

Determinants of Profitability in State-Owned and Privately-Owned Banks in Indonesia: The Role of Credit Risk, Liquidity Risk, Operational Efficiency, and Green Banking

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Keywords:	Abstract
Credit Risk; Liquidity Risk; Operational Efficiency; Green Banking; Profitability	This research examines the effects of credit risk, liquidity risk, operational efficiency, and green banking on the profitability of state-owned (Badan Usaha Milik Negara or BUMN) and privately owned national (Badan Usaha Milik Swasta or BUMS) commercial banks listed on the Indonesia Stock Exchange during the 2020–2024 period. Credit risk is measured using the Non-Performing Loan (NPL) ratio, liquidity risk is measured using the Loan-to-Deposit Ratio (LDR), operational efficiency is measured using the Operating Expenses to Operating Income (BOPO) ratio, and green banking is measured based on the level of sustainable banking implementation, while profitability is proxied by the Net Interest Margin (NIM). This quantitative descriptive-verification study uses secondary data obtained from annual reports and audited financial statements. The sample consists of 14 banks selected through purposive sampling during the 2020–2024 period, resulting in 70 panel observations analyzed using panel data regression with EViews 9. The Random Effects Model (REM) was selected as the most appropriate model based on the Chow, Hausman, and Lagrange Multiplier tests and fulfilled the requirements of classical assumption testing. The results show that NPL has a negative and significant effect on NIM, whereas LDR has a positive and significant effect. Conversely, BOPO and green banking have no significant effect on NIM. Simultaneously, the four independent variables do not have a significant effect on profitability, with an Adjusted R² value of only 6.84 percent. State-owned banks also outperformed privately owned banks across all six indicators examined. These findings indicate that effective credit risk and liquidity management remain key determinants of banking profitability, while the benefits of green banking are more likely to emerge over the long term. The findings provide valuable insights for bank management, regulators, and future researchers.

INTRODUCTION

In the theoretical framework of financial economics, banks are strategic intermediary institutions that connect parties with surplus funds to parties requiring financing (Aramonte et al., 2022; Muriithi, 2024; Rejekiningsih et al., 2022; Trapanese & Lanotte, 2023). During the 2020–2024 period, Indonesia's banking industry faced increasingly complex challenges due to heightened global economic uncertainty, shifts in monetary policy, rapid digital technology development, and intensifying competition among financial institutions. The IMF (2024)

reported that global economic growth slowed due to persistently high inflation and restrictive monetary policies implemented by many countries. The resulting increase in policy interest rates raised banks' funding costs and affected credit demand. Bank Indonesia (2024) noted that domestic financial system stability remained resilient, although external risks arising from global economic deceleration and elevated international interest rates continued to require close monitoring. In addition, the conclusion of the credit restructuring program, which had previously supported financial sector stability, required banks to strengthen credit risk management and adopt more selective lending practices to maintain asset quality and profitability (Avickson et al., 2024; Ayieko, 2025; Luong, 2024; Mayasari et al., 2022; Nwachukwu, 2024; Susanti & Lutfi, 2026).

Beyond macroeconomic conditions, Indonesia's banking industry also faced intensifying competition, not only among conventional banks but also from financial technology companies, digital banks, and other non-bank financial institutions offering faster and more flexible financial services (OJK, 2024). This condition encouraged banks to improve service quality, strengthen product innovation, and undertake business transformation to maintain market share, with competitive advantage increasingly determined by operational efficiency and technology adoption rather than asset size alone. OJK data indicate that the gross NPL ratio of Indonesia's banking industry decreased from 3.12% at the end of 2019 to 3.06% in 2020 and continued declining to 2.08% for Badan Usaha Milik Negara (BUMN) banks by 2024 (OJK, 2022). A similar declining trend occurred among private banks, with the gross NPL ratio decreasing from 1.89% in 2019 to 0.74% in 2024.

Liquidity pressure also affected the Loan-to-Deposit Ratio (LDR), which was influenced by monetary policy conditions and liquidity management strategies, while operational efficiency became an additional challenge amid increasing digitalization-related costs (OJK, 2023).

The social mandate of BUMN banks and their expansion into the micro, small, and medium enterprise (MSME) segment placed them at relatively higher credit risk, reaching approximately 2% throughout the pandemic period. In contrast, privately owned national banks faced more diverse challenges depending on market segmentation and ownership structures. Corporate- and premium-retail-oriented private banks maintained credit quality through stricter lending selection but remained exposed to more volatile institutional customer behavior. Several medium-sized private banks recorded ROA below 1.5% during 2020–2021, which was below the regulator's healthy threshold (OJK, 2021). This divergence reflects fundamental differences in business models, risk tolerance, and shock absorption capacity between the two banking groups (Firdaus & Ariyanti, 2021), reinforcing the argument that profitability analysis should not treat BUMN and Badan Usaha Milik Swasta (BUMS) banks as a single homogeneous sample.

Profitability is a primary indicator of a firm's financial performance because it reflects the ability to generate earnings from available resources. In the banking sector, profitability is commonly assessed using Return on Assets (ROA) and Net Interest Margin (NIM). Indonesian Banking Statistics indicate that the national banking industry's average ROA declined significantly from 2.7% in 2019 to 1.59% in 2020, representing the largest decline in a decade, before gradually recovering to 1.85% in 2022 and 2.45% in 2023 (OJK, 2023). Meanwhile, private banks' average ROA decreased from 1.83% in 2019 to 1.54% in 2020

before recovering to 1.97% in 2022 and 2.04% in 2023. However, this recovery was uneven. BUMN banks demonstrated greater resilience due to stronger capital structures and government policy support, whereas several medium-sized private banks continued to face challenges related to elevated NPL levels and unresolved operational inefficiencies.

These structural differences suggest that BUMN and BUMS banks may exhibit different profitability patterns, further influenced by Bank Indonesia's interest rate normalization policy, which increased funding costs and placed pressure on interest margins. Therefore, further research is needed to examine the determinants of profitability during the 2020–2024 period, particularly focusing on credit risk, liquidity risk, operational efficiency, and green banking implementation as variables closely associated with banks' ability to generate sustainable profits.

