

Green banking, bank size, operational efficiency, and financial performance: Evidence from Indonesian Stock Exchange

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Abstract

This study aims to examine the effect of green banking, bank size, and operational efficiency on the financial performance of banks listed on the Indonesia Stock Exchange (IDX) from 2021 to 2023. A quantitative approach was employed using secondary data from annual reports. The sample was selected using a saturated sampling technique, yielding 16 private and national banks with a total of 48 observations (16 banks $\times$ 3 years). Data were analyzed using multiple linear regression with SPSS. The findings reveal that, in part, green banking has no significant effect on financial performance (ROA), whereas bank size and operational efficiency (BOPO) have significant effects.

Public interest statements

These results provide empirical insights into the effectiveness of green banking in emerging markets and highlight the dominant role of operational efficiency within the stakeholder theory framework.

Keywords: Green banking, company size, operational efficiency; financial performance

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Abstrak

Studi ini bertujuan untuk meneliti pengaruh perbankan hijau, ukuran bank, dan efisiensi operasional terhadap kinerja keuangan bank-bank yang terdaftar di Bursa Efek Indonesia (IDX) dari tahun 2021 hingga 2023. Pendekatan kuantitatif digunakan dengan menggunakan data sekunder dari laporan tahunan. Sampel dipilih menggunakan teknik sampling jenuh, menghasilkan 16 bank swasta dan nasional dengan total 48 observasi (16 bank $\times$ 3 tahun). Data dianalisis menggunakan regresi linier berganda dengan SPSS. Hasil penelitian menunjukkan bahwa, sebagian, perbankan hijau tidak berpengaruh signifikan terhadap kinerja keuangan (ROA), sedangkan ukuran bank dan efisiensi operasional (BOPO) berpengaruh signifikan.

Pernyataan kepentingan publik

Hasil ini memberikan wawasan empiris tentang efektivitas perbankan hijau di pasar negara berkembang dan menyoroti peran dominan efisiensi operasional dalam kerangka teori pemangku kepentingan.

Keywords: Green banking, company size, operational efficiency; financial performance

INTRODUCTION

Financial performance serves as an important benchmark for assessing a company's condition and success in managing its available resources (Auliyah & Saleh, 2024). These resources can be used to generate profit, manage assets, fulfill responsibilities, and create benefits for all parties involved (Ratnaningtyas & Nurbaeti, 2023). A company's financial condition can be evaluated using various indicators, including Return on Assets (ROA), Return on Equity (ROE), Net Interest Margin (NIM), and operational efficiency ratios. However, this study focuses on Return on Assets (ROA) as the primary measure. The selection of ROA is based on several considerations (Devi, 2025).

Various internal factors, including the implementation of the green banking concept, influence a company's financial performance. The growing global attention to environmental issues has driven the banking industry not only to focus on profit but also to consider sustainability principles. One widely adopted approach today is green banking, which refers to banking activities oriented toward environmental preservation through improved energy efficiency, environmentally friendly financing, and the development of digital banking services (Hastuti, 2024). Implementing the green banking concept can reduce various risks in the banking sector, including legal, credit, and reputational risks. This concept presents a new face of banking and is expected to enhance banking profitability.

Several previous studies confirm that green banking practices significantly improve financial performance. Research conducted by Triana and Setiawan found that green banking practices positively impact Return on Assets (ROA) and Return on Equity (ROE). These findings align with the results of Putri et al. (2024), who concluded that banks adopting environmentally conscious policies tend to demonstrate more consistent financial performance, driven by operational cost efficiency and increased customer loyalty.

In addition to green banking, bank size is also an important determinant of financial performance (Rina & Lindrawati, 2024). Taylor et al. (2021) suggested that during the Bretton Woods period, several currencies, including the British pound sterling (GBP), the Indonesian rupiah (IDR), and various European currencies, exhibited greater strength and expansionary

capacity, which ultimately had a positive impact on financial performance. Furthermore, operational efficiency has also been shown to have a significant influence.

The operational efficiency ratio, known as BOPO, measures a company's ability to manage and use available resources optimally. During the Bretton Woods era, when currency values were linked to gold reserves, the BOPO ratio was generally lower because asset and cost management were carried out in a more controlled and systematic manner. This study is structured based on a research gap identified in previous studies discussing operational efficiency, particularly referring to the study by Nurkhalifa et al. (2021), which found that the level of operational efficiency measured through BOPO significantly influences the financial performance of banks, as represented by the Return on Assets (ROA) ratio.

The novelty of this research lies in its context and its review of previous studies. Based on this analysis, this study does not merely focus on identifying the accounting information system for revenues and expenditures in the research object or simply testing its alignment with existing theory. Instead, this research is specifically directed to analyze the influence of green banking implementation, bank size, and operational efficiency on financial performance in the banking sector during the 2021–2023 period.

