficiency after the global financial crisis of 2008, where the preceding studies on Indonesian bank efficiency focused on the Asian financial crisis of 1998. This study would like to investigate whether Indonesian banks' efficiency is worsening as a result of a previous study [17]. Since this study period extends through the Covid-19 pandemic, the impact of that factor on bank cost efficiency is also examined. However, the result shows that Covid-19 is only insignificantly affecting bank cost efficiency. Furthermore, to date, studies rarely consider the effect of board remuneration on bank cost efficiency.

Results of the study revealed that bank capital significantly reduced cost efficiency. This finding is consistent with agency theory, moral hazard theory, and signaling theory. In addition, income diversification, although insignificant, also lowered cost efficiency. This result may be due to a high-risk exposure to non-interest income. Moreover, board remuneration surprisingly increased cost efficiency. Despite its insignificant influence, this factor can be a signal to encourage them to manage cost efficiently. Lastly, this study found an insignificant effect of the Covid-19 pandemic on bank cost efficiency.

This study contributes to the literature by giving a more reliable measure of a bank's efficiency using input-oriented cost efficiency. Secondly, this study points out the important role of capital on cost efficiency. Moreover, this study provides a new finding on the effect of board remuneration on cost efficiency.

The structure of the paper is illustrated as follows. Section 2 provides a brief literature review supporting the paper; section 3 explains model construction and variable description, followed by empirical results in section 4, and section 5 ends the paper by providing conclusion and policy recommendation.

2. Literature Review and Hypothesis Development

2.1. Conceptual Framework, Research Question, and Hypotheses Development

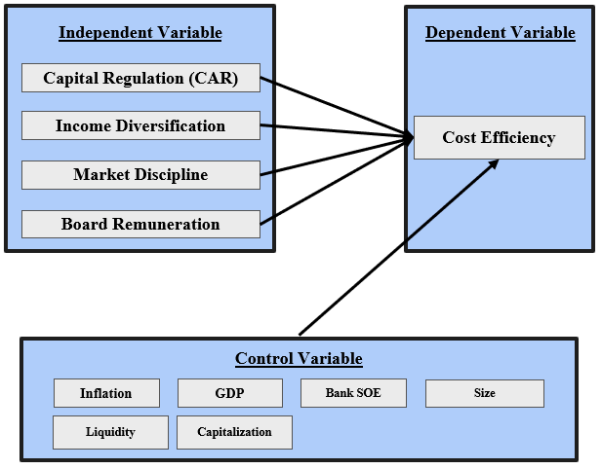


Fig. 1. Conceptual framework of the study

Principal-agent relationship in agency problem theory by [15] assumed humans having self-interested behavior that led to conflict of interest between principal and agent in the organization. They stated that agency conflict characteristics arose from company management tendency to appropriate perquisites from company resources to their interest. When the company is fully owned by the manager, he has full authority; hence, he can maximize his utility. Otherwise, when the authority is limited, the business activity is regulated and supervised, some activity and claims can not easily be taken. In the context of the banking industry, efficiency is usually used to measure banking financial performance because it is best to be examined [20].

Figure 1 depicts the conceptual framework used in this study. The research questions and hypotheses development are constructed based on the figure above. Here are the following research questions and the related null hypotheses:

First question: How does bank capital regulation significantly affect the Indonesian bank cost efficiency in the period of 2013–2022?
H1: Bank capital regulation significantly affects the Indonesian bank cost efficiency in the period of 2013–2022.

Second question: How does bank income diversification significantly affect the Indonesian bank cost efficiency in the period of 2013–2022?

H2: Bank income diversification significantly affects the Indonesian bank cost efficiency in the period of 2013–2022.

Third question: How does market supervision on banks significantly affect the Indonesian bank cost efficiency in the period of 2013–2022?
H3: Market supervision on banks significantly affects the Indonesian bank cost efficiency in the period of 2013–2022.

Fourth question: How does board remuneration significantly affect the Indonesian bank cost efficiency in the period of 2013–2022?
H4: Board remuneration significantly affects the Indonesian bank cost efficiency in the period of 2013–2022.

