THE IMPACT OF GREEN BANKING ON THE FINANCIAL PERFORMANCE OF BANKS IN MALAYSIA

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ABSTRACT

This study aims to investigate how green banking impacts the financial performance of Malaysian commercial banks. To accomplish this, the research used theories like Natural Resource-Based View, Innovation Theory, and Stakeholder Theory. By analysing secondary data from 15 banks over six years (2018-2023). While prior research by Sharif, Sofuoglu, Kocak, and Anwar (2024) identified a knowledge gap in green banking within Malaysia, this study seeks to bridge that gap. The results indicate that green finance initiatives may positively influence the financial performance of banks. This study offers valuable perspectives for policymakers, regulators, and financial institutions by underscoring the importance of promoting green finance initiatives. By exploring the link between green finance and financial outcomes, banks are equipped to make informed choices that bolster their sustainability efforts and strengthen their long-term financial health. It encourages banks to embed sustainability within their business strategies, enabling them to not only support environmental sustainability but also enhance their financial performance, fostering a resilient and sustainable future.

Keywords: Operational efficiency, loan-to-deposit ratio, non-performing loan, return on assets.

INTRODUCTION

This study investigates the impact of green banking on the financial performance of banks in Malaysia. Green banking involves the integration of environmental sustainability into the operations and services of financial institutions. As global awareness of environmental issues increases, many banks are adopting green banking practices to contribute to sustainable development, reduce their carbon footprint, and offer environmentally-friendly financial products. The primary focus of this research is to assess how these green banking initiatives influence the financial performance of banks in Malaysia, considering key financial indicators such as profitability, cost efficiency, and overall market competitiveness. This chapter introduces the research topic and provides a framework for the study. It begins by outlining the background of the study, which presents the context and relevance of the research. It then defines the problem statement, explaining the need for this study and highlighting the gap in current literature. The research questions and research objectives are also clearly stated, guiding the direction of the study. In addition, this chapter emphasizes the significance of the study, highlighting its potential contributions to the banking sector and policy development. Finally, the scope of the study is defined, and an overview of the organization of the thesis is provided, summarizing the structure and contents of the following chapters. This study is motivated by the increasing global and national emphasis on sustainable finance. In Malaysia, green banking remains an emerging area with limited empirical evidence on how

environmental initiatives influence banks' financial outcomes. While previous studies have primarily focused on corporate social responsibility (CSR) or general sustainability practices, few have examined their direct impact on financial performance within the Malaysian banking sector. Therefore, this study aims to fill this gap by providing empirical insights into how green banking practices affect profitability and operational efficiency in Malaysian banks.

Based on the problems discussed above, this study established the general objective of examining the impact of selected financial ratios on the financial performance of banks in Malaysia. This has led to the following specific objectives:

1. To examine the relationship between operational efficiency (OPE) and the financial performance of banks in Malaysia.
2. To investigate the influence of the loan-to-deposit ratio (LDR) on the financial performance of banks in Malaysia.
3. To determine the effect of non-performing loans (NPL) on the financial performance of banks in Malaysia.

This study contributes to the body of knowledge by providing a deeper understanding of the relationship between green banking practices and the financial performance of banks in Malaysia. The findings serve as a foundation for future research in the fields of banking, sustainability, and finance, particularly in the Malaysian context. By examining key financial indicators such as operational efficiency, loan-to-deposit ratio, and non-performing loans, this research offers updated insights into how green banking initiatives align with financial outcomes. Policymakers and regulators may benefit from this study in formulating strategies that promote environmental sustainability without compromising financial performance. Additionally, this research highlights the growing importance of integrating green practices into banking operations as part of a broader move toward sustainable finance. Unlike prior studies, which often focused on general CSR or financial performance alone, this study brings a fresh perspective by narrowing the focus to green banking and its measurable financial impact. The results are particularly relevant to bank management, investors, and stakeholders who are increasingly placing value on environmentally responsible practices. Understanding how green banking initiatives influence financial metrics enables more informed decision-making and supports the long-term goals of both profitability and sustainability. This contributes novelty to the existing literature, offering empirical evidence in a rapidly evolving sector.

LITERATURE REVIEW

Operational Efficiency

Operational efficiency, commonly measured through the Operating Expense (OPE) ratio, is a critical factor in determining a bank's profitability. A lower OPE ratio indicates greater efficiency, as fewer expenses are incurred in generating income, while a higher ratio signals inefficiency and erodes profitability. Studies confirm that OPE has a negative correlation with Return on Assets (ROA), highlighting how rising operational costs reduce bank performance (Syaifuddin & Saleh, 2023). In the context of green banking, this relationship becomes more nuanced. Environmental initiatives such as sustainability reporting, impact assessments, and green compliance introduce new operational costs. Walzer et al., (2024) note that these