Credit risk, defined as the potential loss arising from a debtor's inability to fulfill contractual obligations, represents one of the primary risks faced by banks because lending remains their core intermediation activity. Credit risk is commonly measured using the Non-Performing Loan (NPL) ratio, where a higher NPL ratio indicates lower asset quality. The year 2024 was particularly significant because it marked the end of the credit restructuring policy under POJK No. 11/POJK.03/2020, which had allowed restructured loans to remain classified as performing loans during the pandemic period. The conclusion of this policy exposed banks to renewed risks of increasing non-performing loans, compounded by ongoing global economic uncertainty and interest rate fluctuations. Putri and Pardede (2023) found that NPL had a negative and significant effect on bank profitability in Indonesia. This finding was supported by Liana et al. (2025), who concluded that asset quality is an important determinant of profitability among banks listed on the Indonesia Stock Exchange.

Liquidity risk refers to the risk arising from a bank's inability to fulfill short-term obligations, including customer withdrawal demands, without disrupting financial stability. This risk is commonly proxied by the Loan-to-Deposit Ratio (LDR). A low LDR indicates underutilized intermediation capacity and reduced potential interest income, whereas an excessively high LDR indicates that most collected funds have been distributed as credit, increasing liquidity risk when withdrawal demands rise. Kasmir (2019) defines LDR as an indicator of a bank's ability to manage lending activities using third-party funds collected from the public. Bank Indonesia (2024) emphasized that changing interest rate conditions and global uncertainty require banks to strengthen liquidity risk management to maintain financial system stability. Putri and Pardede (2023) found that LDR affects bank profitability, while Winarno and Atiningsih (2023) similarly concluded that effective liquidity management supports profitability through optimized financial intermediation.

Operational efficiency, commonly measured using the Operating Expenses to Operating Income (BOPO) ratio, represents another fundamental determinant of sustainable bank profitability. A lower BOPO ratio indicates higher operational efficiency and better cost management. Bank Indonesia Circular Letter No. 13/24/DPNP of 2011 identifies BOPO as an important indicator of bank soundness. The rapid expansion of mobile and digital banking during 2020–2024 required substantial investments in information technology infrastructure, cybersecurity, application development, and human resource capabilities. These investments temporarily increased operating costs, although digital transformation was intended to improve service quality and competitiveness in the long term. Putri and Pardede (2023) found

that BOPO had a negative and significant effect on the profitability of conventional commercial banks. This finding is consistent with Winarno and Atiningsih (2023) and Liana et al. (2025), who identified operational efficiency as a consistent determinant of banking financial performance.

The banking industry is increasingly expected to contribute to sustainable development through sustainable finance principles, leading to the emergence of the green banking concept. Green banking encompasses not only financing environmentally friendly projects but also improving internal operational efficiency, reducing resource consumption, and integrating sustainability considerations into business decision-making processes. Indonesia's commitment to sustainable finance is reflected in the OJK Sustainable Finance Roadmap Phase II (2021–2025), which guides the financial services sector in integrating environmental, social, and governance (ESG) aspects into business activities and investment decisions, while supporting initiatives such as the Indonesia Green Taxonomy and strengthened climate risk governance.

Prior studies on the determinants of bank profitability, particularly when measured using Return on Assets (ROA), have produced inconsistent findings. Chairul Adhim and Mulyati (2024) and Savira Ananda et al. (2025) found that higher Non-Performing Loans (NPL) reduce bank profitability, whereas other studies reported that the relationship between NPL and profitability becomes insignificant after considering effective risk management and loan-loss provisioning. These inconsistencies indicate that the relationship between credit risk and profitability requires further investigation. Existing research also has several limitations. First, most previous studies have focused primarily on conventional financial variables, such as Capital Adequacy Ratio (CAR), NPL, Loan-to-Deposit Ratio (LDR), Net Interest Margin (NIM), and Operating Expenses to Operating Income (BOPO), while sustainability-related aspects, such as green banking, remain relatively underexplored despite their increasing strategic importance in modern banking. Second, previous studies generally examine variables partially or in limited combinations. For example, Chairul Adhim and Mulyati (2024) examined only CAR, NPL, LDR, and BOPO without incorporating green banking, whereas Dina Khairuna Siregar et al. (2025) examined only green banking and BOPO without considering credit risk and liquidity risk. Third, most previous studies have focused on a single bank category, such as KBMI banks, Badan Usaha Milik Negara (BUMN) banks, or all banks listed on the Indonesia Stock Exchange, without comparing the characteristics of BUMN and Badan Usaha Milik Swasta (BUMS) banks, despite differences in capital structure, market share, business strategies, and sustainability capabilities. Fourth, much of the existing research was conducted before sustainability issues gained greater attention and before the implementation of the OJK Sustainable Finance Roadmap Phase II (2021–2025), limiting its relevance in the current era of digital transformation and sustainable finance.

This study therefore contributes novelty by simultaneously examining the effects of credit risk (proxied by NPL), liquidity risk (proxied by LDR), operational efficiency (proxied by BOPO), and green banking on bank profitability (proxied by ROA and NIM) among both BUMN and BUMS banks during the 2020–2024 period. This approach is expected to provide more comprehensive empirical evidence regarding the determinants of Indonesian banking profitability while enriching the literature on the integration of financial risk management and sustainability practices in the banking sector. Methodologically, many previous studies have

relied on basic regression approaches without adequately addressing panel data issues, such as endogeneity, heteroscedasticity, and cross-sectional dependence. Therefore, the application of more robust estimation methods is important to produce accurate and reliable empirical findings.

Based on the background described above, this study addresses the following research questions: (1) Does credit risk significantly affect the profitability of BUMN and BUMS banks in Indonesia during the 2020–2024 period? (2) Does liquidity risk significantly affect bank profitability? (3) Does operational efficiency significantly affect bank profitability? (4) Does green banking significantly affect bank profitability? (5) Do credit risk, liquidity risk, operational efficiency, and green banking simultaneously affect bank profitability? (6) Which group, BUMN or BUMS banks, demonstrates better overall performance during the research period?