2.2. Cost Efficiency

Efficiency measures how efficient a bank, compared to best practice limits, is in converting inputs into outputs [14]. This relative limit can be based on the costs used or the profit received [21]. Efficiency is a major factor for preserving confidence, trust, and the soundness of the banking system [22]. In addition, bank efficiency level also helps ensure the financial system effectiveness that contributes to economic growth and development [23, 24].

[14] stated that the concept of cost efficiency is a broader concept than technical efficiency because the concept already refers to technical and allocative efficiency. To measure cost efficiency, input and output variables are needed to determine the efficiency score. The difference in the selection of the two variables in measuring efficiency affects the results significantly [24]. Generally, three measures are widely used in the literature: (1) production approach; (2) intermediation approach; and (3) income approach. In addition to these three approaches, there is one other approach that has also been popular, namely the operations approach [25]. The production and intermediation approaches apply traditional corporate microeconomic theory to banking and differ only in the specifications of banking activities, while the income and operations approaches are superior to the others by incorporating several specific banking activities into the classical theory and then modifying it [24].

There are two widely used methods for calculating efficiency, *Data Envelopment Analysis* (DEA) and *Stochastic Frontier Approach* (SFA). The DEA method calculates non-parametric production limits based on the actual observations of input-output in the sample compared to each firm's efficiency in the sample is measured [26]. This DEA calculation has the advantage of not requiring previous assumptions on the production or cost function [21]. Meanwhile, the SFA method was developed by [27], which takes into account inefficiency measurement error in error term arranged. This method requires a large sample size to produce more robust efficiency estimates [28, 29]. Based on research from [21] in Brazil, the use of these two methods yields similar results.

Between the two measurements, the parametric technique in the SFA method is a more widely considered way to measure economic efficiency [30]. The SFA method was chosen because it can overcome the two main drawbacks of the DEA method. First, DEA does not assume any statistical measurement error (*error*), which can affect the estimation results, thus making efficiency measurements inaccurate [31]. This is different from the SFA method which takes into account inefficiencies and other stochastic shocks in estimating the scores [32]. The second disadvantage of the DEA method is the ignorance of the bank input and output prices, which makes them better used to measure technical efficiency than economic efficiency [30].

2.3. The Effect of Capital Regulation on Cost Efficiency

This subsection explains the first null-hypotheses (H1) testing. Bank capital has the main role as a risk-sharing function, to be a buffer for companies against the probability of regular asset devastation and as a protector for creditors from losses [1]. The study stated that inadequate bank capital levels increases the risk of failure, while the excessive one imposes unimportant costs on the bank and its customers with bad implications for banking system efficiency. In addition, bank capital incentivizes shareholders and management to take less riskier decisions [33]. However, in some circumstances, capital requirements increase greater risk-taking behavior [14].

Research by [12] found that stricter capital regulation is positively related to bank efficiency. This is also in line with the findings from [1] that strengthening the minimum capital requirement policy can improve efficient bank business operations. Meanwhile, [14] found that stricter minimum capital regulations only increase cost efficiency, but decrease profit efficiency. An insignificant effect was found in research conducted by [5].

2.4. The Effect of Business Diversification on Cost Efficiency

This subsection explains the second null-hypotheses (H2) testing. The studies from [1, 12] found that banks' activity restrictions impede their efficiency. [14] differentiated bank efficiency to cost and profit efficiency, then found that greater (smaller) activity restrictions can drop (increase) cost efficiency score and increase (drop) profit efficiency score. The study stated that it occurred since the banks were considered failed in managing their activities, so that the profitability got lower. Additionally, [1] stated that the negative impact of activity restrictions on performance comes from higher regulation expenses arising from banks' involvement in many riskier activities.

Business diversification is a strategy that can be used by banks to increase their efficiency as a response to the negative influence between bank activities restriction and its efficiency [12, 1]. Research [13] shows that increased diversification tends to be proven to increase bank efficiency. Such findings were obtained by [34] in their research conducted in Japan, which concluded that concentration of the income portfolio actually reduces bank efficiency. However, the opposite findings were also

found by [30, 35]. The two studies both state that diversification into non-interest activities impedes bank stability. [30] even recommends replacing the income diversification strategy with funding diversification.