additional activities may increase the OPE ratio during early adoption phases, temporarily reducing ROA. However, over time, banks can offset these costs through innovation such as digital banking, paperless systems, and green IT that improves efficiency and lowers the OPE ratio. Importantly, integrating sustainability into operations can offer strategic advantages. Green banking can attract eco-conscious clients, boost reputation, and enhance stakeholder trust, all of which may indirectly support profitability. Thus, while short-term operational costs may rise, long-term benefits are attainable with strategic implementation (Walzer et al., 2024). During external shocks like the COVID-19 pandemic, many banks maintained stable OPE ratios, demonstrating adaptability and resilience (Nurdiniah & Pangestu, 2024). This highlights the importance of agile cost management, especially when implementing green banking initiatives. In conclusion, while green banking may initially raise operational expenses, studies by Syaifuddin and Saleh (2023), Walzer et al. (2024), and Nurdiniah and Pangestu (2024) show that operational efficiency can improve over time with technological upgrades and strategic management. Recent studies such as Pérez Estébanez et al., (2025) and Khamis et al., (2025) further highlight the positive impact of sustainability on financial performance is stronger in developed economies and when supported by effective cost management. Strong financial performance (high ROA) enables firms to better leverage sustainability for value creation (Astuti & Ahmar, 2025). Thus, maintaining a balance between cost control and sustainability is essential for enhancing ROA and ensuring long-term profitability. The first hypothesis is proposed: *H1: Operational efficiency has a significant negative relationship on banks' financial performance in Malaysia.*

Loan to Deposit Ratio

The Loan to Deposit Ratio (LDR) is a key indicator of a bank's liquidity and its efficiency in converting deposits into income-generating loans. A higher LDR typically suggests stronger lending activity, which can boost profitability provided that non-performing loans (NPLs) remain low. Syaifuddin and Saleh (2023) found that LDR has a significant positive effect on Return on Assets (ROA), affirming that optimal credit disbursement enhances profitability. According to Bank Indonesia Regulation No. 15/7/PBI/2013, the ideal LDR range is between 78% and 92%. Staying within this range ensures a balance between liquidity and income generation. Too high an LDR risks liquidity strain, while too low an LDR indicates underutilized earning potential. In the context of green banking, LDR gains additional complexity. Green loans often involve longer payback periods and higher perceived risks, which may lead banks to adopt a more conservative lending approach. Walzer et al., (2024) note that such caution can limit LDR growth. However, when managed effectively, green lending can improve both LDR and financial performance by attracting eco-conscious clients and meeting sustainability regulations. The commercial loan theory (Koch & MacDonald, 2009) also supports strategic LDR management, advocating for short-term, self-liquidating loans to maintain liquidity. This is especially relevant in green banking, where project durations vary, and risk mitigation is essential. During the COVID-19 pandemic, banks maintained a healthy LDR despite a slight decline due to conservative lending practices. Nurdiniah and Pangestu (2024) observed that this helped banks preserve profitability and liquidity, underscoring that a stable LDR supports financial resilience during economic downturns.

Several recent studies find that a higher LDR indicating more deposits are being used for loans can lead to higher ROA, as banks generate more interest income from lending activities. This relationship is especially strong when credit quality is maintained and risk is managed well (Runtunuwu & Hussin, 2024; Hasbi et al., 2024; Susanto et al., 2024). In green banking, the strategic integration of sustainability with prudent LDR management is vital. Studies by Syaifuddin and Saleh (2023), Walzer et al. (2024), and Nurdiniah and Pangestu (2024) support the view that a well-calibrated LDR especially within a green lending framework enhances both profitability and environmental performance. In conclusion, LDR significantly influences ROA by reflecting how effectively banks utilize deposits to generate returns. The second hypothesis is developed: *H2:* Loan to Deposit Ratio *has a significant positive influence on banks' financial performance in Malaysia.*

Non Performing Loan

Non-performing loans (NPLs) are widely recognized as a key indicator of a bank's asset quality and overall financial health. However, findings on the impact of NPLs on bank profitability remain mixed, particularly in the context of green banking. According to Ratnasari, Surwanti, and Pribadi (2023), NPLs do **not have** a significant impact on profitability for banks that implement green banking practices. Their study suggests that green banking promotes better risk management and more cautious lending, which helps mitigate the typical negative effects of high NPL levels. Similarly, Azzahra et al. (2024) support this view, emphasizing that sustainability-oriented banks are more resilient to credit risk due to their emphasis on prudent lending policies, thereby stabilizing profitability even when NPLs arise. These findings indicate that green strategies not only contribute to environmental goals but also enhance financial risk control. However, contrasting evidence is presented by Juliana (2024), who reports a significant negative relationship between NPLs and bank profitability in Chinese financial institutions. The study reveals that as the NPL ratio increases, Return on Assets (ROA) tends to decrease, signaling that high levels of credit risk directly deteriorate financial performance. Juliana quantifies this by stating that "one unit rise in nonperforming loans decreases ROA by 0.10 units," highlighting a measurable adverse effect. This correlation is attributed to the fact that high NPLs lead to increased loan loss provisions, which reduce net income and return ratios. This negative relationship between NPLs and profitability is consistent with earlier studies by Kolapo et al. (2012) and Ruziqa (2013), who found that poor loan performance weakens bank performance by increasing credit risk and eroding asset quality. These studies reinforce the notion that a high NPL ratio not only reflects inefficient credit assessment but also results in reduced investor and customer confidence, ultimately affecting profitability. Recent studies indicate that high NPL ratios often stem from weak credit assessment, poor borrower monitoring, and inadequate internal controls, reflecting operational inefficiency (Sewanyina et al., 2025; Bhowmik & Sarker, 2024; Jiang & Zheng, 2024). Elevated NPLs reduce profitability by lowering interest income and increasing loan loss provisions, thereby weakening ROA across banking systems (Arthur-Sam, 2025; Rachidy & Rasoanomenjanahary, 2025). Moreover, persistent NPLs erode investor and customer confidence, signalling financial instability. (Chukwa et al., 2024; Hamza et al.,2024). In summary, while traditional evidence supports the view that NPLs negatively impact financial