This research aims to analyze and examine the effects of credit risk, liquidity risk, operational efficiency, and green banking implementation on the profitability of state-owned and privately owned banks in Indonesia during the 2020–2024 period, both partially and simultaneously, as well as to compare the performance of the two bank groups. This research is expected to provide both theoretical and practical contributions. Theoretically, this study enriches the fields of financial management and banking, particularly regarding the determinants of bank profitability by integrating conventional financial variables (credit risk, liquidity risk, and operational efficiency) and sustainability variables (green banking) into a single empirical model. In addition, this study provides empirical evidence regarding differences in performance between state-owned banks and BUMS banks in Indonesia. Practically, this study provides insights for bank management in improving credit and liquidity risk management to enhance profitability, serves as a reference for regulators, including the OJK and Bank Indonesia, in developing banking policies that support financial-sector stability and sustainability, and provides a foundation for future researchers to develop more comprehensive banking profitability models by considering additional factors beyond the financial variables examined in this study.

METHOD

Research Design and Approach

The research design provided a systematic framework for conducting the research process in accordance with the study objectives. This study employed a quantitative approach because it focused on analyzing numerical data using statistical methods to examine the relationships and effects among variables objectively and measurably (Creswell, 2018). The research design used was descriptive-verificative, which aimed to describe the characteristics of the observed variables and test hypotheses developed based on existing theories and previous findings (Sugiyono, 2021). The verificative approach was applied to examine the effects of credit risk, liquidity risk, operational efficiency, and green banking on bank profitability through statistical hypothesis testing.

Location, Time, and Unit of Analysis

This research was conducted on banking companies listed on the Indonesia Stock Exchange (IDX). The research was not conducted directly at the physical location of each company but through the collection and processing of secondary data obtained from

published financial statements available on the official IDX and OJK websites. The observation period covers 2019–2024. The unit of analysis is the annual financial statements of BUMN banks and a number of private banks over the 2020–2024 period, obtained from annual reports, official publications, and the OJK website. To analyze the relationships among variables, this study applies panel data regression analysis. Ghozali (2020) states that multiple linear regression is a statistical technique used to determine the extent to which several independent variables affect a single dependent variable, either simultaneously or partially. This design is expected to provide a comprehensive understanding of the relationship between credit risk, liquidity risk, operational efficiency, and green banking on the profitability of banking companies, and to contribute to the development of research in finance, particularly risk management and financial performance in Indonesia's banking industry.

Population and Sample

The population in this study consists of BUMN and private banking companies listed on and supervised by the Indonesia Stock Exchange during the 2020–2024 research period, totaling 45 banks (4 BUMN banks and 35 private banks, with the remainder consisting of regional development banks and other banks). This sector was selected for its suitability in testing the effect of profitability on credit risk, liquidity risk, operational efficiency, and green banking.

The sample was determined using purposive sampling, i.e., sampling based on specific criteria aligned with the research objectives. The sample-selection process is presented in Table 1.

Table 1. Sample Selection Process

No.	Criteria	Number of Companies
1.	Banking companies listed on the Indonesia Stock Exchange (IDX)	45
2.	Banking companies that did not publish complete financial statements throughout the 2020–2024 research period or had not yet listed within that period	(2)
3.	Banking companies with incomplete data on the research variables (credit risk, liquidity risk, operational efficiency, and profitability)	(15)
4.	Banking companies that experienced delisting or cessation of operations during the research period	(14)
	Total sample companies	14
	Total sample (panel observations)	14 × 5 years = 70

Source: Processed by the Researcher, 2026

Data Types, Sources, and Collection Technique

This study uses secondary data, i.e., data obtained indirectly through already-available sources. Secondary data were selected because this study relies on published and standardized financial information. Data were sourced from the IDX, which provides comprehensive and consistent corporate financial data, comprising the annual financial statements of banking-sector companies listed on the IDX during 2019–2024. Data were collected through documentary study by gathering secondary data sourced from company

financial statements available on the IDX website. This technique was chosen because the study does not involve direct respondents but instead analyzes historical financial data to test the relationships among variables quantitatively.

Data Analysis Technique

This study applies a quantitative method using panel data regression, supported by the Chow test, Hausman test, and LM test, processed using EViews 9.

Panel Data Regression Model

Panel data regression was chosen because the data combine a cross-sectional dimension (14 banks) with a time-series dimension (2020–2024), providing more complete information than either data type alone. Because profitability is measured using two indicators (ROA and NIM), two separate panel data regression models were constructed. All analytical stages—model selection, classical assumption testing, and hypothesis testing—were applied to both models; the model that satisfied all testing stages was used as the basis for discussion and conclusions, while the other model's results are presented as supporting information only. The general panel regression equation used is:

$$Y_{it} = \alpha + \beta_1 NPL_{it} + \beta_2 LDR_{it} + \beta_3 BOPO_{it} + \beta_4 GB_{it} + e_{it}$$

where Y represents profitability (ROA or NIM); α is the constant; β is the regression coefficient; NPL is credit risk; LDR is liquidity risk; BOPO is operational efficiency; GB is green banking; e is the standard error; and it denotes the cross-section (i) and time period (t).

Panel Data Model Theory

Model Selection

The choice among CEM, FEM, and REM is based on the Chow test, the Hausman test, and the Lagrange Multiplier (LM) test. The Chow test determines whether CEM or FEM is more appropriate; if FEM is selected, the Hausman test is then used to choose between FEM and REM. The LM test is used to choose between CEM and REM when the Chow test favors CEM, or as a final confirmation step for REM versus CEM.

Classical Assumption Tests

Hypothesis Testing

RESULTS AND DISCUSSION

Descriptive Statistics

Profitability

Profitability is a key indicator of banking financial performance because it reflects a bank's ability to generate profit from its assets and productive activities. In this study, profitability is measured using two indicators, ROA and NIM, to provide a more comprehensive picture of banks' ability to generate returns from total assets and to manage net interest income effectively.