2.5. The Effect of Market Supervision on Banks on Cost Efficiency

This subsection explains the third null-hypotheses (H3) testing. There are two approaches to bank supervision, namely private/market monitoring and official supervision [14]. The first approach argues that monitoring from the private sector, through such entities as depositors, debtholders, and shareholders, will produce better outcomes for the banking industry, while the latter argues that powerful supervision from officers can avoid market failure by directly overseeing, regulating, and disciplining banks. From those approaches, most economists suggest a bigger reliance on market monitoring over official supervision [12]. They argue that the officers do not have any ownership in banks, so that results in different incentives with private stakeholder in assessing banks. In addition, [36] found that private monitoring practices helped the company's financial performance become efficient and positively affect the bank loan integrity in countries with good law institutions.

Market supervision has a significant and positive relationship with increasing cost and profit efficiency [14] as well as technical efficiency [37]. In contrast, [1] suggested that strengthening supervision from the private sector can actually hamper efficient bank operations due to several factors, such as the credibility of information and relatively high costs. This can be explained by what was written by [38]. They explained that the high number of disclosure requirements has a detrimental effect on efficiency due to the costs involved in the additional disclosures process, Investor Relations department maintenance, the additional time and effort in formal disclosure documents preparation, and the sensitivity of information to competitors.

2.6. The Effect of Board Remuneration on Cost Efficiency

This subsection explains the fourth null-hypotheses (H4) testing. Providing remuneration can be an effort to align shareholders' interest with management action [15], so that it can be oriented towards increasing the value of the company. [16] states that an appropriate remuneration package can be a corporate internal governance mechanism to align the interests of principal and agents. However, according to [39], a positive relationship between remuneration and company performance is not found in centralized ownership structures, found in dispersed ownership structures [40], and low levels of concentration [41]. In such companies, the family has very strong control, so they can choose management from relatives even though they are incompetent except to look after their own interests. This means that whatever remuneration is provided, it will not affect the company's performance. Furthermore, the study by [42] and [43] stated that remuneration is an ineffective mechanism in countries with weak governance environments and high corruption due to high opportunities for entrenchment.

3. Research Methodology

This study uses a balanced panel data of 77 commercial banks registered with the Indonesian Financial Service Authority (OJK) in the period from 2013 to 2022. The sample is chosen based on the following criteria: (1) the bank is listed with the OJK, (2) the bank has provided complete annual reports during the observation period; and (3) all variables needed are available.

The analysis is conducted using two stages of calculation. First, the level of bank cost efficiency calculated using the Stochastic Frontier Analysis (SFA). Then, to examine the impact of capital regulation, business diversification, market supervision and board remuneration, a regression analysis using a random effect model is conducted.

3.1. Cost Efficiency Estimation Model

This study uses an intermediary approach in estimating bank cost efficiency. Three components for each input and output were used. The three inputs were (1) the cost of borrowed funds (P_1) obtained from the ratio of interest costs to total deposits [14], (2) labor costs (P_2) from the ratio of labor costs and total assets [14], and (3) the physical capital cost (P_3) from the ratio of other operating costs to fixed assets [5]. The three outputs were total loans, total securitization, and operating income [5]. The following formula is the efficiency estimation model used in this study:

$$ln\left(\frac{TC_{it}}{P_{2it}}\right) = \alpha_0 + \alpha_1 lnY_{1it} + \alpha_2 lnY_{2it} + \alpha_3 lnY_{3it} + \beta_1 ln\left(\frac{P_{1it}}{P_{2it}}\right) + \beta_3 ln\left(\frac{P_{3it}}{P_{2it}}\right) + \frac{1}{2}\alpha_{11}(lnY_{1it})^2$$

$$+ \frac{1}{2}\alpha_{22}(lnY_{2it})^2 + \frac{1}{2}\alpha_{33}(lnY_{3it})^2 + \alpha_{12} lnY_{1it} lnY_{2it} + \alpha_{13} lnY_{1it} lnY_{3it} + \alpha_{23} lnY_{2it} lnY_{3it}$$

$$+ \frac{1}{2}\rho_{11}\left(ln\frac{P_{1it}}{P_{2it}}\right)^2 + \frac{1}{2}\rho_{33}\left(ln\frac{P_{3it}}{P_{2it}}\right)^2 + \rho_{13} ln\left(\frac{P_{1it}}{P_{2it}}\right) ln\left(\frac{P_{3it}}{P_{2it}}\right) + \gamma_{11} lnY_{1it} ln\left(\frac{P_{1it}}{P_{2it}}\right)$$