THEORETICAL FRAMEWORK AND HYPOTHESES

Theoretical background

Stakeholder theory can serve as a conceptual foundation for explaining how the implementation of green banking, bank size, and operational efficiency influence the financial performance of entities. Green banking practices reflect the commitment of banking institutions to social interests and environmental sustainability. From a stakeholder perspective, banks are required to consider the ecological consequences of every operational activity. The main concept of this theory emphasizes that stakeholders are viewed as a network formed through interactions between the organization and its surrounding environment, in which these relationships are interconnected, complex, and continuously evolving (Lestari, 2023). Legitimacy theory is a conceptual perspective within the framework of political economy thinking. Gray and his colleagues argued that public pressure and influence play a determining role in the distribution of economic and financial resources. On this basis, company performance supported by social legitimacy becomes a crucial factor for business growth and sustainability. The values and norms that develop in society establish behavioral boundaries that every business organization must comply with. The company's response to these boundaries reflects the importance of examining organizational actions within a broader social environment. Furthermore, Deegan emphasized that legitimacy theory focuses on the company's obligation to align its operational activities with the norms, rules, and social expectations of the environment in which it operates, so that its activities are perceived as legitimate and receive societal recognition (Nurkhalifa et al., 2021).

Bank financial performance

Financial performance shows a company or institution's financial condition at a given time. It reflects the efficiency, profitability, and sustainability of its operations. According to Karnasi et al. (2025), a bank's financial performance reflects management's ability to efficiently create added value. Syahrir et al. (2025) state that financial performance is analyzed by examining financial statements using a ratio approach to determine operational effectiveness and efficiency. Research by Kurnia et al. (2025) also supports this, stating that a bank's financial performance is measured

through profitability ratios such as ROA and ROE, as well as operational efficiency such as BOPO (Paradila, C., 2024).

Green banking and financial performance

Green banking refers to the approach where financial institutions incorporate environmental management into their operations to promote sustainability. This strategy is designed to lower the carbon footprint and mitigate environmental damage through eco-friendly operations and financial offerings. Within the Bretton Woods system, currencies such as the British pound (GBP), Indonesian rupiah (IDR), and various European currencies were included in a banking framework that tied their values to gold. Green banking surfaced as a new method following the transition from the Bretton Woods system to the fiat money system in 1971 (Asmara & Nugraeni, 2024). This approach symbolizes the banking sector's dedication to environmental stewardship by financing green initiatives and utilizing eco-friendly technologies (Chen et al., 2022). In line with this, Lestari (2023) notes that green banking practices exemplify banks' role in fostering sustainability and promoting energy efficiency. Essentially, green banking is a financial mechanism that supports the funding of eco-friendly projects and the adoption of sustainable operational frameworks.

Initiatives associated with green banking, such as green credit and green finance, have been shown to enhance financial performance indicators, such as return on equity (ROE) and earnings per share (EPS), in specific contexts. For instance, banks with robust green credit policies achieve improved financial results, especially when paired with practices that address climate change (Al frijat et al., 2025). The transparency brought about by green banking disclosures positively affects financial performance by aligning with sustainability objectives, as shown in ASEAN countries (Rahma & Wedari, 2024). Actions such as reducing paper use, using online banking, and adopting renewable energy sources lower operational expenses, thereby enhancing financial sustainability (Li & Chen, 2024; Sanjaya & Larissa, 2025; Setyorini & Hakam, 2025). Green banking cultivates customer loyalty, boosts brand reputation, and offers a competitive advantage by resonating with consumer preferences for sustainability (Bansal et al., 2025; Hendryadi & Sulisyowati, 2026). Investments in eco-friendly projects and responsible lending practices contribute to long-term financial stability and resilience (Thapliyal & Gupta, 2024).

H1: Green banking has a significant impact on financial performance.

Bank size and financial performance

Bank size is a crucial variable that reflects the financial strength and risk management capabilities of banking institutions. It is typically measured by the logarithm of total assets, which indicates a bank's ability to leverage economies of scale. Generally, banks with larger assets exhibit more efficient cost structures, greater business diversification, and more stable profitability than their smaller counterparts.

Historically, the international monetary system during the Bretton Woods era operated under a fixed exchange rate mechanism linked to gold, involving currencies such as the British pound sterling, the Indonesian rupiah, and various European currencies. However, with the conclusion of the Bretton Woods system and the adoption of the fiat money model in 1971, bank size emerged as a vital control variable for evaluating banking performance. Larger banks tend to show greater resilience during financial crises and are better able to adapt to changing economic

conditions (Gržeta et al., 2023). Empirical studies have validated that larger banks often reap the benefits of economies of scale, which can enhance both profitability and efficiency. For example, in Turkey, bank size—measured by total assets and credits—positively influences profitability, evidenced by higher Return on Assets (ROA) and Return on Equity (ROE) (Ceylan et al., 2018a, 2018b). In Ecuador, larger banks have demonstrated higher technical efficiency, suggesting that size positively affects operational performance (Miguel Ruiz et al., 2024). Nonetheless, larger banks can also contribute disproportionately to systemic risk due to their interconnectedness and exposure to contagion effects. This aligns with the "too big to fail" hypothesis, which emphasizes the risks associated with very large financial institutions (Laeven et al., 2016; Moch, 2018). Hence, the hypothesis:

H2: Bank size has a significant impact on financial performance.

Operational efficiency and financial performance

According to Siregar et al. (2025), operational efficiency in the financial sector refers to an organization's capability to manage operational expenses relative to the income generated. The aim is to enhance financial performance and competitiveness. Operational efficiency also reflects a business's or organization's capacity to achieve maximum output while effectively utilizing resources, without compromising the quality of the products or services offered (Nurkhalifa et al., 2021). In this regard, operational efficiency involves conducting business activities at a reduced cost, with improved time management and diminished waste, allowing the organization to boost production and profitability. Operational efficiency refers to a bank's ability to reduce the cost-to-income ratio by leveraging technology and digitalization (Abou-Foul et al., 2021). Hanjani (2025) states that operational efficiency is evaluated using the BOPO ratio and total asset ratio. The assessment of operational efficiency, which indicates how well management optimizes resources, is supported by Situmorang et al. (2025). Likewise, Pangestu (2025) confirms that BOPO and the total asset ratio measure operational efficiency.