Table 2. Descriptive Statistics of Profitability, BUMN and BUMS Banks in Indonesia, 2020–2024

Variable	Mean	Maximum	Minimum	Std. Dev.
ROA	1.941	6.030	0.270	1.218
NIM	4.867	8.240	1.360	1.319

Source: Processed Data, 2026

Based on Table 2, ROA has a mean of 1.94%, a minimum of 0.27%, and a maximum of 6.03%, indicating that the sampled banks generated profit averaging around 1.94% of total assets during the research period. The standard deviation of 1.21% indicates a fairly wide dispersion in profitability across banks. NIM has a mean of 4.86%, a minimum of 1.36%, and a maximum of 8.24%, indicating that banks generally earned reasonably strong net interest income from their productive assets; the standard deviation of 1.31% likewise indicates variation in efficiency across banks in generating net interest income. Overall, the average ROA and NIM values indicate that Indonesia's banking industry remained relatively healthy in generating profit and managing productive assets during the research period, although differing characteristics between BUMN and private banks may still produce divergent profitability patterns.

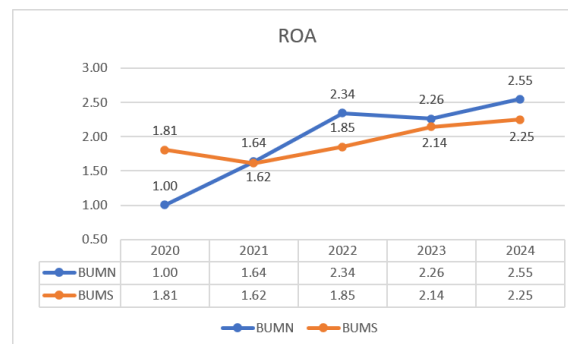


Figure 1. Comparison of ROA between BUMN and BUMS Banks in Indonesia, 2020–2024

Source: Processed Data, 2026

BUMN bank ROA generally trended upward, from 1.00% in 2020 to 2.55% in 2024, despite a slight dip in 2023 (2.26%), reflecting increasingly efficient asset utilization over time. BUMS bank ROA also trended upward, from 1.81% in 2020 to 2.25% in 2024, but more erratically, including a decline in 2021 (1.62%) before recovering in subsequent years. BUMS ROA was higher at the start of the period (2020), but from 2022 onward BUMN ROA tended to match or exceed BUMS, indicating that BUMN banks strengthened their asset-management effectiveness more consistently in the latter part of the period.

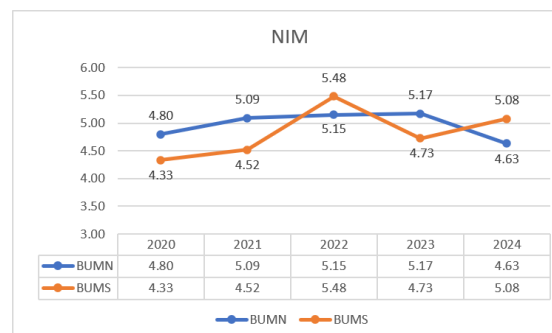


Figure 2. Comparison of NIM between BUMN and BUMS Banks in Indonesia, 2020–2024

Source: Processed Data, 2026

BUMN bank NIM rose from 4.80% in 2020 to 5.17% in 2023, before falling to 4.63% in 2024, indicating margin strengthening through 2023 followed by pressure in the final year. BUMS bank NIM was more volatile but trended upward overall, rising from 4.33% in 2020

to 5.48% in 2022, falling to 4.73% in 2023, and recovering to 5.08% in 2024—reflecting a more dynamic, market-responsive management of net interest income. BUMS NIM exceeded BUMN NIM in 2022 and 2024, suggesting that private banks were, at those points, more efficient at generating interest income relative to their productive assets.

Credit Risk

Credit risk in banking research is most commonly measured using the Non-Performing Loan (NPL) ratio, which shows the proportion of problem loans to total loans disbursed; a higher NPL indicates greater credit risk.

Table 3. Descriptive Statistics of Credit Risk, BUMN and BUMS Banks in Indonesia, 2020–2024

Variable	Mean	Maximum	Minimum	Std. Dev.
NPL	1.256	2.850	0.120	0.731

Source: Processed Data, 2026

NPL has a mean of 1.25%, a maximum of 2.85%, and a minimum of 0.12%, indicating that the average level of non-performing loans among sampled BUMN and BUMS banks during 2020–2024 was well below the 5% regulatory threshold, reflecting generally sound credit quality. The standard deviation of 0.73%, smaller than the mean, indicates relatively low dispersion, meaning credit risk was fairly stable and homogeneous across banks. Overall, controlled and relatively low credit risk during this period suggests that BUMN and BUMS banks maintained productive-asset quality through sound credit-risk management, which is expected to support profitability by reducing the need for loan-loss provisioning.

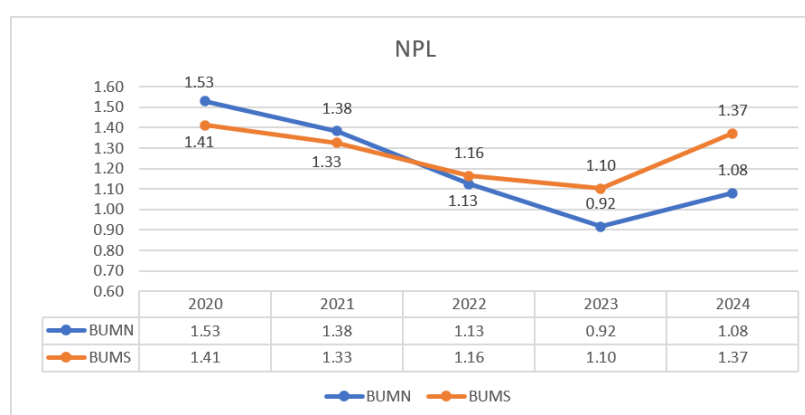


Figure 3. Comparison of NPL between BUMN and BUMS Banks in Indonesia, 2020–2024

Source: Processed Data, 2026

NPL at BUMN banks declined consecutively from 1.53% in 2020 to 1.38% in 2021, 1.13% in 2022, and a low of 0.92% in 2023, before rising again to 1.08% in 2024—still well below the 5% regulatory threshold. BUMS bank NPL followed a similar pattern, falling from 1.41% in 2020 to 1.33% in 2021, 1.16% in 2022, and 1.10% in 2023, before rising more sharply to 1.37% in 2024. In 2020–2021, BUMN NPL was higher than BUMS; from 2022 onward this reversed, with BUMN maintaining lower NPL than BUMS through the end of the period, indicating BUMN banks' improved credit-risk management from 2022 onward. Overall, both groups remained below the 5% threshold throughout 2020–2024, indicating that despite the 2024 uptick, credit risk in Indonesian banking remained relatively well controlled.