$$+ \gamma_{13} lnY_{1it} ln\left(\frac{P_{3it}}{P_{2it}}\right) + \gamma_{21} lnY_{2it} ln\left(\frac{P_{1it}}{P_{2it}}\right) + \gamma_{23} lnY_{2it} ln\left(\frac{P_{3it}}{P_{2it}}\right) + \gamma_{31} lnY_{3it} ln\left(\frac{P_{1it}}{P_{2it}}\right)$$

$$+ \gamma_{33} lnY_{3it} ln\left(\frac{P_{3it}}{P_{2it}}\right) + v_{it} + u_{it}. \quad (1)$$

where P_1 is the funds cost, P_2 is the labor cost, and P_3 is the physical capital cost as input variable. Meanwhile, for the output variable, Y_1 reflects total credit, Y_2 is total investment/securitization, and Y_3 is operational income.

[14] explains that the calculation of the efficiency estimate is obtained from the estimated limit obtained from $CE_{kt} = exp\ (u_i)$. Therefore, the estimated cost efficiency

score will be in the range of values between 0 and 1 with a value close to 1 implying a higher level of efficiency.

3.2. Empirical Models

For examining the effect of Capital Regulations, Business Diversification, Market Supervision of Banks, and Board Remuneration on the Cost Efficiency, this study uses a dependent variable, which is bank cost efficiency, independent variables including Capital Adequacy Ratio (CAR), bank business diversification, market supervision at banks, and board remuneration, and control variables such as inflation and GDP as nation-level characteristics and bank ownership, company size, liquidity, and capitalization as company-level characteristics. The regression model used is as follows.

$$EFFICIENCY_{i,t} = \alpha_0 + \alpha_1 CAR + \alpha_2 DIV + \alpha_3 AUDIT + \alpha_4 REMUN + \alpha_5 INF + \alpha_6 PDB + \alpha_7 STATE + \alpha_8 SIZE + \alpha_9 LIQUID + \alpha_{10} CAPITAL + in_{it} \quad (2)$$

Table 1. Variable Operationalization

Dependent Variable	Description	References
Bank efficiency estimation score **(EFFICIENCY)**	The extent of bank cost efficiency, relative to best practice limits, in converting inputs into outputs	[5]
Independent Variable	**Description**	
Minimum capital requirements **(CAR)**	The capital adequacy ratio of RWA to cover the risk of loss that may be faced by the bank	[44]
Bank business diversification **(DIV)**	Portion of interest and non-interest income in the company's total operating income. The measurement method refers to Doan et al. (2018)	[13]
Market supervision at banks **(AUDIT)**	Dummy variable for (1) if audited by a "*Big 4*" auditor and (0) by the "*Non-Big 4*" auditor	[12]
Board Remuneration **(REMUN)**	Compensation/incentive programs by the company to the company Board	[45]
Variable Control	**Description**	
Inflation **(INF)**	Increase in the price of goods in general in a certain period	[14]
Nominal Gross Domestic Product **(PDB)**	The total added value of goods and services produced by various	[12]

	production units in an area within a certain period of time	
Bank ownership **(STATE)**	Dummy variable for (1) if owned by the state and (0) by private	[12]
Company size **(SIZE)**	Log total assets	[12, 1]
Liquidity **(LIQUID)**	Total loans to total deposits	[1]
Capitalization **(CAPITAL)**	Total equity to total assets	[1]

4. Analysis and Discussion

4.1. Descriptive Statistics

Cost Efficiency Estimation Score. Table 2 presents the cost efficiency scores of the sample study. Of the 770 observations, 468 observations (61%) had efficiency scores above the average, while the remaining 302 observations (39%) were below average. The lowest efficiency score was owned by Bank NTB Syariah in 2018 of 12.3%, while the highest score reached a perfect level of 100% obtained by 78 sample observations. Thus, in terms of performance per year, the average efficiency score was fluctuating throughout the 2013 - 2017 period, then continued to decline in the 2018 - 2021 that may be due to the pandemic period, then slightly increased in 2022.