performance, more recent research highlights that green banking practices can potentially buffer this impact. By adopting environmentally responsible lending and sound credit risk management, banks may reduce their exposure to bad loans, supporting long-term financial stability even in the presence of NPLs (Ratnasari et al., 2023; Azzahra et al., 2024; Juliana, 2024). The last hypothesis is formulated: *H3: Non-performing loans has a significant negative effect on banks' financial performance in Malaysia.*

Theoretical Framework

There are three types of theories have been applied to this study. The theories are:

Natural-Resource-Based View (NRBV)

The Natural-Resource-Based View (NRBV), introduced by Hart (1995), expands the Resource-Based View by emphasizing that environmental capabilities can provide a competitive advantage. It highlights strategies like pollution prevention and sustainable development as key to improving firm performance (Hart & Dowell, 2011). For Malaysian banks, adopting green practices such as eco-friendly loans and clean technologies can reduce costs, attract environmentally conscious customers, and enhance reputation. These initiatives also help improve risk management and may lower non-performing loans (Shi et al., 2012). Tan et al. (2022) support the view that environmental strategies boost both financial and environmental outcomes by building stakeholder trust and market differentiation. In short, NRBV offers a strong framework for Malaysian banks to align sustainability with financial success (Hart, 1995; Shi et al., 2012; Tan et al., 2022).

Diffusion of Innovation Theory

The Diffusion of Innovation Theory by Rogers (2003) explains how new ideas and technologies spread over time, making it highly relevant to green banking. Innovation helps banks adopt sustainable practices such as paperless transactions, digital banking, and energy-efficient operations. Ratnasari et al. (2023) highlight that technologies like mobile banking reduce environmental impact while improving service and efficiency. Such innovations attract environmentally conscious customers, create new revenue streams (e.g., green loans, renewable energy investments), and improve competitiveness. Similarly, Azzahra et al. (2023) emphasize that digital transformation supports sustainable finance goals. By embracing innovation, banks can reduce their carbon footprint, lower costs, and align with customer expectations. In short, adopting green technologies enables banks to stay competitive, meet sustainability targets, and enhance financial performance goals that align with the core of Diffusion of Innovation Theory (Ratnasari et al., 2023; Azzahra et al., 2023).

Signaling Theory

Stakeholder Theory, introduced by Freeman (1984), argues that firms should create value for all stakeholders not just shareholders but including employees, customers, communities, and the environment. Long-term business success relies on addressing these diverse interests. Research shows that aligning business strategies with stakeholder needs and environmental goals leads to stronger performance, especially in developing economies with weaker institutions (Fiaschi et al., 2015; Marano et al., 2017; Zheng et al., 2015; Schaltegger et al., 2019). Baah et al. (2021) note that regulatory pressures often push firms to adopt green practices, enhancing both reputation and financial performance. While internal pressures may lead to short-term costs, they yield long-term sustainability benefits. In banking, Tria et al. (2023) found that green practices build trust and loyalty, improving customer relationships and

financial results. Azzahra et al. (2023) add that CSR aligned with stakeholder values especially environmental ones can boost long-term profitability. In summary, Stakeholder Theory supports the idea that green banking enhances both stakeholder trust and financial outcomes, making it a strategic approach for Malaysian banks (Freeman, 1984; Baah et al., 2021; Tria et al., 2023; Azzahra et al., 2023).

In Figure 1, the theoretical framework illustrates the relationship between selected banking indicators and the financial performance of Malaysian banks. The independent variables in this study are Non-Performing Loans (NPL), Operational Efficiency (OPE), and Loan-to-Deposit Ratio (LDR). The dependent variable is Return on Assets (ROA), which serves as a proxy for measuring financial performance.