Liquidity Risk

Liquidity risk arises from a bank's inability to meet maturing short-term obligations, whether due to limited funds or an inability to convert assets to cash without significant loss. This study proxies liquidity risk using the Loan to Deposit Ratio (LDR).

Table 4. Descriptive Statistics of Liquidity Risk, BUMN and BUMS Banks in Indonesia, 2020–2024

Variable	Mean	Maximum	Minimum	Std. Dev.
LDR	80.558	142.680	40.070	18.901

Source: Processed Data, 2026

LDR has a mean of 80.55%, a maximum of 142.68%, and a minimum of 40.07%, indicating that on average BUMN and BUMS banks channeled 80.55% of collected third-party funds into credit—suggesting reasonably sound intermediation with some remaining liquidity buffer for short-term obligations. The standard deviation of 18.90%, smaller than the mean, indicates moderate dispersion; while liquidity levels vary across banks, differences generally remained within a reasonable range. The wide range (40.07%–142.68%) indicates differing liquidity-management strategies, from conservative to more aggressive lending approaches, making LDR an important variable in analyzing the effect of liquidity risk on ROA and NIM.

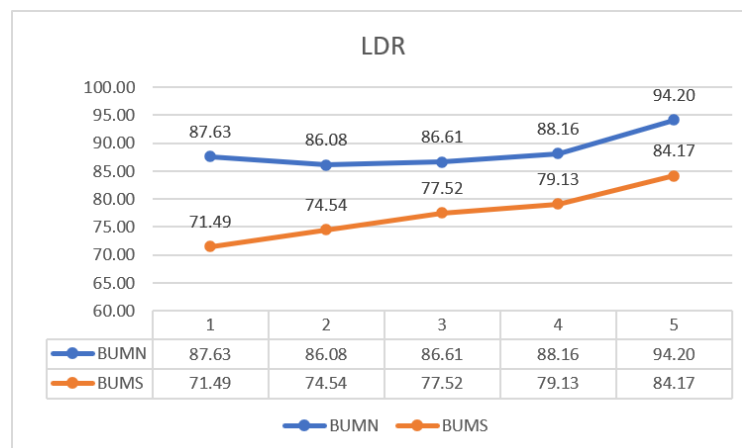


Figure 4. Comparison of LDR between BUMN and BUMS Banks in Indonesia, 2020–2024

Source: Processed Data, 2026

BUMN bank LDR was 87.63% in 2020, dipped slightly to 86.08% in 2021, then rose to 86.61% in 2022, 88.16% in 2023, and 94.20% in 2024, indicating increasing credit disbursement relative to third-party funds and progressively more optimal intermediation, though requiring careful liquidity management to keep risk controlled. BUMS bank LDR rose more steadily, from 71.49% in 2020 to 74.54% in 2021, 77.52% in 2022, 79.13% in 2023, and 84.17% in 2024, reflecting a gradual increase in credit disbursement relative to funds collected. BUMN LDR was consistently higher than BUMS throughout 2020–2024, indicating a more aggressive lending posture; the gap narrowed from roughly 16.14 percentage points in 2020 (87.63% vs. 71.49%) to about 10.03 points in 2024 (94.20% vs. 84.17%), showing that BUMS banks gradually expanded their intermediation capacity.

Although BUMN LDR approached 95% in 2024, this still reflects an ability to optimize credit disbursement for interest income generation.

Operational Efficiency

Operational efficiency is an important indicator of a bank's ability to manage resources to generate income optimally, commonly measured using the BOPO ratio, where a lower value indicates more efficient operational performance.

Table 5. Descriptive Statistics of Operational Efficiency, BUMN and BUMS Banks in Indonesia, 2020–2024

Variable	Mean	Maximum	Minimum	Std. Dev.
BOPO	75.983	119.340	41.700	13.828

Source: Processed Data, 2026

BOPO has a mean of 75.98%, a minimum of 41.70%, and a maximum of 119.34%, indicating that on average around 75.98% of operating income was used to cover operating expenses—a moderate level of operational efficiency. The standard deviation of 13.82% indicates fairly diverse efficiency levels across BUMN and BUMS banks, reflecting differing characteristics, business strategies, and cost-management effectiveness.

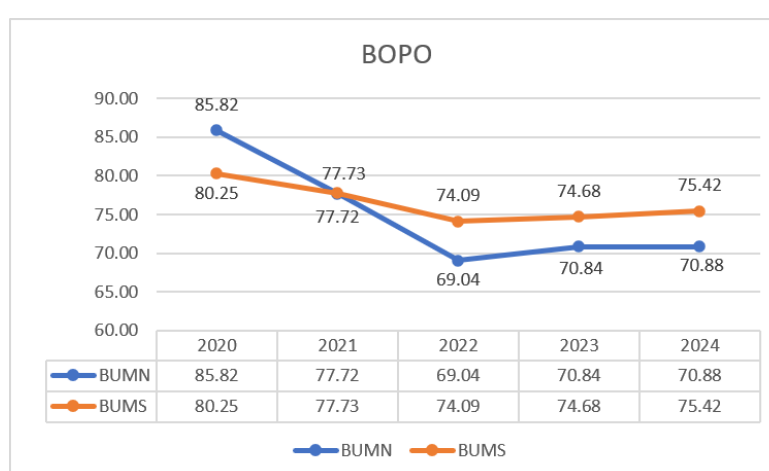


Figure 5. Comparison of BOPO between BUMN and BUMS Banks in Indonesia, 2020–2024

Source: Processed Data, 2026

BUMN bank BOPO fell from 85.82% in 2020 to 77.72% in 2021, then declined more sharply to 69.04% in 2022, before edging up slightly to 70.84% in 2023 and remaining broadly stable at 70.88% in 2024—indicating a growing ability to control operating expenses relative to operating income. BUMS bank BOPO was comparatively more stable, at 80.25% in 2020, rising slightly to 77.73% in 2021, 74.09% in 2022, 74.68% in 2023, and 75.42% in 2024—indicating largely stagnant but still reasonably efficient operational performance. BUMN banks generally showed better operational efficiency than BUMS across nearly the entire period, reflected in consistently lower BOPO; the gap was around 5.57 percentage points in 2020 (85.82% vs. 80.25%) but narrowed substantially in subsequent years, showing that BUMS efficiency began converging toward BUMN even as BUMN retained the advantage in controlling operating costs.