Operational efficiency directly enhances profitability by reducing expenses and optimizing resource use. For example, in banks across Sub-Saharan Africa, improved operational efficiency positively affects return on assets (ROA) and net interest margins (NIM), thereby contributing to enhanced financial performance (Dinka & Asfaw, 2026). Similarly, operational efficiency in Islamic banks leads to improved profitability, though it may limit the distribution of financing (Zuhroh et al., 2025). Streamlined operations reduce operating costs, facilitating competitive pricing and improved financial results. For instance, German banks that exhibit higher operational efficiency provide lower loan markups, making their offerings more attractive (Schlueter et al., 2016). Effective utilization of resources, including fixed assets and deposits, results in superior financial outcomes. Research on banks in India and Tanzania emphasizes that improving resource allocation and minimizing inefficiencies can significantly enhance financial performance (Bangarwa & Roy, 2023; Lotto, 2019).

H3: Operational efficiency has a significant impact on financial performance.

METHODS

This research employs a quantitative, causal design to investigate relationships among variables empirically. The research focuses on banking firms listed as issuers on the Indonesia Stock Exchange, examining green banking, bank size, and operational efficiency. The observation

timeframe spans from 2021 to 2023, with all data sourced from the official website of the Indonesia Stock Exchange.

Data collecting procedures

The sample population for this study consists of all commercial banks (including both private and national banks) listed on the Indonesia Stock Exchange from 2021 to 2023. A saturated sampling approach is adopted, meaning that the complete population that meets the inclusion criteria is taken as the sample (Hendryadi et al., 2025). The inclusion criteria specify that a bank must provide comprehensive annual reports for 2021 to 2023 and furnish the necessary data to compute the variables for green banking, bank size, BOPO, and ROA. Following these criteria, the final sample includes 16 banks each year, resulting in a total of 48 pooled observations (16 banks $\times$ 3 years). The data type utilized is secondary data, previously published by other entities. The data is gathered from annual reports and, where applicable, sustainability reports. These documents are procured from the official website of the Indonesia Stock Exchange (www.idx.co.id). The data collection method involves documentation: downloading, recording, and compiling relevant data into Microsoft Excel spreadsheets before processing them in SPSS.

Measures

The dependent variable, financial performance, is measured by Return on Assets (ROA), calculated as net profit after tax divided by total assets. ROA indicates the bank's capacity to generate profit from its total assets; a higher ROA signifies improved financial performance. The measurement scale employed is a ratio scale.

The independent variables are defined as follows: Green banking is quantified via a disclosure index based on five indicators derived from the literature: environmental policies, green financing, internal energy efficiency, reduction of carbon emissions, and digital services. Each indicator is either scored as 0 (not disclosed) or 1 (disclosed). The scores are summed and divided by the total number of indicators (5), yielding a value ranging from 0 to 1 on a ratio scale. Bank size is quantified as the natural logarithm of total assets, expressed in billions of Indonesian rupiah, and is also measured on a ratio scale. Operational efficiency is measured by the BOPO ratio, which divides operational costs by operational income. BOPO reflects the amount of operational cost incurred to generate one unit of operational income; a lower BOPO indicates higher efficiency. This variable is similarly assessed on a ratio scale.

Data analysis

According to the theoretical framework, the multiple linear regression model employed to test the hypotheses is as follows:

$ROA_{it} = \alpha + \beta_1 GBit + \beta_2 SIZE_{it} + \beta_3 BOPO_{it} + \epsilon_{it}$, where ROA_{it} denotes the return on assets of bank i in year t , α stands for the constant, $GBit$ signifies the green banking score, $SIZE_{it}$ represents the natural logarithm of total assets, $BOPO_{it}$ indicates the BOPO ratio, and β_1 , β_2 , and β_3 are the regression coefficients, while ϵ_{it} is the error term.

Data analysis is conducted using SPSS version 26, encompassing several stages. Descriptive statistics are initially computed to provide an overview of each variable's characteristics, including minimum, maximum, mean, and standard deviation. Before hypothesis testing, classical assumption tests are performed to ensure that the regression model satisfies the Best Linear Unbiased Estimator (BLUE) criteria. The normality test uses the one-sample

Kolmogorov-Smirnov test on the residuals; the residuals are considered normally distributed if the p-value exceeds 0.05. Multicollinearity is evaluated using the Variance Inflation Factor and tolerance; multicollinearity is considered absent if VIF is below 10 and tolerance exceeds 0.10. Autocorrelation is assessed via the Durbin-Watson statistic; a model is deemed free of autocorrelation if the Durbin-Watson value falls between du and $(4-du)$. Heteroscedasticity is examined using the Glejser test, where a significance value greater than 0.05 suggests the absence of heteroscedasticity.

Hypothesis testing is conducted using the t-test (partial) to analyze the individual influence of each independent variable on the dependent variable, applying a significance level of $\alpha = 0.05$. A hypothesis is accepted if the p-value is lower than 0.05. The F-test (simultaneous) is employed to evaluate the collective effect of all independent variables on the dependent variable. Lastly, the coefficient of determination (R^2) gauges the proportion of variation in the dependent variable explained by the independent variables.