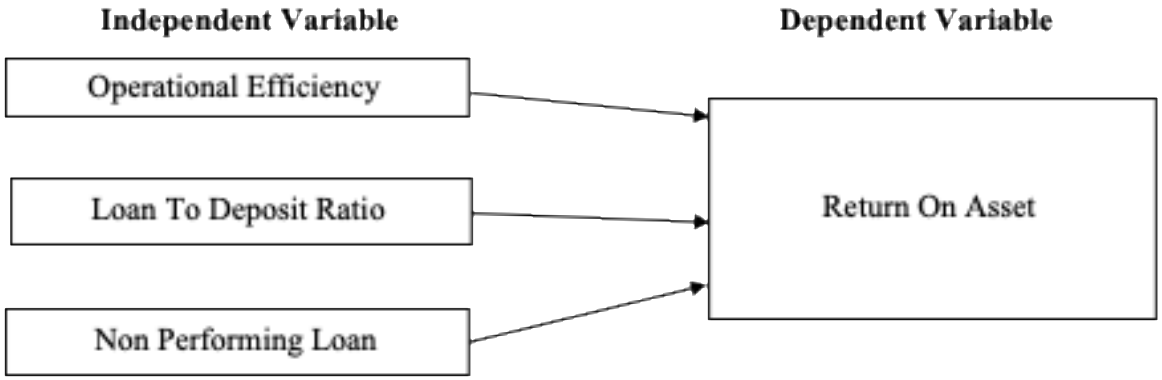


Figure 1: Theoretical Framework

DATA AND METHODOLOGY

This quantitative analysis study examines the relationship between green banking variables and financial performance by using a sample of 15 banks in Malaysia, covering the period from 2016 to 2019. To ensure sufficient data coverage, secondary data were collected from the published annual reports and audited financial statements of the selected banks. Additional information was obtained from reliable sources such as Bank Negara Malaysia (BNM), the UNIMAS ORBIS database, official bank websites, academic journals, and other relevant publications. The financial performance of the banks is measured using Return on Assets (ROA), while the key green banking variables in this study include Non-Performing Loans (NPL), Operational Efficiency (OPE), and Loan-to-Deposit Ratio (LDR). NPL serves as a proxy for credit risk and is calculated by dividing the total non-performing loans by the total gross loans of the bank. A higher NPL ratio indicates lower asset quality and potentially reduced profitability. OPE, on the other hand, measures operational efficiency by comparing the bank's operating expenses to its operating income. A lower OPE ratio reflects greater efficiency and cost management. Lastly, LDR assesses liquidity and is calculated by dividing the total loans by the total deposits. It indicates the bank's ability to convert deposits into revenue-generating loans without facing liquidity risk. To analyze the data and assess the relationship between the independent variables and financial performance, the E-Views software was employed. The findings from the analysis are discussed in the subsequent sections.

RESULTS AND DISCUSSION

Descriptive Statistic

Table 1 displays the summary of the descriptive statistics for the variables used in this study. Among all variables, FIZE recorded the highest mean, maximum, and median values, reflecting the large asset size variation among banks. ROA showed the lowest mean and minimum values, which is expected as it reflects profitability ratios. All variables reported positive minimum values, indicating consistent data without extreme negative outliers. In terms of variation, FIZE also showed the highest standard deviation due to its scale, while ROA had the smallest, suggesting more consistent profitability across the sample. Skewness results indicate that most variables have slight deviations from symmetry, with some positively or negatively skewed distributions. Kurtosis values suggest a leptokurtic pattern in a few variables, especially OPE and NPL. While the Jarque-Bera test indicates that most variables are not normally distributed, ROA stands out with a p-value above 0.05, suggesting it follows a near-normal distribution. Overall, the descriptive statistics present a well-structured dataset with consistent patterns across key financial indicators, suitable for further regression analysis.

Table 1. Descriptive Statistics for LDR, NPL, OPE, FIZE, and ROA

Statistic	LDR	NPL	OPE	FIZE	ROA
Mean	0.861895	0.022300	0.521452	62,839,404	0.008106
Median	0.930685	0.018319	0.476900	22,880,942	0.009000
Maximum	1.055391	0.106027	1.433800	298,000,000	0.014300
Minimum	0.331847	0.002972	0.315100	1,025,308	0.000100
Std. Dev.	0.175311	0.019281	0.167176	78,618,149	0.003277
Skewness	-1.774220	2.076814	2.514654	1.641559	-0.442950
Kurtosis	5.059111	7.939990	12.387520	4.719432	2.625124
Jarque-Bera	62.41603	154.4748	420.5974	50.93512	3.431446
Probability	0.000000	0.000000	0.000000	0.000000	0.179834
Sum	76.70863	1.98472	46.4092	5,590,666,000	0.7214
Sum Sq. Dev.	2.704589	0.032716	2.459419	5.44×10^{17}	0.000945
Observations	89	89	89	89	89
Variables	Tobin's Q	DPR	PE	EPS	FS
Mean	1.230234	0.75325	27.2913	0.29072	21.2459
Median	0.938148	0.46963	19.4195	0.106	21.01
Maximum	5.037568	14.1577	819.355	2.034	23.81
Minimum	-3.80695	-3.3333	-368.85	-0.195	19.42
Std. Dev	1.220043	2.03709	117.543	0.47164	1.2548
Skewness	0.497983	4.4824	3.50433	2.12563	0.59448
Kurtosis	7.084513	28.1105	28.1172	6.84957	2.39779