Green Banking

Green banking reflects a company's ability to conduct banking practices that consider not only financial return but also environmental and social impact; a higher level of implementation indicates a stronger sustainability commitment.

Table 6. Frequency Distribution of Green Banking, BUMN and BUMS Banks in Indonesia, 2020–2024

Green Banking	Frequency	Percentage (%)
Implements	35	50.0
Does Not Implement	35	50.0
Total	70	100.0

Source: Processed Data, 2026

Of the 70 bank-year observations, 35 (50.0%) reflect implementation of green banking and 35 (50.0%) reflect non-implementation, indicating an even split between banks that have and have not adopted green banking practices within this sample.

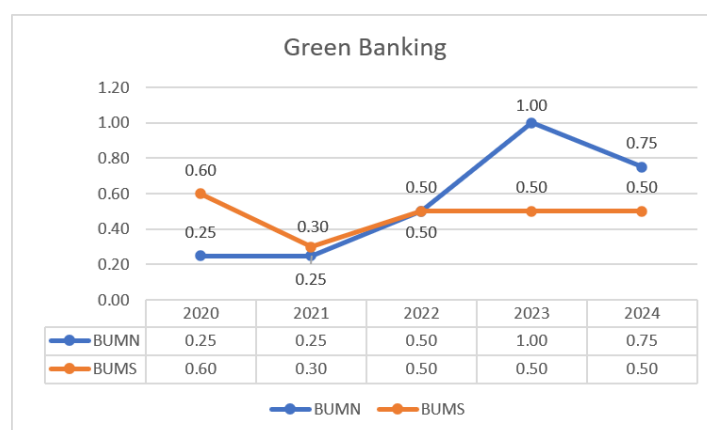


Figure 6. Comparison of Green Banking between BUMN and BUMS Banks in Indonesia, 2020–2024

Source: Processed Data, 2026

BUMN banks showed an increasing trend in green banking implementation: the index remained at 0.25 in both 2020 and 2021 (relatively low implementation), rose to 0.50 in 2022, and increased sharply to a period-high of 1.00 in 2023, before easing slightly to 0.75 in 2024—still higher than in earlier years—indicating a strengthening commitment to green banking principles with a modest adjustment in the final year. BUMS banks showed a more stable pattern: the index was 0.60 in 2020, fell to 0.30 in 2021, rose to 0.50 in 2022, and remained at 0.50 through 2024, indicating a fairly consistent but less rapidly improving level of implementation. BUMS held a higher green banking index than BUMN in 2020–2021; the two groups converged at 0.50 in 2022; and from 2023 onward BUMN surpassed BUMS by a considerable margin, a lead that was maintained (albeit slightly reduced) in 2024—indicating that in recent years BUMN banks have shown a stronger commitment to integrating sustainability principles into their operations.

Based on the descriptive analysis of each research variable, a comparative recap of BUMN and BUMS bank performance is presented in Table 7.

Table 7. Recapitulation of Performance Comparison between BUMN and BUMS Banks

No	Variable	BUMN	BUMS	Better-Performing Group
1	NPL (%)	1.21	1.28	BUMN
2	LDR (%)	88.53	77.37	BUMN
3	BOPO (%)	74.86	76.43	BUMN
4	Green Banking	0.55	0.48	BUMN
5	ROA (%)	1.96	1.93	BUMN
6	NIM (%)	4.97	4.83	BUMN

Source: Processed Data, 2026

The recap indicates that BUMN banks generally outperformed BUMS banks across all research variables—lower credit risk (NPL), more optimal liquidity management (LDR), higher operational efficiency (BOPO), relatively stronger green banking implementation, and higher profitability under both ROA and NIM. This suggests that during 2020–2024, BUMN banks were relatively more capable of managing risk, performing intermediation, controlling operating costs, implementing sustainable banking practices, and generating profit than BUMS banks.

Regression Analysis

Model Selection

Panel data regression was carried out using EViews software with two dependent variables, ROA and NIM, and four independent variables: credit risk, liquidity risk, operational efficiency, and green banking. Panel data was used because it combines the time-series and cross-sectional dimensions, producing more efficient estimation and better capturing the characteristics of each research object.

a. Chow Test

The Chow test is the initial step in panel data regression analysis, used to determine the more appropriate model between CEM and FEM by testing whether cross-sectional units have distinct characteristics requiring a fixed-effects specification. The hypotheses are H_0 : CEM is the most appropriate model; H_1 : FEM is the most appropriate model. If the Cross-section F probability > 0.05 , H_0 is accepted (CEM); if ≤ 0.05 , H_0 is rejected (FEM), and testing proceeds to the Hausman test.

Table 8. Chow Test Results

Effects Test	Statistic	d.f.	Prob.
Cross-section F	6.402643	(13,52)	0.0000
Cross-section Chi-square	66.903590	13	0.0000

Source: Processed Data, 2026

Table 8 shows a Cross-section F probability of $0.0000 \leq 0.05$, so H_0 is rejected; the selected model is FEM, and testing proceeds to the Hausman test.

b. Hausman Test

The Hausman test is conducted when the Chow test favors FEM, to determine the more appropriate model between FEM and REM by testing whether individual effects are

correlated with the independent variables. The hypotheses are H_0 : REM is the most appropriate model; H_1 : FEM is the most appropriate model. If the Cross-section Random probability ≤ 0.05 , H_0 is rejected (FEM); if > 0.05 , H_0 is accepted (REM).

