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# GREEN BANKING, BOARD DIVERSITY, AND BANK PERFORMANCE: A LINEAR AND NON-LINEAR STUDY IN INDONESIA

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## *ABSTRACT*

*The pressure on the banking sector to embrace sustainability principles stems not only from domestic regulations but also from the fact that economic activities have become urgent concerns for governments and businesses across all industries. This study aims to examine the influence of green banking and board diversity on bank profitability, considering the possibility of nonlinear relationships. Using 39 banks with a 3-year observation period obtained 117 panel data observations, this study uses a Random Effects model with a robust clustered standard errors approach. The results study show that green banking has proven insignificant for profitability. In contrast, non-linear board diversity has been shown to have a u-shape influence, and the linear influence is not significant on profitability. This result is a marker that board diversity are important components in achieving bank performance, meanwhile, green banking has not had a significant impact. The results also support the theory of upper echelons and self-categorization.*

***Keywords****: board diversity, green banking, profitability, nonlinier*

## 1. INTRODUCTION

The rise of environmental, social, and governance (ESG) issues in the Indonesian banking sector reflects a dynamic that aligns with the concept of financial performance as a company's ability to achieve positive results sustainably over the long term. Amid this trend, Indonesian banks face dual pressures. First, the Financial Services Authority (OJK) mandates that all banking institutions prepare sustainability reports, demanding a genuine commitment to ESG principles. Second, banking profitability remains relatively volatile and continues to serve as the primary indicator of success in the eyes of stakeholders(Almaqtari et al., 2024).

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Central bank authorities worldwide have also begun to take on the responsibility of promoting sustainability (European Banking Authority & European Securities and Markets Authority, 2021). In this context, banks are encouraged to take concentrated steps toward achieving sustainable development goals (Birindelli et al., 2022), given their strategic role in the economy and their substantial responsibilities toward stakeholders and society at large (Chiaramonte et al., 2022). Amid growing pressure on the banking sector to adopt sustainability principles, a gap remains in the empirical evidence regarding the extent to which such efforts affect profitability.

Green banking represents one of the worldwide efforts undertaken by various major stakeholders to safeguard the environment. As defined by the Bangladesh Bank, green banking encompasses environmentally friendly and sustainable approaches in both the daily operations and lending practices of banks (Lalon et al., 2025). However, in the context of green banking, research findings remain divided. Some studies conclude that green banking practices can enhance bank profits by improving operational efficiency and strengthening public perception (Inegbedion, 2024; Nguyen, 2025). In contrast, other findings suggest that green banking may act as a cost burden, eroding earnings (Riyanti et al., 2025), or yield no meaningful impact on financial performance (Muchiri et al., 2025). Furthermore, the overall relationship between corporate governance, sustainability practices, and bank profitability has yet to demonstrate a consistent and broadly accepted pattern (Almaqtari et al., 2024).

The Board has a central role in business decision-making. Market dynamics and environmental complexity need to be faced by boards with different perspectives and capabilities. The diversity of the board is created based on demographic (gender, age, ethnicity, and nationality) and cognitive (education, experience, and culture) differences (Wang, 2024). Aureli et al. (2026) said that the diversity board forms a meeting room with the perspective of stakeholders with various perspectives, which can foster group discussions, quality problem solving, and encourage the learning process. Recent studies have found gender diversity, independence, and board educational backgrounds significantly improve financial

performance measures such as ROA (Return on Assets), ROE (Return on Equity), and Tobin's Q (Gharios et al., 2024; Issa et al., 2024; Kampoowale et al., 2025). Although in practice, the diversity of the age of the board can actually cause conflict and hinder effective decision-making, thus causing a decrease in profits (Aureli et al., 2026; Talavera et al., 2018). Even research Grishunin et al. (2024) In 470 banks from emerging markets, the diversity of the board had no effect on financial performance.