Correlation Matrix

Table 2 presents the correlation between the variables. The results show that LDR and FIZE have a positive relationship with ROA, while NPL and OPE are negatively related to ROA. Among all, LDR has the strongest positive correlation with ROA (0.251171), suggesting that better loan-to-deposit performance may improve profitability. Conversely, NPL has a moderate negative correlation with ROA (-0.27441), indicating that higher non-performing loans may reduce firm performance. The correlations between OPE and FIZE with ROA are very weak, implying limited influence. A strong negative correlation is also observed between LDR and NPL (-0.57449), meaning that increased lending may help reduce non-performing loans.

Table 2. Correlation between LDR, NPL, OPE, FIZE, and ROA

	LDR	NPL	OPE	FIZE	ROA
LDR	1	-0.57449	0.070474	0.055032	0.251171
NPL	-0.57449	1	0.067314	-0.22467	-0.27441
OPE	0.070474	0.067314	1	-0.28642	-0.04145
FIZE	0.055032	-0.22467	-0.28642	1	0.045245
ROA	0.251171	-0.27441	-0.04145	0.045245	1

Pooled Ordinary Least Squares (POLS) Regression Model

The R-squared value of 0.090152 indicates that approximately 9% of the variation in ROA can be explained by the independent variables in the model (LDR, NPL, OPE, and FIZE). Although this is relatively low, it is not uncommon in studies involving financial ratios, where performance is often influenced by many unobserved factors. The F-statistic value of 2.080772 and its corresponding Prob(F-statistic) of 0.090511 suggest that the overall model is not statistically significant at the conventional 5% level. However, it is near the 10% threshold, which may be considered weakly significant. The model is considered weak because the independent variables explain only a small portion of the variation in ROA. Meanwhile, the POLS model equation is formed as follows from the results in Table 4:

Table 3. Pooled Ordinary Least Squares (POLS) Regression Model Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007002	0.002625	2.667529	0.0092
LDR	0.002705	0.002403	1.125998	0.2634
NPL	-0.032720	0.022294	-1.467580	0.1460
OPE	-0.000860	0.002143	-0.402580	0.6883
FIZE	-7.74E-13	4.64E-12	-0.166670	0.8680

Statistic	Value
R-squared	0.090152
Adjusted R-squared	0.046826
F-statistic	2.080772
Prob(F-statistic)	0.090511

Random Effect Model (REM)

Table 4 shows the result of the Random Effects Model (REM), where ROA has a positive relationship with LDR and C, while NPL, OPE, and FIZE show a negative relationship. The findings suggest that a 1% increase in LDR leads to a 0.42% rise in ROA, while a 1% rise in NPL, OPE, and FIZE would reduce ROA by 1.05%, 0.05%, and 0.000000031% respectively.

However, all variables are statistically insignificant as their p-values exceed the 5% significance level. This indicates that the predictors do not have a strong explanatory power on ROA under the REM model.

Table 4. Random Effect Model (FEM) Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.005008	0.003923	1.276824	0.2052
LDR	0.004204	0.003948	1.064711	0.2901
NPL	-0.010560	0.028665	-0.368500	0.7134
OPE	-0.000490	0.002121	-0.230410	0.8183
FIZE	-3.12E-13	9.32E-12	-0.033460	0.9734

Statistic	Value
R-squared	0.023714
Adjusted R-squared	-0.022780
F-statistic	0.510090
Prob(F-statistic)	0.728441
Mean dependent var	0.002536

Fixed Effect Model (FEM)

Table 5 illustrates the FEM results, where ROA has a positive relationship with LDR and C, while NPL, OPE, and FIZE are negatively related. The findings indicate that a 1% increase in LDR contributes to a 0.41% rise in ROA, while a 1% increase in NPL and OPE slightly reduces ROA by 0.035% and 0.029% respectively. FIZE also shows a very small negative impact on ROA. However, none of the variables are statistically significant, as all p-values exceed the 5% significance level. This suggests that although some variables show directional influence, they do not strongly predict ROA within the fixed effects framework. The FEM equation is formed as follows from the results in 7:

Table 5. Fixed Effect Model (FEM) Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.006527	0.006818	0.957401	0.3417
LDR	0.004147	0.006396	0.648308	0.5189
NPL	-0.000350	0.033462	-0.010350	0.9918
OPE	-0.000290	0.002289	-0.125010	0.9009
FIZE	-2.93E-11	4.35E-11	-0.673140	0.5031