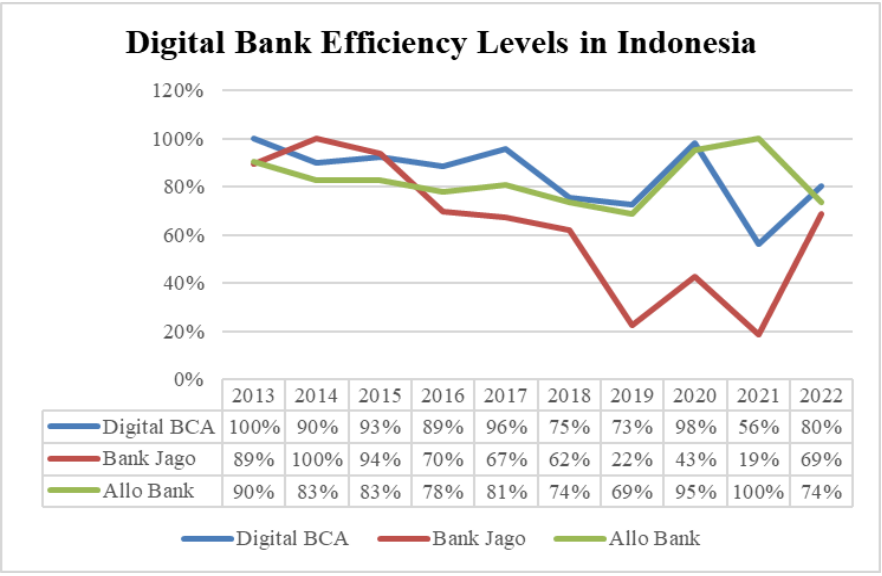
Table 2. Descriptive Statistics of Cost Efficiency Estimation Scores

Variable	Obs	Mean	Std. Dev	Min	Max
Overall Efficiency Score					
EFFICIENCY	770	0.814	0.168	0.123	1
Efficiency Score per Year					
2013	77	0.858	0.170	0.186	1
2014	77	0.842	0.163	0.207	1
2015	77	0.844	0.144	0.272	1
2016	77	0.830	0.133	0.350	1
2017	77	0.841	0.120	0.505	1
2018	77	0.826	0.145	0.123	1
2019	77	0.809	0.162	0.224	1
2020	77	0.776	0.179	0.159	1
2021	77	0.747	0.217	0.144	1
2022	77	0.764	0.191	0.175	1
Efficiency Score Based on Bank Ownership					
Government bank	284	0.843	0.162	0.123	1
Private bank	486	0.796	0.169	0.144	1

In terms of bank ownership, government banks have a greater efficiency score of 84.3% than private banks (79.6%), which is similar to the findings of [1] and [14]. [46] explains that state banks are contributors for nation development and welfare improvement. In this case, government-owned financial institutions have great power to regulate loan programs. Without intervention from the government, banks will not

allocate their funds to projects with the highest returns [46]. This can also be explained through the high NIM level owned by private banks. A high level of NIM indicates inefficiency in the financial intermediation process by banks [19]. [19] stated that banks that operate inefficiently will set large NIMs to compensate for losses due to high costs in supporting their operational activities. In 2021, the highest NIM in Indonesia is owned by Bank BTPN Syariah at 26.57%, then Bank Amar Indonesia at 11.8%, and third by Bank BPD Central Kalimantan at 7.83% [47]. Meanwhile, the state-owned bank with the largest NIM is owned by Bank BRI at 6.89%, very far from the NIM level in the first position. Then, when compared to NIM among Indonesian banks which have a core capital of over IDR 70 trillion, in 2022, Bank BCA occupies the second largest position at 5.3%, after Bank BRI is in first position which recorded a value of 6.8%. In the third and fourth positions are Bank Mandiri with a NIM of 5.16% and Bank BNI with 4.81%. Even though Bank BRI is the largest, in terms of growth, Bank BRI's NIM has decreased from the previous year. On the contrary, the value of Bank BCA's NIM in 2022 is an increase from before.

Another interesting fact is the digital banks' efficiency performance. There are three digital banks, namely Bank Jago, Bank Digital BCA, and Bank Allo Bank Indonesia in this study. Their transformation into digital form was not carried out from the start, but only started around 2020, depending on the policies and strategies of each company. Bank Jago started its digital transformation in 2020. Bank Digital BCA also transformed to digital in the same year, 2020, in line with the acquisition by the BCA Group of Bank Royal. Meanwhile, Bank Allo Bank Indonesia has just started its digitization process in 2021. The following is a graph of the efficiency level of each digital bank during the research period.