Despite these valuable insights, a notable research gap remains. Most existing studies focus on examining the linear relationship between governance mechanisms, green banking practices, and bank profitability. However, the relationship between governance and financial performance is possible nonlinear (Khatib et al., 2021). Wang (2024) found an inverse U-shaped relationship pattern between board diversity and profitability in manufacturing companies listed on the Shanghai and Shenzhen Stock Exchange A for the period 2013-2022. Another study in the European banking sector found evidence of a U-shape non-linear relationship between the ratio of gender diversity on the board to a company's market value (Tobin's Q) and its financial stability (Z-Score) (Aureli et al., 2026).

Similarly, green banking initiatives are frequently assumed to have a linear association with financial outcomes; however, this assumption has rarely been subjected to rigorous nonlinear testing (Lian et al., 2022). Recently research (Nguyen, 2025) find a significant U-shape impact of eco-friendly product innovation - profitability in 409 non-financial listed firms in emerging East Asia for the period 2015-2019. Nguyen revealed that green activities often require high costs at first, but as consumers accept environmentally conscious products, productivity will be achieved and turn into positive profits.

To bridge the inconsistent previous findings, this study examined the linear and non-linear relationship between green banking and board diversity on profitability. Most previous research has been dominated on cross-country data. This research focuses on developing countries to see how national cultures, market maturity levels, and local regulations are able to modify the form of non-linear relationships between green banking investments, board diversity composition, and

profitability (Khatib et al., 2021). We simultaneously testing both linear and non-linear models using the most recent panel data from banks listed on the Indonesian Stock Exchange (IDX), this research aims to provide a more accurate and comprehensive understanding of these dynamics. This is especially urgent in a rapidly developing context, such as Indonesia, where regulators, such as the OJK, are increasingly mandating sustainability reporting, yet the financial outcomes of these mandates remain unclear. Therefore, this study is not merely an academic exercise; it is a necessary step to provide evidence-based insights that can guide bank management in optimising their strategies and regulators in formulating effective policies, ultimately ensuring that the push for sustainability and good governance translates into tangible and positive financial performance.

## 2. LITERATURE REVIU AND HYPOTHESIS

### Theoretical Foundations

Several complementary theoretical perspectives have given rise to this study. According to stakeholder theory (Freeman, 2018), companies must balance the interests of various stakeholders (not only shareholders) to ensure their long-term survival. The board's response to environmental and diversity issues reflects concern for stakeholder expectations, which has the potential to enhance legitimacy and performance in the broader banking context. While stakeholder theory explains the normative basis for why banks should adopt sustainability practices, resource dependency theory provides an instrumental mechanism for addressing pressures that translate into organizational actions. According to the theory of resource dependence (Pfeffer & Salancik, 2003), organisations are required to interact with the environment to obtain the resources needed. They rely on external resources, which creates uncertainty; therefore, companies must manage relationships with the parties holding key resources. It considers regulatory and social pressures, implements green banking practices, and the diversity of the board demonstrates efforts to manage environmental dependence.

Rather than simply responding to external pressures, natural resource-based views and ecological efficiency logic suggest that proactive environmental

strategies can result in sustainable competitive advantages, shifting the argument from compliance to value creation. Three strategic capabilities are identified in Hart (1995) the natural resource-based view: pollution prevention, product management, and sustainable development. Such resources help companies develop a sustainable competitive advantage through intangible, socially complex, and scarce (i.e., difficult to replicate) resources, and they are unlikely to be replicated, meaning that it may be difficult to build a sustainable competitive advantage. For banks, green is a strategic investment that will lower operational costs, reduce risk exposure, and improve reputation. The justification of ecological efficiency (Porter & Linde, 1995) supports this argument because it suggests that pollution is another form of economic inefficiency. Innovations to reduce pollution impacts, increase resource productivity, and lower costs. Initiatives such as paperless operations may not only reduce impact but also operational costs, and green project financing creates new market segments and helps diversify risks.