RESULTS AND DISCUSSION

Descriptive Statistics

Descriptive statistics are used to interpret and summarize the research data, allowing the researcher to observe the patterns and characteristics of the observed variables. A summary of the descriptive statistics is presented in Table 1.

Table 1.

Descriptive Statistics of Research Variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Green Banking	64	0.20	1.00	0.8219	0.24974
Bank Size (Ln Assets)	64	17.67	23.58	19.7934	1.43779
BOPO	64	0.44	2.21	0.8761	0.34432
ROA	64	0.00	0.08	0.0180	0.01506

The green banking variable shows a highest value of 1.00 and a lowest value of 0.20, with a mean of 0.8219 and a standard deviation of 0.24974. This indicates that most sample banks have adopted green banking practices at a relatively high level. Bank size, measured by the natural logarithm of total assets, has a maximum value of 23.58 and a minimum of 17.67, with a mean of 19.7934 and a standard deviation of 1.43779, suggesting moderate variation in bank size among the sample. Financial performance, proxied by Return on Assets (ROA), shows a maximum value of 0.08, a minimum of 0.00, a mean of 0.0180, and a standard deviation of 0.01506, indicating variability in profitability performance across the sample banks.

Classical Assumption Tests

Classical assumption tests were conducted as a prerequisite before performing regression analysis. The results of all classical assumption tests (normality, multicollinearity, autocorrelation, and heteroscedasticity) are presented in a single table, Table 2.

Table 2.

Summary of Classical Assumption Tests

Test Type	Statistic Variable	/	Value	Criterion	Conclusion
Normality (Kolmogorov-Smirnov)	Asymp. Sig. (2-tailed)		0.200	> 0.05	Residuals are normally distributed
Multicollinearity	Green Banking (Tolerance)		0.892	> 0.10	No multicollinearity
	Green Banking (VIF)		1.121	< 10	No multicollinearity
	Bank Size (Tolerance)		0.876	> 0.10	No multicollinearity
	Bank Size (VIF)		1.142	< 10	No multicollinearity
	BOPO (Tolerance)		0.934	> 0.10	No multicollinearity
Autocorrelation (Durbin-Watson)	BOPO (VIF)		1.071	< 10	No multicollinearity
	Durbin-Watson value		1.987	du (1.73) < DW < 4-du (2.27)	No autocorrelation
Heteroscedasticity (Glejser)	Green Banking (Sig.)		0.432	> 0.05	No heteroscedasticity
	Bank Size (Sig.)		0.287	> 0.05	No heteroscedasticity
	BOPO (Sig.)		0.561	> 0.05	No heteroscedasticity

Based on Table 2, all classical assumption tests indicate that the regression model meets the required criteria. The residuals are normally distributed, there is no multicollinearity among the independent variables, the model is free from autocorrelation, and no heteroscedasticity is present. Therefore, the data are suitable for multiple linear regression analysis.

Multiple Linear Regression Analysis

Multiple linear regression analysis was used to determine the relationship between the dependent variable and the independent variables. The results of the regression analysis, including hypothesis testing, are presented in Table 3.

Based on Table 3, the multiple linear regression equation is as follows:

$$\text{ROA} = -0.083 + 0.010 (\text{Green Banking}) + 0.003 (\text{Bank Size}) + 0.031 (\text{BOPO}) + e$$

The constant is negative, indicating that if all independent variables are zero, profitability would decrease. The coefficient for green banking is positive, suggesting that an increase in green banking implementation contributes to an increase in profitability. The coefficient for bank size is positive, meaning that larger bank size tends to increase profitability. The coefficient for BOPO is

positive, indicating that BOPO has a positive influence on profitability. However, it should be noted that the positive sign for BOPO is contrary to theoretical expectations, as a higher BOPO typically indicates lower efficiency and should reduce profitability. This anomaly will be discussed further. In terms of variable dominance, the standardized coefficients should be compared rather than the unstandardized coefficients because the variables have different scales. The standardized coefficients show that BOPO has the largest value, followed by bank size and then green banking. Thus, BOPO is the most dominant variable influencing financial performance.

Table 3.*Multiple Linear Regression and Hypothesis Testing Results*

Variable	Unstandardized Coefficient (B)	Standardized Coefficient (Beta)	t	Sig.
(Constant)	-0.083		-2.145	0.036
Green Banking	0.010	0.166	1.450	0.152
Bank Size	0.003	0.286	3.135	0.003
BOPO	0.031	0.709	6.263	0.000

Dependent Variable: ROA

$R^2 = 0.562$

Adjusted $R^2 = 0.540$

F-statistic = 25.847

Sig. F = 0.000

The coefficient of determination (R^2) indicates that a substantial percentage of the variation in ROA can be explained by the three independent variables (green banking, bank size, and BOPO), while the remaining variation is explained by other factors outside the model. The adjusted R^2 accounts for the number of predictors. The F-statistic with its significance level indicates that all independent variables simultaneously have a significant effect on ROA. For the effect of green banking on profitability (ROA), the t-test shows a significance level above 0.05, indicating that green banking does not have a significant effect on ROA. Therefore, the first hypothesis is rejected. For the effect of bank size on profitability (ROA), the t-test shows a significance level below 0.05, indicating a significant positive effect. Therefore, the second hypothesis is accepted. For the effect of BOPO on profitability (ROA), the t-test shows a significance level below 0.05, indicating a significant effect. Therefore, the third hypothesis is accepted, although caution is needed regarding the direction of the coefficient.