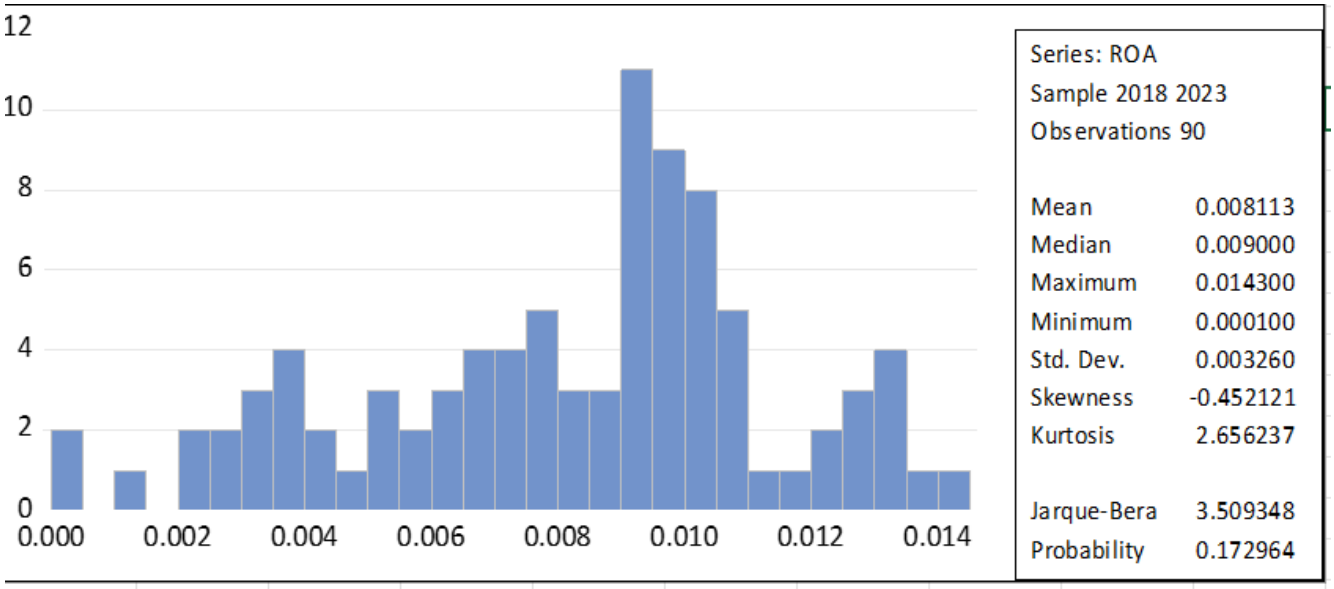
Statistic	Value
R-squared	0.635106
Adjusted R-squared	0.541276
F-statistic	6.768687
Prob(F-statistic)	0

Normality Test – Jarque-Bera (JB)

The normality test for ROA (2018–2023) indicates that the data is approximately normally distributed. The histogram shows a slightly left-skewed bell-shaped curve, supported by a

skewness of -0.452 and a kurtosis of 2.656. The mean (0.0081) and median (0.0090) are close, suggesting only minor asymmetry. Most importantly, the Jarque-Bera test yields a p-value of 0.173, which is greater than 0.05. Therefore, the null hypothesis of normality cannot be rejected. This confirms that ROA data meets the normality assumption, making it suitable for further parametric analysis.

Table 6. Normality Test



Autocorrelation Durbin Watson Test (DW)

In this model, the Durbin-Watson statistic is reported as 2.321402. The value of the Durbin-Watson statistic ranges from 0 to 4. A value close to 2 indicates no autocorrelation. A value less than 2 suggests positive autocorrelation, where residuals tend to be followed by residuals of the same sign. Conversely, a value greater than 2 indicates negative autocorrelation, where positive residuals are more likely to be followed by negative ones, and vice versa. The value of 2.321402 is slightly above 2, which suggests a mild presence of negative autocorrelation in the residuals. However, because the value is close to 2, the negative autocorrelation is not strong and is unlikely to significantly affect the reliability of the regression results.

Table 7. Autocorrelation Durbin Watson Test (DW)

Statistic	**Value**
R-squared	0.635106
F-statistic	6.768687
Prob(F-statistic)	0
Durbin-Watson stat	2.321402

Multicollinearity Test

Table 8 presents the results of the multicollinearity test using a correlation matrix. The purpose of this test is to examine whether there is a strong linear relationship between the independent variables that may affect the accuracy of the regression model. Based on the results, the highest

correlation value is observed between Loan-to-Deposit Ratio (LDR) and Non-Performing Loan (NPL) at -0.5745, which still falls within an acceptable range. All other variables also show correlation values well below the critical threshold of ±0.80. This indicates that multicollinearity is not a serious issue in this model, as no pair of independent variables are highly correlated.