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Digital BCA	100%	90%	93%	89%	96%	75%	73%	98%	56%	80%
Bank Jago	89%	100%	94%	70%	67%	62%	22%	43%	19%	69%
Allo Bank	90%	83%	83%	78%	81%	74%	69%	95%	100%	74%

Fig. 2. Digital bank efficiency levels in Indonesia. Bank Jago's efficiency level shows an irreversible movement from others in 2019k, Allo Bank in 2021. Significant spikes occurred during the 2019–2022 period due to the need for adaptation in their transformation process. Bank Jago and Digital BCA began their transformation in 2020, Allo Bank Indonesia in 2021.

There is an interesting issue regarding the trend of movement in the digital bank efficiency score. All three showed an increase in efficiency values in the first year when the digitization process began (Bank Jago and Bank Digital BCA in 2020 and Bank Allo Bank Indonesia in 2021) and then dropped drastically the following year. Concerning the input side, digital banks have had very large growth in other operating expense components as well as total assets. Even in the second year after the digitization process began, all three banks had growth that could reach 1–5 times the previous year in these two components. This perhaps explains why the efficiency level of the three banks in the second period after the transformation was carried out both decreased. This also proves that the increase in total assets has a positive correlation with other operating expenses that are increasing. This finding agrees with [48] in which large banks have incentives to take riskier actions.

Furthermore, the large increase in other operating expenses was due to the business development to strengthen the platform of their digital services, such as for technology and information, promotions, and other administrative matters. In terms of output, loan and securitization rates have consistently increased at the three digital banks. Meanwhile, the operating income component fluctuated in the cases of Bank Jago and Bank Digital BCA, but consistently increased in Bank Allo Bank Indonesia.

These three components compensate for each other, thus forming an up or down movement of the efficiency score. In the case of Bank Jago, in 2020, the company recorded an operational loss. This means that the increase in Bank Jago's efficiency value in 2020 was caused by the increase in loans and securitization, which reached 2 and 6 times. Meanwhile, in the case of Bank Digital BCA, in 2020, the bank did not provide any loans at all, but the company managed to record an operating profit that increased 4 times. Even though the three output components at Bank Allo Bank Indonesia continue to increase, the decline in the efficiency score that occurs in 2022 can be explained by the high increase in input costs, which reached 1–3 times. That way, it can be concluded that the development of digital banks in Indonesia is currently still at an immature stage because it is still in the development process.

Statistics Descriptive of All Variables. Table 3 shows the descriptive statistics of the variables in this study. It shows that the average CAR of 26.7% indicates that the average commercial bank in Indonesia has complied with the capital regulations set by Bank Indonesia of at least 8%. In fact, with the smallest CAR value in the sample of 8%, it shows that most commercial banks in Indonesia have complied with Bank Indonesia's capital regulations.

Table 3. Descriptive Statistics of All Research Variables

Variable	Obs	Mean	Std. Dev	Min	Max
EFFICIENCY	770	0.814	0.168	0.123	1
CAR	770	0.267	0.347	0.080	8.209
DIV	770	0.245	0.258	-5.283	0.500
AUDIT	770	0.436	0.496	0	1
REMUN (million rupiah)	770	47,000	74,400	1,820	644,000
INF	770	0.042	0.023	0.017	0.084
PDB (millions USD)	770	$1,030	$137	$861	$1,320
STATE	770	0.369	0.483	0	1
SIZE (million rupiah)	770	84,300,000	221,000,000	470,000	1,990,000,000
LIQUID	770	0.918	0.528	0	9.607
CAPITAL	770	0.157	0.084	-0.008	0.692

Then, the average DIV is at 26.7%, which shows that the average Indonesian banking system is in the middle between perfectly diversified conditions (50%) and perfectly concentrated. On dummy variable AUDIT, the majority of commercial banks in the sample use non-Big 4 auditors with a portion of 56.36% (434 observations) compared to 43.64% (336 observations) using an Big 4 auditor. Furthermore, the REMUN variable shows that there is a very large deviation between

nominal remuneration in the banking industry in Indonesia. This can be explained by the unequal size among banks in Indonesia, which is shown in the SIZE variable. Then, the STATE variable shows that the majority of the research sample are private banks with a portion of 63.12% (486 observations), while state banks are only 36.88% (284 observations). The very small number in the LIKUID variable is due to the fact that in 2020, BCA Digital Bank will not provide loans at all. Meanwhile, the smallest value that reached negative in the CAPITAL due to the increase in the amount of losses transferred to Bank JP Morgan Indonesia in 2013, thus resulting in negative equity.