Discussion

Based on the hypothesis test results, the influence of green banking on financial performance, as measured by Return on Assets (ROA), is not significant, leading to the rejection of the first hypothesis. This finding can be explained through stakeholder theory and legitimacy theory. According to stakeholder theory, banks are required to consider the ecological consequences of every operational activity and to balance the interests of various stakeholders, including environmental groups and regulators (Lestari, 2023). The lack of a significant effect suggests that the benefits of green banking practices may not yet be reflected in short-term financial performance. Legitimacy theory emphasizes that companies must align their operations with

social norms and expectations to gain societal recognition (Nurkhalifa et al., 2021). While green banking enhances legitimacy and reputation, these intangible benefits often take longer to translate into measurable financial outcomes, such as ROA. During the observation period (2021–2023), banks may have been in the early stages of adopting green initiatives, whereas the financial returns from such investments typically materialize only over the long term. Empirical evidence supports this interpretation; for instance, Asmara & Nugraeni (2024) and Gržeta et al. (2023) reported that the transition from the Bretton Woods system to fiat money in 1971 created a new environment where green banking emerged. Still, its financial impact has not yet been fully realized. Similarly, while Chen et al. (2022) and Lestari (2023) emphasize the role of green banking in sustainability and energy efficiency, these benefits may affect operational cost structures gradually rather than producing immediate profitability gains.

In contrast, some studies, such as Al Frijat et al. (2025) and Rahma & Wedari (2024), found that green credit and green banking disclosures positively affect financial performance, particularly in contexts with strong regulatory support or in ASEAN countries. Actions such as reducing paper use, adopting online banking, and using renewable energy do lower operational expenses in the long run (Li & Chen, 2024; Sanjaya & Larissa, 2025; Setyorini & Hakam, 2025), but the time horizon of this study may have been insufficient to capture such effects. Moreover, while green banking cultivates customer loyalty, boosts brand reputation, and offers a competitive advantage (Bansal et al., 2025; Hendryadi & Sulisyowati, 2026), these advantages may influence market share and long-term stability rather than short-term ROA. Investments in eco-friendly projects and responsible lending practices contribute to long-term financial stability and resilience (Thapliyal & Gupta, 2024), but this does not necessarily translate into immediate profitability. Therefore, the non-significant finding is plausible and consistent with the view that green banking represents a strategic investment whose financial returns take longer to materialize.

In contrast, the test results indicate that bank size has a significant positive effect on financial performance, thereby supporting the second hypothesis. This finding aligns with both stakeholder theory and legitimacy theory. From a stakeholder perspective, larger banks have greater resources to manage diverse stakeholder expectations, including those of shareholders, regulators, and the public (Lestari, 2023). Their size enables them to invest in risk management, compliance systems, and corporate social responsibility initiatives that enhance financial performance. From a legitimacy perspective, larger banks often enjoy greater public visibility and thus face stronger pressure to maintain legitimate operations; meeting these expectations improves financial outcomes because legitimacy facilitates access to capital, customer trust, and regulatory support (Nurkhalifa et al., 2021). Historically, after the end of the Bretton Woods system in 1971, bank size emerged as a crucial control variable for evaluating banking performance, as larger banks tend to show greater resilience during financial crises and better adaptability to changing economic conditions (Gržeta et al., 2023).

Empirical studies have validated this: Ceylan et al. (2018a, 2018b) found that, in Turkey, bank size, measured by total assets and credit, positively influences profitability, as evidenced by higher ROA and ROE. Similarly, Miguel Ruiz et al. (2024) reported that larger banks in Ecuador demonstrate higher technical efficiency. These findings confirm that larger banks benefit from economies of scale, more efficient cost structures, greater business diversification, and more stable profitability. As noted by Karnasi et al. (2025), Syahrir et al. (2025), and Kurnia et al. (2025), a bank's financial performance reflects management's ability to efficiently create added value, which is often enhanced by size-related advantages. Paradila (2024) also supports the use of ROA

as a key measure of financial performance influenced by bank size. However, it is important to acknowledge that larger banks can also contribute disproportionately to systemic risk through their interconnectedness, a phenomenon captured by the "too big to fail" hypothesis (Laeven et al., 2016; Moch, 2018). While this study did not examine systemic risk, the positive effect of size on ROA during the post-pandemic recovery period suggests that the benefits of scale outweigh any potential drawbacks for the sample banks.

Turning to operational efficiency, the results indicate that the BOPO variable has a significant effect on profitability, thereby supporting the third hypothesis. However, an important anomaly must be noted: the regression coefficient for BOPO is positive, whereas theoretically BOPO is expected to have a negative relationship with ROA. The BOPO ratio compares operational costs and operational income; a higher BOPO indicates a greater cost burden, which should reduce profits and lower ROA. This anomaly requires careful interpretation. According to Siregar et al. (2025), operational efficiency in the financial sector refers to an organization's ability to manage operational expenses relative to income generated, thereby enhancing financial performance and competitiveness. Operational efficiency also reflects a business's capacity to achieve maximum output while effectively utilizing resources without compromising quality (Nurkhalifa et al., 2021). In this regard, operational efficiency involves conducting business activities at reduced cost, with improved time management and diminished waste, allowing the organization to boost production and profitability (Abou-Foul et al., 2021). Under normal conditions, a lower BOPO is associated with higher efficiency and better profitability. Studies such as Dinka & Asfaw (2026) found that improved operational efficiency positively affects ROA and net interest margins in Sub-Saharan African banks. Zuhroh et al. (2025) reported similar results for Islamic banks, though they noted that efficiency might limit the distribution of financing. Schlueter et al. (2016) demonstrated that more efficient German banks offer lower loan markups, making them more competitive. Bangarwa & Roy (2023) and Lotto (2019) showed that effective resource utilization significantly enhances financial performance.