Table 8. Multicollinearity Test

	LDR	**NPL**	**OPE**	**FIZE**	**ROA**
LDR	1	-0.5745	0.07047	0.05503	0.25117
NPL	-0.5745	1	0.06731	-0.2247	-0.2744
OPE	0.07047	0.06731	1	-0.2864	-0.0415
FIZE	0.05503	-0.2247	-0.2864	1	0.04525
ROA	0.25117	-0.2744	-0.0415	0.04525	1

Variance Inflation Factor (VIF) Test

Table 9 show VIF values well below the threshold of 10, with the highest being 1.626 for NPL. This indicates that there is no serious multicollinearity problem in the model. Additionally, the 1/VIF values are relatively high, further confirming that the variables are not strongly related to one another. Therefore, the independent variables can be confidently used in the regression analysis without risking distorted or unstable results.

Table 9. Variance Inflation Factor (VIF) Test

Variable	R^2	VIF	1/VIF
LDR	0.338	1.511	0.662
NPL	0.385	1.626	0.615
OPE	0.092	1.101	0.909
FIZE	0.136	1.157	0.865

Heteroskedasticity LR Test

Table 10 shows this assumption, known as homoskedasticity which is important to ensure the accuracy of standard errors and the validity of statistical inference. In this analysis, the LR test 74 produced a likelihood ratio value of 40.1557 with 15 degrees of freedom and a p-value of 0.0004. Since the p-value is below the 0.05 significance level, the test indicates the presence of heteroskedasticity in the model. This means that the variance of the residuals differs across cross sections, which is common in panel data involving institutions of varying size and characteristics. Rather than posing a limitation, this outcome highlights an opportunity to further refine the model by applying robust techniques.

Table 10. Heteroskedasticity

Test Component	**Value**
Likelihood Ratio	40.1557
Degrees of Freedom (df)	15
Probability	0.0004
Restricted Log Likelihood	387.5639

Unrestricted Log Likelihood	407.6417

Breusch-Pagan Lagrangian Multiplier Test

Table 11 is Breusch-Pagan Lagrange Multiplier (LM) test used to determine whether the Random Effects Model (REM) is more suitable than the Pooled Ordinary Least Squares (OLS) model. The Pooled OLS model performs better than the REM with higher R-squared value (0.0902 vs 0.0237), a higher F-statistic (2.0808 vs 0.5101), and a lower p-value (0.0905 vs 0.7284), indicating better explanatory power and statistical reliability. As a result, the LM test supports the selection of the Pooled OLS model over REM. Therefore, the next step is to conduct the Chow test to compare the OLS model with the Fixed Effects Model (FEM) for further model selection.

Table 11. Breusch-Pagan Lagrangian Multiplier Test

Model	R-squared	Adjusted R-squared	F-statistic	Prob(F-statistic)	Durbin-Watson stat
Pooled OLS	0.0902	0.0468	2.0808	0.0905	0.9536
Random Effects	0.0237	-0.0228	0.5101	0.7284	2.0391

Chow Test

The Chow Test was conducted to determine whether significant individual effects exist across the cross-sectional units in the panel data. Specifically, this test assesses whether each firm possesses its own distinct intercept, which would support the use of the Fixed Effects Model (FEM) over the Pooled Ordinary Least Squares (OLS) model. As shown in the test results in Table 12, both the Cross-section F statistic and the Cross-section Chi-square statistic yield p-values of 0.000, which are below the 0.05 significance threshold. This indicates strong evidence to reject the null hypothesis of no individual effects. The findings suggest Fixed Effects Model (FEM) is more appropriate for this analysis than the Pooled OLS model. This study proceeds with FEM to ensure a more accurate and reliable estimation of the regression coefficients.

Table 12. Chow Test

Test Type	**Statistic**	**d.f.**	**Prob.**
Cross-section F	7.467284	(14, 70)	0.0000
Cross-section Chi-square	81.31664	14	0.0000

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.007002	0.002625	2.667529	0.0092
LDR	0.002705	0.002403	1.125998	0.2634
NPL	-0.032718	0.022294	-1.467576	0.1460
OPE	-0.000863	0.002143	-0.402578	0.6883
FIZE	-7.74E-13	4.64E-12	-0.166670	0.8680

Summary of Result Panel Regression Analysis

Table 13. Summary of Result Panel Regression

ROA	POOLED OLS	REM	FEM
C	0.007002 -2.667529	0.005008 1.276824	0.006527 0.957401
LDR	0.002705 1.125998	0.004204 1.064711	0.004147 0.648308
OPE	-0.00086 0.40258	-0.00049 -0.23041	-0.00029 -0.12501
NPL	-0.03272 -1.46758	-0.01056 -0.3685	-0.00035 -0.01035
FIZE	-7.74E-13 -0.16667	-3.12E-13 -0.03346	2.93E-11 -0.67314
Observation	90	90	90
LM Test	0.090511 0.728441 (OLS is more appropriate)		
Chow Test		6.768687 0.00000 (FEM is more appropriate)	