4.2. Regression Results

Table 4 gave the results of the regression. The CAR variable has a significant, but negative effect on bank efficiency. This finding is contrary to the results found by [12] and [1]. However, this finding agrees with the findings of [49, 44]. This negative influence can be explained in relation to management's attitude towards banking risk [50]. Within the dynamic model framework, CAR increases banking risk [51]. [52] found a positive association between changes in capital and risk. This can also be explained further through agency theory, *moral hazard*, and *signaling theory* [53]. In addition, this study found a negative effect of income diversification on cost efficiency. However, the impact is not significant. This finding might be related to the high ratio of expenses incurred [54] and the high-risk exposure to non-interest income [13].

Moreover, the effect of AUDIT variables that represent market supervision has a negative but insignificant impact on bank efficiency. This is contrary to the findings of [12], but agrees with [1] and [38]. This negative influence can be explained by the large commission charged by the Big 4 auditor in comparison to the non-Big 4 auditor [55, 56]. Additionally, board remuneration (REMUN) has a positive but insignificant effect on bank efficiency. This finding agrees with agency theory itself [15] and findings from [16]. However, this insignificant effect can be explained in terms of the centralized character of the ownership structure in Indonesia as well as poor governance and levels of corruption. The study of [57] conducted in Pakistan found that remuneration packages are not an effective tool for management there due to the excessive power of majority shareholders and the high level of corruption in the country.

Table 4. Regression Results and Robustness Check

Dependent Variable	
Independent Variable	**EFFICIENCY**
CAR	-0.7175088**
	(0.000)

DIV	-0.992696
	(0.171)
AUDITOR	-0.0359139
	(0.124)
REMUN	0.0052919
	(0.735)
Variable Control	
INF	0.1117657
	(0.631)
PDB	0.0230679
	(0.699)
STATE	-0.0282929
	(0.671)
SIZE	-0.0260932
	(0.285)
LIQUID	0.4805542**
	(0.000)
CAPITAL	0.2983722
	(0.353)
Observation	740
R-Square	29.02%
Correlation	-0.532
Prob>F	0.000

**Significant at 5%

The six control variables are classified into two types, namely those related to the characteristics of the country level (INF & GDP) and the company level (STATE, SIZE, LIQUID, & CAPITAL). Of the six control variables, there is only one control variable that has a significant influence, namely bank liquidity (LIKUID). The positive and significant effect of liquidity on cost efficiency indicates the necessity of banks as a financial intermediary institution in distributing credits. As liquidity is calculated by the ratio of total loans over total deposits, it means the higher the loans that banks distribute, the higher their liquidity, then the more improved their efficiency. However, the country-level characteristics had no significant effect on bank efficiency. This finding implies that cost efficiency is mostly affected by a firm-specific factor.

The INF variable has an insignificant positive impact on bank efficiency. This means the bank will be more efficient in an environment with high inflation. Higher inflation, higher real interest rates and GDP growth, and a smaller proportion of the unemployed indicates strong growth in the economy. This contrasts with the findings from [12], but agrees with [44]. Research from [58] also shows a positive

relationship, but with the dependent variable return on investment (ROA). Furthermore, the GDP variable has no significant positive effect on bank efficiency. This is similar to the findings of [12] that the bigger the market, the more efficient a bank is.

The STATE and SIZE variables both have an insignificant negative effect on bank efficiency. The STATE variable, which has a negative effect, indicates that government banks are not more efficient than private banks. This finding is different from what was produced in the descriptive statistics of the study. However, this agrees with what [59] did. [60] explained that state banks are governed by politicians who use banks as a tool to achieve their political and personal objectives. Then, the negative effect of the SIZE variable agrees with the findings from [1] and [30]. [48] stated that large banks have greater incentives to take riskier investments. Then, both the LIQUID and KAPITAL variables have a favorable effect on EFFICIENCY, but only the LIQUID variable is significant. This positive effect is consistent with the findings of [1]. However, contrary to this result, in that study, only the CAPITAL variable was significant, but not the LIQUID variable. The positive influence on KAPITAL confirms the arguments that state that capital functions as a banking buffer that protects banks from the possibility of bankruptcy. It also confirms the findings of [5] that high capitalization rates help reduce agency problems as well as provide incentives to oversee management performance and ensure that banks are operated efficiently.