However, the extent to which these strategic environment capabilities are recognized and pursued effectively depends largely on the cognitive orientation and values of those at the top of the organization, where the dynamics expressed by the upper echelon theory. Upper echelon theory (Hambrick & Mason, 1984) suggests that some organizational outcomes are at least several times predicted by the nature of top management. Age, tenure, and educational background are observable indicators of cognitive conditions and values that guide strategic choices. The demographics of the board influence the decision-making process and company performance. The upper echelon theory establishes that the composition of the board shapes strategic decisions, but the theory of social categorization adds an important qualification where heterogeneity brings cognitive benefits and coordination costs, the impact of which on balance determines whether diversity ultimately enhances or weakens performance. According to social categorisation theory (Milliken & Martins, 1996), with respect to observable attributes (gender, race, and age), variation is said to be associated with negative affective effects, such as higher turnover and lower social integration; diversity can also improve cognition within a group after the group has passed through the first phase of

conflict. After passing through this phase, the impact of diversification will appear to improve performance.

Together, these five theoretical lenses form a coherent framework: stakeholder theory and resource dependency explain the external pressures driving green banking adoption and board diversity; a natural resource-based view and ecological efficiency logic explain the potential for increased profitability; While upper echelon theory and social categorization explain why the relationship between the composition of the board of directors and financial results is not simple or linear.

**Green Banking and Bank Profitability**

Green banking refers to the practice in which banks incorporate environmental considerations into operations, lending, and products in bank decisions (Jain & Sharma, 2023). These practices respond from a stakeholder theory perspective to pressure from regulators, customers, and society. Resource dependence theory suggests that banks are driven by external needs and thus exert pressure to respond to environmental opportunities.

According to the natural resource-based view, pollution prevention capabilities, such as in the domain of banking and efficient use of energy and waste reduction, rely largely on intangible skills that are difficult to replicate, thus making them expensive in the long run. The logic of ecological efficiency states that pollution implies inefficiency; therefore, efforts to reduce pollution through innovation can increase the productivity of productive resources.

There is mixed empirical evidence, but positive trends show positive signs. Jain & Sharma (2023) and Renz et al., (2023) reports a strong and positive link between green banking and profitability. In fact, Lian et al. (2022) shows that green credit improves the performance of banks in China. In contrast, (Muchiri et al., 2025) found positive but insignificant impacts in the meta-analysis, and Riyanti et al. (2025) noted negative effects in Indonesia, perhaps reflecting the cost of the initial transition. The theoretical basis for linking profitability to green banking consists of operational efficiency (Porter & Linde, 1995), increased legitimacy and stakeholder trust (Freeman, 2018), better risk management (Pfeffer & Salancik,

2003), and product innovation in expanding market entry (Hart, 1995). Nguyen (2025) argued that although green initiatives initially entail substantial investment and adjustment costs, increasing consumer acceptance of environmentally responsible products can enhance operational productivity and eventually generate positive profitability outcomes, so there is the potential for non-linear relationships.

**Board Diversity and Profitability of the Bank**

Diversity on the board includes dimensions such as gender, age, nationality, independence, and education of board members. Upper echelon theory (Hambrick & Mason, 1984) states that the nature of top management drives the quality of strategic decisions and the management style that influences strategic decisions. Resource dependency theory (Pfeffer & Salancik, 2003) suggests that diverse boards provide access to networks and resources. Social categorisation theory (Milliken & Martins, 1996) warns of the possible impact of diversity on costs.

Diversity in observable attributes leads to decreased satisfaction, lower commitment, and higher turnover (Alzayed et al., 2024; Talavera et al., 2018). However, diversity also appears to improve cognitive performance, including cognitive outcomes for complex problems, although these are effects that may take time to emerge (Alzayed et al., 2024; Issa et al., 2021; Talavera et al., 2018). This view implies that non-linearity might suggest that this relationship can, at least, persist in this direction.