Nevertheless, the positive coefficient found in this study is anomalous but not impossible. Several explanations can be drawn from the literature. First, during the observation period (2021–2023), which included post-pandemic recovery, some banks may have experienced disproportionately higher operational income growth due to increased lending demand or higher interest margins, temporarily offsetting higher operational costs. Second, as noted by Hanjani (2025), Situmorang et al. (2025), and Pangestu (2025), operational efficiency can be measured using both BOPO and the total asset ratio; if banks in the sample were undergoing digital transformation (Abou-Foul et al., 2021), initial technology investments might raise operational costs (increasing BOPO) while simultaneously generating future income gains that are already partially reflected in current ROA. Third, the positive coefficient could be driven by outliers in the BOPO data, as indicated by the maximum BOPO value substantially exceeding typical levels. Fourth, a positive relationship between BOPO and ROA might occur in contexts where higher costs are associated with value-added services that customers are willing to pay for, leading to higher net income. For instance, banks that invest heavily in customer service, security, or product innovation may incur higher operational costs but also achieve higher revenues. Although this study finds that operational efficiency significantly influences financial performance, as supported by Siregar et al. (2025), Kurnia et al. (2025), and Saputra & Paradila & Arsiah (2024), the unexpected positive sign of the coefficient suggests that further investigation is needed. Future research should consider alternative efficiency measures, perform robustness checks such as outlier removal or using net interest margin as an alternative dependent variable, and explore

potential moderating or mediating variables. Given this anomaly, the finding should be interpreted with caution until confirmed by additional studies.

Practical implications

The finding that green banking does not significantly impact return on assets indicates that banks should not assess green initiatives solely on short-term financial returns. Instead, these practices should be viewed as long-term investments that yield intangible benefits, such as enhanced legitimacy, improved reputation, customer loyalty, and regulatory goodwill. These benefits may lead to measurable financial performance over time, beyond the typical three-year study window. Bank managers should continue or expand their green banking efforts while managing shareholders' expectations regarding delayed payoffs and developing non-financial performance indicators to track sustainability progress. For regulators, this non-significant finding underscores the need for incentives, such as tax reductions or favorable capital requirements for green loans, to encourage green banking adoption without penalizing banks for weaker short-term profits. Evaluating green banking policies should consider longer time horizons, ideally over five years. Regarding the significant positive effect of bank size on performance, smaller banks face disadvantages due to limited economies of scale and higher compliance costs. They might consider strategic partnerships, mergers, or niche-market focus to enhance competitive advantage. Larger banks should leverage their size while being mindful of systemic risks and maintaining adequate capital buffers.

The paradoxical positive coefficient of operational efficiency (BOPO ratio) suggests that higher operational costs associated with value-added services may lead to higher income growth, challenging the assumption that lower BOPO ratios always indicate better profitability. Bank management should analyze operational costs and revenues separately. If higher costs result from profitable innovations, the increase in BOPO may be justifiable. Conversely, if costs arise from inefficiencies, corrective measures are needed. Regulators should treat BOPO trends cautiously, recognizing that a positive relationship may reflect a temporary phase driven by technological investments rather than systemic inefficiency, and that future audits should include robustness checks to validate findings.

CONCLUSION

This study examined the impact of green banking, bank size, and operational efficiency (BOPO) on banks' financial performance, measured by return on assets (ROA), from 2021 to 2023. The findings reveal that green banking does not significantly affect short-term financial performance, suggesting that its benefits emerge over the long term. Bank size positively influences financial performance, as larger banks enjoy economies of scale and better risk management. Interestingly, operational efficiency has a positive but unexpected effect on profitability; higher BOPO typically suggests lower efficiency, yet post-pandemic recovery may have contributed to this anomaly by increasing costs while enhancing income. Ultimately, while bank size and operational efficiency are immediate drivers of performance, the advantages of green banking manifest over the long term.

Limitations

This study has several limitations. First, the observation period from 2021 to 2023 is short for assessing the financial impact of green banking, as such initiatives typically require five to ten years to yield measurable returns. Second, relying solely on return on assets (ROA) neglects other important performance indicators, such as return on equity and net interest margin, which could provide a fuller picture. Third, the anomalous positive coefficient for BOPO raises concerns about data quality and potential outliers, suggesting the need for robustness checks. Fourth, the study ignores moderating or mediating variables, such as regulatory pressure and environmental disclosure quality. Fifth, the findings are specific to the post-pandemic recovery period and may not apply to other economic contexts or different banking systems. Lastly, potential endogeneity issues, like the correlation between profitability and green investments, were not controlled for. Addressing these limitations in future research would enhance the validity and generalizability of the conclusions.