Table 9. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	3.479053	4	0.4811

Source: Processed Data, 2026

Table 9 shows a Cross-section random probability of $0.4811 > 0.05$, so H_0 is accepted; the selected model is REM, and testing proceeds to the Lagrange Multiplier (LM) test.

c. Lagrange Multiplier (LM) Test

The Breusch-Pagan LM test determines the more appropriate model between CEM and REM by testing whether the random-effects specification provides better estimation results than the common-effects specification. The hypotheses are H_0 : CEM is the most appropriate model; H_1 : REM is the most appropriate model. If the cross-section Breusch-Pagan probability > 0.05 , H_0 is accepted (CEM); if ≤ 0.05 , H_0 is rejected (REM).

Table 10. Lagrange Multiplier Test Results

Test	Cross-section	Time	Both
Breusch-Pagan	30.80439 (0.0000)	0.291186 (0.5895)	31.09558 (0.0000)

Source: Processed Data, 2026

Table 10 shows a cross-section probability of $0.0000 \leq 0.05$, so H_0 is rejected; the selected model is REM. Based on the full model-selection process, the Random Effect Model (REM) is established as the best model for the panel data regression analysis.

Classical Assumption Tests

Before hypothesis testing, classical assumption tests were conducted on the selected REM specification, covering normality, multicollinearity, heteroskedasticity, and autocorrelation.

a. Normality Test

The normality test determines whether the regression residuals are normally distributed, using the Histogram-Normality Test in EViews together with the Jarque-Bera (JB) statistic and its probability. If Prob. Jarque-Bera > 0.05 , residuals are normally distributed (H_0 accepted); if ≤ 0.05 , they are not (H_0 rejected).

The Jarque-Bera probability obtained was 0.663, greater than the 0.05 significance level, indicating that the regression residuals are normally distributed and the normality assumption is satisfied.

b. Multicollinearity Test

The multicollinearity test determines whether high correlation exists among the independent variables, which could otherwise destabilize regression coefficients and impair the accuracy of interpretation. The model is considered free of multicollinearity if the correlation coefficient among independent variables is below 0.80.

Table 11. Multicollinearity Test Results (Correlation Matrix)

	NPL	LDR	BOPO	GB
NPL	1.000000	0.033000	-0.128000	0.106000
LDR	0.033000	1.000000	-0.087000	0.017000
BOPO	-0.128000	-0.087000	1.000000	0.272000
GB	0.106000	0.017000	0.272000	1.000000

Source: Processed Data, 2026

The correlation matrix shows that the highest correlation coefficient among the independent variables is 0.272 (between BOPO and GB), well below 0.80. This indicates that the regression model does not suffer from multicollinearity, and each independent variable contributes distinct information in explaining the dependent variable.

c. Heteroskedasticity Test

The heteroskedasticity test determines whether residual variance is constant across observations. A good regression model exhibits homoskedasticity. This study uses a scatter plot of standardized residuals against fitted values generated by EViews; the model is free of heteroskedasticity if the points are randomly scattered above and below the zero line without forming a discernible pattern.

The residual scatter plot shows points randomly distributed around the zero line without forming a cone, fan, or wave-shaped pattern, and residual variance remains relatively constant across observations. The regression model is therefore free of heteroskedasticity and satisfies the homoskedasticity assumption.

d. Autocorrelation Test

The autocorrelation test determines whether correlation exists between residuals across periods, which can render parameter estimates inefficient. This study uses the Durbin-Watson (DW) statistic from the EViews regression output; the model is free of autocorrelation if the DW statistic lies between dU and 4-dU. Based on the Durbin-Watson table at $\alpha = 5\%$, with 56 observations and $k = 4$, dL = 1.413 and dU = 1.724.

Table 12. Autocorrelation Test Results

Statistic	Value
Mean dependent var	1.791694
S.D. dependent var	0.932926
Sum squared resid	52.70534
Durbin-Watson stat	1.990408

Source: Processed Data, 2026

The Durbin-Watson statistic obtained is 1.990, which lies between dU and 4-dU ($1.724 \leq 1.990 \leq 2.276$). Based on this criterion, the regression model is free of autocorrelation and satisfies the requirement for further analysis.

Hypothesis Test Results

Once the best panel data regression model was determined and shown to satisfy the classical assumptions, hypothesis testing was carried out, covering the regression equation, the simultaneous test (F-test), the partial test (t-test), and the coefficient of determination (Adjusted R²).

a. Panel Regression Model

The regression equation estimates the relationship between the independent variables and Net Interest Margin (NIM), showing the direction and magnitude of the effect of credit risk, liquidity risk, operational efficiency, and green banking, holding other variables constant (*ceteris paribus*). Results are presented in Table 13.

Table 13. Panel Data Regression Results (Random Effect Model, Dependent Variable: NIM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.837445	1.294708	2.191571	0.0320
NPL	−0.451049	0.223590	−2.017301	0.0478
LDR	0.024833	0.010681	2.325024	0.0232
BOPO	0.009129	0.013468	0.677803	0.5003
GB	−0.196431	0.236757	−0.829674	0.4098

R-squared: 0.122371 Adjusted R-squared: 0.068363 F-statistic: 2.265799 Prob(F-statistic): 0.071545

Durbin-Watson stat: 1.990408

Source: Processed Data, 2026

Based on Table 13, the estimated regression equation is:

$$\text{NIM} = 2.837 - 0.451(\text{NPL}) + 0.025(\text{LDR}) + 0.009(\text{BOPO}) - 0.196(\text{GB}) + e$$

The constant of 2.837 indicates that if NPL, LDR, BOPO, and GB are held at zero, NIM is estimated at 2.837%. The NPL coefficient of −0.451 indicates that a 1-unit increase in credit risk decreases NIM by 0.451%, holding other variables constant. The LDR coefficient of 0.025 indicates that a 1-unit increase in liquidity risk increases NIM by 0.025%. The BOPO coefficient of 0.009 indicates that a 1-unit increase in BOPO increases NIM by 0.009%. The GB coefficient of −0.196 indicates that a 1-unit increase in green banking implementation decreases NIM by 0.196%. The term *e* represents the residual, capturing the effect of factors not included in the model.

b. Simultaneous Test (F-Test)

The simultaneous test determines whether NPL, LDR, BOPO, and GB jointly affect NIM. Table 13 shows an F-statistic of 2.266 with a probability of 0.072, greater than 0.05, so *H*₀ is accepted and *H*₁ is rejected. Credit risk, liquidity risk, operational efficiency, and green banking therefore do not simultaneously have a significant effect on NIM among the sampled banks.

c. Partial Test (t-Test)

Effect of Credit Risk (NPL) on NIM. NPL has a t-statistic of −2.017 and a probability of 0.0478, less than 0.05, so *H*₀ is rejected and *H*₁ is accepted: credit risk has a negative and significant effect on NIM—as NPL rises, NIM tends to decline.