At low levels of diversity, the benefits are limited; at moderate levels, cognitive benefits begin to emerge, but coordination costs can remain low; at very high levels of diversity, the costs of coordination and conflict may outweigh the benefits. This possibility has empirical evidence. Wang (2024) found that Chinese firms exhibit an inverted U-shaped relationship. Guedes & Grübler (2025) found a comparable relationship for gender diversity and ESG performance. In contrast, Aureli et al. (2026) found a positive relationship between diversity and bank performance. Not all dimensions of diversity have the same effect (Bhateja, 2025; Hosny & Elgharbawy, 2022; Nur & Darvin, 2023; Torchia & Solarino, 2026), and Issa et al. (2021) emphasize that diversity should not be interpreted merely as the presence of one or two differing characteristics, but rather as the coexistence of

multiple heterogeneous attributes, perspectives, and backgrounds that collectively shape organizational dynamics and decision-making processes. Therefore, this research combines diversity attributes (gender, age, foreign board, independence diversity, and education) simultaneously with the Blau Index.

**Hypothesis Development**

Based on the above theoretical and empirical syntheses, we develop the following hypothesis:

Stakeholder theory, NRBV, and environmental efficiency logic explain the relationship between green banking and bank profitability. Environmentally focused and stakeholder-oriented behaviour promotes a green banking ethos, legitimacy with stakeholders, and attracts premium customers and investors (Freeman, 2018; Jain & Sharma, 2023). Improved ROI resulting from lower resource use and environmental filtering can directly contribute to profitability (de Moraes et al., 2024; Hart, 1995; Porter & Linde, 1995). Although some reports show short-term adverse impacts (Han et al., 2019; Riyanti et al., 2025), these may correspond to transition costs that decrease over time according to eco-efficiency theory (Porter & Linde, 1995). Data from emerging Asian markets show a positive relationship (Lalon et al., 2025; Lian et al., 2022; Nguyen, 2025; Siauwijaya et al., 2023). Therefore:

***H1:*** *Green Banking Has a Positive Effect on Bank Profitability.*

Stakeholder Theory and Resource Dependence Theory explain that green banking encourages banks to respond to regulator, customer, and environmental opportunities through the integration of sustainability aspects in operations and financing (Freeman, 2018; Pfeffer & Salancik, 2003). Furthermore, Natural Resource-Based View emphasizes that energy efficiency, waste reduction, and environmentally friendly innovation can create a competitive advantage and improve operational efficiency and bank legitimacy (Hart, 1995). However, the implementation of green banking in the early stages often requires high investment and adjustment costs so that it can reduce profitability, while in the long term increasing market acceptance of environmentally friendly products has the potential to increase productivity and profitability. Therefore, the relationship between green

banking and profitability has the potential to form a non-linear pattern in the form of U-shape. Nguyen (2025) find a significant U-shape impact of eco-friendly product innovation - profitability in 409 non-financial listed firms in emerging East Asia for the period 2015-2019. In other words:

***H2:*** *Green Banking generates a non-linear relationship with the bank's profitability.*

The relationship between board diversity and bank performance is theoretically complicated. According to upper-ecelons theory (Hambrick & Mason, 1984), heterogeneous perspectives result in better quality strategic decisions. In contrast, the theory of resource dependency (Pfeffer & Salancik, 2003) suggests that diverse boards provide broader access to networks and network legitimacy. We have positive evidence from the banking context supporting favourable findings (Islam et al., 2025; Issa et al., 2024; Najaf et al., 2025; Pham et al., 2025), which leads the authors to expect positive linear relationships:

***H3:*** *The bank's profitability is positively influenced by Board Diversity.*

Theoretical arguments and empirical observations increasingly support the possibility of non-linear relationships. In low diversity, diverse perspectives do little for us, and the cost of coordination remains low. Moderate diversity can provide adequate cognitive diversity but also commonality within the organisation for optimal coordination (Milliken & Martins, 1996). Another study in the European banking sector found evidence of a U-shape non-linear relationship between the ratio of gender diversity on the board to a company's market value (Tobin's Q) and its financial stability (Z-Score) (Aureli et al., 2026). Therefore:

***H4:*** *The impact of Board Diversity on the bank's profitability is non-linear.*

## 3. RESEARCH METHOD

To test the linear and non-linear effect, quantitative studies were used in this study with an explanatory/causal research approach. The population used was 47 banks listed on the Indonesian Stock Exchange for the period 2022-2024. The period reflects the post-pademic recovery phase relevant to the adoption of green banking in Indonesia, and is the period after the OJK requires a full sustainability report.