Discussion

This study tested three main hypotheses related to financial performance, and all were supported by the findings. Firstly, the results show that Operational Efficiency (OPE) has a negative and significant impact on financial performance. This means that when operational costs increase, bank profitability tends to decrease. This finding aligns with Syaifuddin and Saleh (2023), who emphasized that a higher OPE ratio erodes profitability by reducing Return on Assets (ROA). Although Walzer et al., (2024) argue that sustainability initiatives may initially increase operating expenses, their study also highlights how technological innovation and green IT can improve efficiency in the long run. Similarly, Nurdiniah and Pangestu (2024) found that banks maintained stable OPE ratios during external shocks such as COVID-19, underscoring the importance of cost efficiency for resilience. Taken together, these studies reinforce the current finding that operational efficiency is a crucial determinant of bank performance.

Secondly, the results confirm that the Loan to Deposit Ratio (LDR) has a positive and significant relationship with financial performance. This is consistent with the findings of Syaifuddin and Saleh (2023), who observed that optimal credit disbursement enhances ROA. Moreover, Walzer et al. (2024) noted that while green lending may face longer payback periods and higher risks, effective management of green loans can strengthen both profitability and sustainability. The resilience of LDR management is further supported by Nurdiniah and Pangestu (2024), who reported that stable LDR during the COVID-19 crisis helped banks preserve both liquidity and profitability. These insights validate the second hypothesis and highlight the strategic importance of balanced LDR management in enhancing financial

performance. Lastly, the findings indicate that Non-Performing Loans (NPLs) negatively and significantly affect financial performance. This supports the traditional view reported by Juliana (2024), who found that rising NPL ratios reduce ROA, as higher credit risk increases loan loss provisions and weakens profitability. Earlier studies by Kolapo et al. (2012) and Ruziqa (2013) also reinforce this outcome, showing that poor loan performance erodes asset quality and undermines financial returns. However, the results stand in partial contrast with Ratnasari, Surwanti, and Pribadi (2023) and Azzahra et al. (2024), who argued that green banking practices may mitigate the negative effects of NPLs by promoting better risk management and cautious lending. Despite this, the overall evidence suggests that high NPL ratios remain a significant threat to bank profitability, confirming the third hypothesis.

In conclusion, the findings are strongly supported by prior literature: operational efficiency (Syaifuddin & Saleh, 2023; Walzer et al., 2024; Nurdiniah & Pangestu, 2024), loan-to-deposit ratio (Syaifuddin & Saleh, 2023; Walzer et al., 2024; Nurdiniah & Pangestu, 2024), and non-performing loans (Juliana, 2024; Kolapo et al., 2012; Ruziqa, 2013) all significantly influence bank performance. The evidence demonstrates that while green banking introduces new challenges, it also provides pathways for long-term financial resilience when managed strategically.

CONCLUSION

This study investigates the effect of green banking on banks' financial performanceamong selected Malaysian banks from 2018 to 2023. The analysis was conducted using panel data regression methods, including Pooled Ordinary Least Squares (OLS), Random Effects Model (REM), and Fixed Effects Model (FEM). After applying diagnostic tests such as the LM test and the Chow test, the Fixed Effects Model was selected as the most appropriate for capturing the unobserved heterogeneity across the banks in the sample. The findings revealed that LDR has a positive relationship with profitability, suggesting that higher lending activities may contribute to bank performance. NPL and OPE were found to negatively influence ROA, consistent with existing literature that poor loan quality and inefficiency undermine financial performance. Firm size (FIZE), meanwhile, demonstrated a weak effect on profitability. Despite the limited statistical significance of these variables, their directional consistency with financial theory provides valuable insights into the internal factors shaping bank performance. Several limitations were identified in this study. Firstly, the scope of financial indicators was limited, excluding qualitative and ESG-related factors that may influence long-term profitability. Secondly, the study focused solely on the banking sector in Malaysia without comparative analysis across other financial or non-financial sectors. This limits the generalizability of the findings. Additionally, the relatively small sample size and data constraints from secondary sources such as annual reports, TradingView, UNIMAS Remotes Orbis, and Bank Negara Malaysia could have impacted the depth of the analysis.Future research is recommended to incorporate broader variables, including environmental, social, and governance (ESG) indicators, as well as to expand the sectoral scope and sample size to improve accuracy and generalizability. The findings of this study have significant implications for policymakers, regulators, and banking practitioners. Regulators such as Bank Negara Malaysia can use the results to design incentives and frameworks that encourage sustainable banking practices. For practitioners, understanding how operational efficiency, lending behavior, and credit risk interact with green strategies can guide better financial planning and risk management. Moreover, integrating green banking principles into corporate strategy can enhance banks' competitive advantage and long-term stability. In conclusion, this study contributes to the understanding of how internal financial variables relate to bank profitability

in Malaysia and underscores the need for further, more expansive research to support sustainable performance in the evolving financial landscape.

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