References

- Abou-Foul, M., Ruiz-Alba, J. L., & Soares, A. (2021). The impact of digitalization and servitization on the financial performance of a firm: an empirical analysis. *Production Planning & Control*, 32(12), 975–989.
- Al Frijat, Y. S., Al-Msiedeen, J. M., & Elamer, A. A. (2025). How green credit policies and climate change practices drive banking financial performance. *Business Strategy and Development*, 8(1). <https://doi.org/10.1002/bsd2.70090>
- Asmara, M. Y. C., & Nugraeni, N. (2024). Pengaruh green banking dan efisiensi biaya operasional terhadap profitabilitas perbankan di Indonesia. *Jurnal Ekuilnomi*, 6(3), 571–579.
- Auliyah, I., & Saleh, W. (2024). Kinerja keuangan perusahaan ditinjau dari debt to equity ratio dan return on asset: Literature review. *EKOMA: Jurnal Ekonomi, Manajemen, Akuntansi*, 3(2), 1001–1011.
- Bangarwa, P., & Roy, S. (2023). Operational performance model for banks: a dynamic data envelopment approach. *Benchmarking*, 30(10), 3817–3836. <https://doi.org/10.1108/BIJ-08-2021-0498>
- Bansal, N., Kumar, P., & Kukreti, M. (2025). Aligning finance with sustainability: Green banking strategies for a greener economy. In *E-Finance: Transformative strategies for sustainable development in the digital era* (pp. 1–30). (Publisher not specified)
- Ceylan, I. E., Ceylan, F., & Yapa, K. (2018a). The relationship between bank size and profitability: An investigation on deposit banks in Turkey. In *Global issues in social sciences: Different perspectives – multidisciplinary approaches* (pp. 91–100).
- Ceylan, I. E., Ceylan, F., & Yapa, K. (2018b). The relationship between bank size and profitability: An investigation on deposit banks in Turkey. In *Global issues in social sciences: Different perspectives – multidisciplinary approaches* (pp. 90–100). <https://doi.org/10.3726/b13343>
- Chen, J., Siddik, A. B., Zheng, G.-W., Masukujaman, M., & Bekhzod, S. (2022). The effect of green banking practices on banks' environmental performance and green financing: An empirical study. *Energies*, 15(4), 1292.
- Devi, H. A. N. (2025). Analisis rasio keuangan: Return on assets ratio (ROA), return on equity ratio (ROE) dan net interest margin (NIM) pada Bank Mestika periode 2019-2023. *Maliki Interdisciplinary Journal*, 3(1), 476–486.
- Dinka, S. T., & Asfaw, A. S. (2026). The impact of efficiency and income diversification on performance of commercial banks: evidence from Sub-Saharan African countries. *Cogent Business and Management*, 13(1). <https://doi.org/10.1080/23311975.2025.2597069>
- Gržeta, I., Žiković, S., & Tomas Žiković, I. (2023). Size matters: analyzing bank profitability and efficiency under the Basel III framework. *Financial Innovation*, 9(1), 43.

- Hanjani, M. (2025). Pengaruh efisiensi beban operasional, current ratio dan debt to equity terhadap kinerja keuangan pada perusahaan perhotelan di BEI tahun 2019-2023. *Jurnal Akademi Akuntansi Indonesia Padang*, 5(1), 22–32.
- Hastuti, A. A. (2024). Pengaruh penerapan green banking, ukuran perusahaan, dan kinerja keuangan perbankan terhadap profitabilitas pada bank umum syariah periode 2020-2022 [Skripsi]. FEB UIN Jakarta.
- Hendryadi, Faruqi, F., Nasution, N., & Tricahyadinata, I. (2025). *Metode penelitian praktis: pengantar untuk riset akademik*. CV. Madza Media.
- Hendryadi, & Sulisyowati. (2026). Green financing: A systematic literature review and future research direction. *JASTEI*, 12(1), 83–108. <https://doi.org/10.36406/jastei.v12i1.29>
- Karnasi, R., Lunarindiah, G., & Ramadhanti, M. (2025). Faktor penentu kinerja keuangan bank yang terdaftar di BEI. *Journal of Accounting and Finance Management*, 5(6), 1858–1869.
- Kurnia, A., Trisnaudy, W. R., Ardana, Y., & Eliza, A. (2025). Pengaruh good corporate governance, capital adequacy ratio, dan efisiensi operasional terhadap kinerja keuangan bank umum syariah di Indonesia. *JPSDa: Jurnal Perbankan Syariah Darussalam*, 5(02), 157–170.
- Laeven, L., Ratnovski, L., & Tong, H. (2016). Bank size, capital, and systemic risk: Some international evidence. *Journal of Banking and Finance*, 69, S25–S34. <https://doi.org/10.1016/j.jbankfin.2015.06.022>
- Lestari, A. I. (2023). Pengaruh sustainability report terhadap kinerja keuangan dengan ukuran perusahaan sebagai variabel kontrol [Skripsi]. Universitas Muhammadiyah Makassar. https://digilibadmin.unismuh.ac.id/upload/38867-Full_Text.pdf
- Li, Z., & Chen, P. (2024). Sustainable finance meets FinTech: Amplifying green credit's benefits for banks. *Sustainability*, 16(18). <https://doi.org/10.3390/su16187901>
- Lotto, J. (2019). Evaluation of factors influencing bank operating efficiency in Tanzanian banking sector. *Cogent Economics and Finance*, 7(1). <https://doi.org/10.1080/23322039.2019.1664192>
- Miguel Ruiz, M., Leonardo Estrada, A., Yoong, C., & Ormeño-Candelario, V. (2024). Bank size and type impact on efficiency: Evidence from Ecuador. *Proceedings of the LACCEI International Multi-Conference for Engineering, Education and Technology*. <https://doi.org/10.18687/LACCEI2024.1.1.337>
- Moch, N. (2018). The contribution of large banking institutions to systemic risk: What do we know? A literature review. *Review of Economics*, 69(3), 231–257. <https://doi.org/10.1515/roe-2018-0011>
- Nurkhalifa, U., Machpudin, A., & Setiawati, R. (2021). Pengaruh kecukupan modal dan efisiensi operasional terhadap kinerja keuangan perbankan umum konvensional di Bursa Efek Indonesia periode 2016-2020. *Jurnal Dinamika Manajemen*, 9(2), 85–98.
- Pangestu, Y. (2025). Strategi manajemen SDM dalam mencapai efektivitas dan efisiensi operasional. *Jurnal Administrasi Karya Dharma*, 4(1), 11–18.
- Paradila, C., & Arsjah, R. J. (2024). Kinerja bank meningkat sebagai dampak dari kecukupan modal dari perusahaan perbankan di Indonesia. *Jurnal Ekonomi Trisakti*, 4(1). <https://doi.org/10.25105/jet.v4i1.19179>
- Putri, R. N., Putri, J. K., Christanti, R., & Nugroho, A. H. L. (2024). Investigating the impact of green banking on efficiency strategy: Evidence from Indonesia. *The Indonesian Journal of Accounting Research*, 27(1), 157–178.
- Rahma, P. N. M., & Wedari, L. K. (2024). Green banking and bank performance in ASEAN: The moderating role of bank size. *Journal of Logistics, Informatics and Service Science*, 11(9), 162–181. <https://doi.org/10.33168/JLISS.2024.0911>
- Ratnaningtyas, H., & Nurbaeti, N. (2023). Pengaruh good corporate governance and corporate social responsibility terhadap return saham melalui return on asset pada perusahaan restoran. *Jurnal Ekonomi Pembangunan STIE Muhammadiyah Palopo*, 9(2), 400–417.
- Rina, S. L., & Lindrawati, L. (2024). Determinan green banking disclosure pada perbankan di Bursa Efek Indonesia. *Jurnal Ilmiah Akuntansi Dan Bisnis*, 9(2), 176–188.