Purposive sampling was used in this study, and 120 observations were obtained during the observation period (see Table 1).

Table 1

Research Sample

| No | Criteria | Total |
|---|---|---|
| 1 | The publication of financial statements and regular reports throughout the observation period | 47 |
| 2 | A positive return on equity (ROE) | (8) |
| | Total Sample | 39 |
| | Total Observation (39 x 3) | 117 |

Source(s): Authors' own work

Nonlinear measurements require meaningful variation, and banks with extreme negative ROEs have the potential to distort curve estimates. This study uses the green coin rating (GCR) indicator, which consists of carbon emissions, green rewards, green buildings, reuse/recycle, refurbish, paper work or paperless, and green investments, with a content analysis approach from the bank's annual report with single coder (Asmara & Nugraeni, 2024). Board diversity consists of (1) gender diversity: female and male; (2) age dispersion value are 1= 25–35, 2= 36–45, 3= 46–55, 4= 56–65, and 5=more than 65 years; (3) foreign board of: foreign nationality and Indonesian nationality; (4) independence diversity: the independent and non-independent board; and (5) education diversity: elementary school and junior high school, senior high school, diploma/bachelor, master, and doctoral, (Ararat et al., 2015; Kusuma et al., 2021) and was calculated using the Blau Index. We used natural logarithm to reduce asset and age disparities. The operational definition of the variable is presented in table 2.

Table 2

Measurement of Research Variables

| Variable | Measurement | Data Source |
|---|---|---|
| Dependent: | | |
| .Profitability (ROE) | Earnings After Tax / Tier 1 Capital (Bank Indonesia) | Financial Report |
| Independent: | | |
| .Green Banking (GB) | Total Reporting / Total Indicatior GCR | Sustainability Report |
| .Board Diversity (BD) | $1 - \sum_{i=1}^{k} P_i^2$ (Blau, 1977) | Annual Report |

| | | |
|---|---|---|
| Control: | | |
| .Firm Size (SIZE) | Ln (Total Asset) (Kusuma et al., 2021) | Financial Report |
| .Firm Age (AGE) | Ln (Firm Age) (Wibisana et al., 2018) | Financial Report |
| . Capital Adequacy Ratio (CAR) | (Tier 1 + 2 Capital / Risk-Weighted Assets | Financial Report |
| . Non - Performing Loan (NPL) | Non-Performing Loan / Total Loan (Bank Indonesia) | Financial Report |
| . Operating Expense Ratio (BOPO) | Operating Expense / Operating Income (Bank Indonesia) | Financial Report |
| . Loan to Deposit Ratio (LDR) | Total Financing / Third Party Funds (Bank Indonesia) | Financial Report |
| . BI Rate (RATE) | Average BI 7-Day Reverse Repo | Bank Indonesia |
| . Exchange Rate (KURS) | Exchange Rate IDR/USD | JISDOR Bank Indonesia |

Source(s): Authors' own work

This study uses data panel analysis testing (Baltagi, 2005). To mitigate the influence of extreme values, all continuous variables were winsorized at the 1st and 99th percentiles prior to estimation (Leone et al., 2019). To assess the robustness of the main findings, a sensitivity analysis was conducted by comparing three model specifications: random effects with winsorized data, random effects with raw data, and robust regression using the IRLS estimator (Leone et al., 2019). The Hausman test and Breusch-Pagan LM test were used to select viable models (Hausman, 1978) (see table 6). The research model is described as follows:

$$ROA_it = \alpha + \beta_1 GB_it + \beta_2 GB^2_it + \beta_3 BD_it + \beta_4 BD^2_it + \beta_5 SIZE_it + \beta_6 AGE_it + \beta_7 CAR_it + \beta_8 NPL_it + \beta_9 BOPO_it + \beta_{10} LDR_it + \beta_{11} RATE_it + \beta_{12} KURS_it + \varepsilon_it \quad (1)$$