Effect of Liquidity Risk (LDR) on NIM. LDR has a t-statistic of 2.325 and a probability of 0.023, less than 0.05, so H_0 is rejected and H_1 is accepted: liquidity risk has a positive and significant effect on NIM—as LDR rises, NIM tends to increase.

Effect of Operational Efficiency (BOPO) on NIM. BOPO has a t-statistic of 0.678 and a probability of 0.500, greater than 0.05, so H_0 is accepted and H_1 is rejected: operational efficiency does not have a significant effect on NIM.

Effect of Green Banking (GB) on NIM. GB has a t-statistic of -0.830 and a probability of 0.410, greater than 0.05, so H_0 is accepted and H_1 is rejected: green banking does not have a significant effect on NIM.

d. Coefficient of Determination

The Adjusted R-squared obtained is 0.0684, indicating that NPL, LDR, BOPO, and GB jointly explain 6.84% of the variation in NIM, while the remaining 93.16% is explained by other factors outside the research model.

Effect of Credit Risk, Liquidity Risk, Operational Efficiency, and Green Banking on Profitability

The simultaneous test shows that NPL, LDR, BOPO, and GB jointly have no significant effect on profitability (NIM), with an F-statistic of 2.266 ($p=0.072 > 0.05$). Although NPL and LDR are each significant individually, their combined explanatory power is weak—Adjusted R^2 is only 6.84%, meaning 93.16% of NIM variation is explained by factors outside the model, such as cost of funds, market interest rates, asset structure, third-party funding composition, fee-based income, and macroeconomic conditions. This suggests bank profitability depends on a broader range of internal and external factors beyond the variables studied, and that future research should incorporate variables more directly tied to NIM formation (e.g., CAR, DPK, COF, LLP, NIS, bank size, BI Rate, inflation, and economic growth).

Effect of Credit Risk on Profitability

NPL has a negative and significant effect on NIM (coefficient -0.451 , $p=0.048$), supporting the first hypothesis. Higher non-performing loans raise loan-loss provisions and collection costs while reducing potential interest income, compressing net interest margin. This aligns with Risk Management Theory and prior findings that credit risk significantly affects bank profitability and that credit-risk management is an important determinant of banking performance.

Effect of Liquidity Risk on Profitability

LDR has a positive and significant effect on NIM (coefficient 0.025, $p=0.023$): more optimal credit channeling increases interest income, provided lending stays within safe limits. This supports Commercial Loan Theory and is consistent with prior studies linking sound liquidity management to improved profitability and financial performance.

Effect of Operational Efficiency on Profitability

BOPO shows no significant effect on NIM (coefficient 0.009, $p=0.500$), suggesting NIM is more influenced by asset and interest-income management than by cost efficiency. This contrasts with several prior studies that found BOPO significantly affects profitability, possibly due to differences in profitability indicators, sample, or observation period.

Effect of Green Banking on Profitability

Green banking shows no significant effect on NIM (coefficient -0.196 , $p=0.410$), likely because its benefits—from digital investment, sustainable operations, and green financing—typically materialize over the longer term rather than immediately. This is consistent with prior findings that green banking's role lies more in building reputation and long-term sustainability than in generating short-term profit gains, though it contrasts with studies finding a positive effect of green credit, particularly among smaller banks.

CONCLUSION

Based on the analysis of credit risk, liquidity risk, operational efficiency, and green banking as determinants of profitability among Badan Usaha Milik Negara (BUMN) and Badan Usaha Milik Swasta (BUMS) banks in Indonesia during the 2020–2024 period, credit risk (NPL) was found to have a negative and significant effect on profitability (NIM). This finding indicates that an increase in non-performing loans reduces a bank's ability to generate net interest income. Meanwhile, liquidity risk (LDR) had a positive and significant effect, indicating that more optimal channeling of third-party funds into lending activities increases net interest income. Conversely, operational efficiency (BOPO) and green banking did not have a significant effect on NIM, suggesting that changes in operational costs and the implementation of sustainability practices had not yet produced measurable short-term improvements in net interest margins, with the benefits of green banking being more likely to emerge over the longer term. Simultaneously, credit risk, liquidity risk, operational efficiency, and green banking did not significantly affect profitability. The model explained only 6.84% of the variation in NIM (Adjusted $R^2 = 0.068363$), while the remaining 93.16% was explained by factors outside the model, such as cost of funds, productive asset structure, fee-based income, capital adequacy, interest rate policy, and macroeconomic conditions. BUMN banks were also found to outperform BUMS banks across all examined indicators, reflecting stronger risk management, financial intermediation, cost efficiency, and sustainability practices during the research period.

Given the model's limited explanatory power, future research should incorporate additional variables that are theoretically closer to the formation of Net Interest Margin, such as the Capital Adequacy Ratio (CAR), Third-Party Funds (TPF), Cost of Funds, Loan Loss Provision (LLP), Net Interest Spread, bank size, and macroeconomic indicators, including the BI Rate, inflation, and economic growth. These additions are expected to improve the model's ability to explain variations in banking profitability and provide more comprehensive insights for bank management and regulators. For bank management, it is recommended that credit risk monitoring be strengthened through the implementation of early warning systems, optimization of loan portfolio diversification, and improvement of loan restructuring policies to maintain NPL levels within acceptable limits. For regulators, it is recommended that incentive mechanisms be developed for banks that successfully maintain low NPL levels and optimal LDR ratios within prudential limits, while providing support for banks in the early stages of green banking adoption through technical assistance and appropriate regulatory incentives.

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