4.3. Implication of the Findings

The negative and significant impact of CAR on cost efficiency indicates the existence of moral hazard behavior in the Indonesian banking industry. It is also proven by the upward trend of average BOPO ratio (Operating Cost to Operating Revenue) during the period of 2013–2022. This finding emphasizes the need for regulators to examine further the Indonesian banking sector governance and make an evaluation concerning the existing regulation on banking capital management, especially in the risk-taking behavior context.

Secondly, the negative impact of income diversification on cost efficiency implies that the strategy is not appropriate to boost bank efficiency. Currently, the Indonesian banking sector should switch their diversification strategy toward funding diversification, as suggested by [30]. With the current trend in the banking sector that is characterized by intense competition and rapid globalization, banking consolidation through merger and acquisition to increase capacity scale has become a trend. A diversified source of funding allows banking companies to easily choose the better sources to be taken, so that they can be an actor in the banking consolidation process. In addition, intense competition among banks and any similar financial companies makes specialization become a cheaper choice in terms of the cost.

Thirdly, the negative and insignificant impact of the use of Big 4 auditors on cost efficiency underscores that the status or the category of the auditor is not a significant attribute to the assessment of information quality produced by the bank. The rapid globalization and intense competition have forced audit companies to become excellent in this area. Then, in terms of the quality, the status of auditor became less important gradually. So, for the Indonesian banking company, they should be more aware and pay attention to the quality service of the audit company than their status.

Lastly, the insignificant and positive impact of board remuneration on cost efficiency emphasizes the importance of remuneration to overcome agency problems in the company as [15] stated. However, the insignificant impact indicates that in Indonesia board remuneration is not the only way to boost bank cost efficiency. An Indonesia company categorized as a family-owned company that has significant control can appropriate minority shareholders through any form of entrenchment. Since they have wider authority, they do not choose Board members based on competencies, instead on how their interest is secured. Because of that, the amount of remuneration will not significantly impact company performance. The Board govern following the direction of majority shareholder interest. So, this finding underscores the importance of remuneration, but it should be calculated well before.

5. Conclusions and Policy Recommendations

This study analyzes how bank regulations and board remuneration affect commercial banks' cost efficiency in Indonesia in the period of 2013–2022. Three dimensions of banking regulations were examined, namely minimum capital requirements, bank business diversification, and market supervision to the bank through the use of Big 4 auditors. This study found CAR has a negative and significant effect on bank cost efficiency. This finding can be explained through its relation to an increase in banking risks as a cause of the moral hazard action by management. Interestingly, bank business diversification had a negative relationship on cost efficiency with no significant effect. It can be explained due to the non-interest income's high ratio of expenses and its volatility to risk. Third, although insignificant, the use of Big 4 auditors reduces bank cost efficiency. High service charges by the Big 4 auditor may explain that relationship. Finally, the Board's remuneration mechanism has proven to have a non-significant positive effect on bank efficiency. This insignificance effect can also occur because of its relation to the centralized ownership structure in Indonesia and the higher level of corruption.

The findings in this study can become the basis for bank management to improve their efficiency and for regulators (OJK and BI) to create a legal environment that ensures more efficient banking in Indonesia. Among the efforts that can be carried out jointly by the two are governance reforms and improvement of the legal and corruption environment. With better governance and supported by a fair legal

environment and reduced levels of corruption, it is hoped that banks will be able to operate more efficiently, so as to be able to realize the goals of banking in Indonesia as one of the driving forces of the country's economy.

For further studies, some variables can be considered, especially related to the bank risk and management behavior toward risk as CAR and DIV show a negative relationship to efficiency. Other than that, extending the sample size may solve those problems. This study only uses Indonesian commercial banks as the sample. Other countries' commercial banks can be included in this area of study. Thus, a more comprehensive analysis can be conducted by comparing each country's commercial banks efficiency to others.

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