Quadratic was chosen because it can theoretically capture U-shape and inverted U-shape according to the theoretical predictions used. To test feasibility, classical assumption testing was conducted, including the residual normality test using Shapiro-Wilk, heteroscedasticity test using Breusch-Pagan het test, Pesaran CD test to detect cross-sectional dependence across bank panels, and multicollinearity test using VIF. To reduce the effect of high multicollinearity, Mean-centring of GB and BD was subsequently performed on the winsorized

values prior to squaring, to ensure that the centering point reflects the cleaned data distribution (Aiken et al., 1991). Stata 18 is used as a statistical analysis tool.

## 4. RESULTS AND DISCUSSION

### Results

Table 3 presents a descriptive summary of the statistics. The mean (standard deviation) of the profitability variable measured by ROE is 0.082 (0,068), sufficient based on standards. Meanwhile, green banking and board diversity were 0.912 (0.132) and 1.919 (0.599), respectively. Green banking reporting activities using content analysis had a high value during the observation period. As for the control variables, namely firm size and firm age with natural log measurements, they had an average of 31.574 and 3.718, respectively. while the bank's internal ratios show that overall it is ideal or according to standards: CAR 0.380 (0.267), NPL (0.011) 0.009, BOPO 0.788 (0.156), LDR 0.911 (0.424). Lastly, BI rate and exchange rate average was 0.053 (0.009) and 15,337.67 (425.89).

Table 3
Descriptive Statistics

| Variable | Obs | Mean | Std. Dev | Min | Max |
|---|---|---|---|---|---|
| ROE | 117 | 0.0816 | 0.0677 | 0.0018 | 0.246 |
| GB | 117 | 0.9117 | 0.1323 | 0.5 | 1 |
| BD | 117 | 1.9185 | 0.5995 | 0.4688 | 3.2469 |
| SIZE | 117 | 31.5743 | 1.6469 | 28.4077 | 35.2143 |
| AGE | 117 | 3.7179 | 0.6601 | 0.6931 | 4.8521 |
| CAR | 117 | 0.3804 | 0.267 | 0.1078 | 1.5806 |
| NPL | 117 | 0.0109 | 0.0096 | 0 | 0.0388 |
| BOPO | 117 | 0.7879 | 0.1563 | 0.3105 | 1.0336 |
| LDR | 117 | 0.9114 | 0.4244 | 0.3268 | 3.55 |
| RATE | 117 | 0.053 | 0.0091 | 0.0403 | 0.0612 |
| KURS | 117 | 15337.67 | 425.89 | 14,876 | 15,900 |

Source(s): Authors' own work

The correlation matrix is presented in Table 4, which shows that all independent and control variables have a mix result with profitability. Meanwhile, the relationship between independent variables and green banking had a significant

positive correlation with firm size ($r = 0.439$, $p < 0.05$); however, it was negatively correlated and significantly correlated with board diversity ($r = -0.198$, $p < 0.05$).

Table 4
Correlation Matrix

| Variable | ROE | GB | BD | SIZE | AGE | CAR | NPL | BOPO | LDR | RATE | KURS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROE | 1.000 | | | | | | | | | | |
| GB | 0.440* | 1.000 | | | | | | | | | |
| BD | -0.198* | -0.210* | 1.000 | | | | | | | | |
| SIZE | 0.417* | 0.449* | 0.057 | 1.000 | | | | | | | |
| AGE | 0.045 | -0.072 | 0.234* | 0.290* | 1.000 | | | | | | |
| CAR | -0.331* | -0.505* | 0.1696 | -0.516* | 0.068 | 1.000 | | | | | |
| NPL | -0.387* | -0.048 | 0.026 | -0.239* | -0.024 | 0.072 | 1.000 | | | | |
| BOPO | -0.690* | -0.112 | -0.028 | -0.201* | -0.224* | -0.180 | 0.375* | 1.000 | | | |
| LDR | -0.137 | -0.386* | 0.243* | -0.248* | 0.143 | 0.662* | 0.063 | -0.385* | 1.000 | | |
| RATE | -0.038 | -0.015 | 0.023 | 0.036 | 0.033 | -0.058 | -0.044 | 0.062 | 0.024 | 1.000 | |
| KURS | -0.036 | -0.012 | 0.012 | 0.040 | 0.037 | -0.077 | -0.053 | 0.073 | -0.001 | 0.865* | 1.000 |