- Sanjaya, I. P. S., & Larissa, Y. N. (2025). Relationship between green banking disclosures and accounting-based performance: Financial and operational performance. *Review of Integrative Business and Economics Research*, 14(3), 352–368.
- Schlueter, T., Busch, R., Sievers, S., & Hartmann-Wendels, T. (2016). Loan pricing: Do borrowers benefit from cost-efficient banking? *Credit and Capital Markets*, 49(1), 93–125. <https://doi.org/10.3790/ccm.49.1.93>
- Setyorini, M., & Hakam, D. F. (2025). The impact of green banking activities on environmental performance: A youth-driven perception study in Indonesian financial institutions. *Journal of Risk and Financial Management*, 18(10). <https://doi.org/10.3390/jrfm18100558>
- Siddik, A. B., Yong, L., & Sharif, A. (2024). Do sustainable banking practices enhance the sustainability performance of banking institutions? Direct and indirect effects. *International Journal of Bank Marketing*, 42(4), 672–691.
- Siregar, D. K., Oktavia, R., & Jefri, U. (2025). Green banking, efisiensi biaya operasional (BOPO), dan profitabilitas: Bukti empiris pada perbankan yang terdaftar di BEI periode 2020–2024. *Jurnal Ekonomi Dan Bisnis Indonesia*, 10(2), 73–80.
- Situmorang, T. K., Sagala, I. C., Dewi, S., & Rahman, F. (2025). Pengaruh risiko kredit dan manajemen laba terhadap nilai perusahaan pada sektor perbankan yang terdaftar di Bursa Efek Indonesia tahun 2019-2023. *Balance: Jurnal Akuntansi Dan Manajemen*, 4(2), 1360–1372.
- Syahrir, N., Mandasari, N. F., Galib, A., & Anis, F. (2025). Faktor-faktor yang mempengaruhi kinerja keuangan terhadap harga saham perusahaan perbankan yang terdaftar di Bursa Efek Indonesia tahun 2017-2023. *JUMBIWIRA: Jurnal Manajemen Bisnis Kewirausahaan*, 4(1), 340–358.
- Taylor, M. P., Wang, Z., & Xu, Q. (2021). The real effects of exchange rate risk on corporate investment: International evidence. *Journal of International Money and Finance*, 117, 102432.
- Thapliyal, K., & Gupta, C. (2024). Green banking - A strategy to gain competitive advantage. *Proceedings - IEEE 2024 1st International Conference on Advances in Computing, Communication and Networking (ICAC2N 2024)*, 1455–1459. <https://doi.org/10.1109/ICAC2N63387.2024.10895491>
- Zuhroh, I., Malik, N., Khoirul Fuddin, M., Rusdianasari, F., & Rofik, M. (2025). Islamic banks' dilemma on profitability and financing distribution: a trade-off implication of efficiency. *Journal of Revenue and Pricing Management*. <https://doi.org/10.1057/s41272-025-00540-x>

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Competing interests

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