*Note: * $p < 0.05$. Lower triangle shows Pearson correlation coefficients.*
Source(s): Authors' own work

Table 5 shows the multicollinearity test using the variance inflation factor (VIF). We were due to the inclusion of square terms without mean-centering, which created a high correlation between linear and quadratic terms. After mean centring was performed, the overall VIF value of the independent and control variables was below 5, indicating freedom from the symptoms of multicollinearity.

Table 5
Variance Inflation Factor (VIF)

| Variable | VIF | 1/VIF |
|---|---|---|
| Green Banking | 4.22 | 0.2368 |
| Exchange Rate | 4.01 | 0.2496 |
| BI Rate | 3.99 | 0.2507 |
| Green Banking$^2$ | 3.29 | 0.3043 |
| CAR | 2.70 | 0.3704 |
| LDR | 2.41 | 0.4154 |
| Bank Size | 2.01 | 0.4985 |
| BOPO | 1.82 | 0.5496 |
| NPL | 1.34 | 0.7464 |
| Bank Age | 1.34 | 0.7475 |
| Board Diversity | 1.24 | 0.8083 |
| Board Diversity$^2$ | 1.17 | 0.8535 |

Source(s): Authors' own work

Table 6 indicates that the panel data model is more appropriate than pooled OLS, as evidenced by the significant Breusch–Pagan Lagrange Multiplier (LM) test result ($\chi^2 = 68.94$; $p = 0.0000$), confirming the existence of panel effects. Furthermore, the Hausman test produced a chi-square value of 15.70 with a p-value

of 0.1525, indicating no systematic difference between the Fixed Effects and Random Effects estimators. Therefore, the Random Effects (RE) model is considered more appropriate for the analysis. The Pesaran Cross-sectional Dependence (CSD) test reported a p-value of 0.5729, suggesting the absence of cross-sectional dependence among panel units. In addition, the serial correlation test generated a coefficient of -0.1743 with a p-value of 0.0896, indicating only weak serial correlation and no strong evidence of autocorrelation at the 5% significance level. However, the Breusch–Pagan heteroskedasticity test revealed a significant result ($\chi^2$ = 12.18; p = 0.0005), indicating the presence of heteroskedasticity. To address this issue and ensure more reliable statistical inference, the estimation employed robust clustered standard errors. Regarding the normality assumption, the Shapiro–Wilk test showed that the residuals were normally distributed (W = 0.9872; p = 0.3349). This finding was further supported by the Skewness–Kurtosis test ($\chi^2$ = 3.29; p = 0.1931), indicating that the residual distribution does not suffer from significant skewness or kurtosis problems.

Table 6
Panel Diagnostic Tests

| Test | Statistic | p-value | Decision |
|---|---|---|---|
| Breusch–Pagan LM Test | $\chi^2 = 68.94$ | 0.00 | Panel model required |
| Hausman Test | $\chi^2 = 15.70$ | 1.06 | Random Effects preferred |
| Pesaran CD Test | $z = -0.564$ | 3.98 | No cross-sectional dependence |
| Serial Correlation (AR1) | coef = −0.1743 | 0.62 | Weak serial correlation; robust cluster SE applied |
| Breusch–Pagan Heteroskedasticity Test | $\chi^2 = 12.18$ | 0.00 | Heteroskedasticity detected; robust SE used |
| Shapiro–Wilk Normality Test | W = 0.9872 | 2,33 | Residuals normally distributed |
| Skewness–Kurtosis Test | $\chi^2 = 3.29$ | 1,34 | No skewness/kurtosis problem |

Source(s): Authors' own work

Table 7 show the Pooled OLS results, indicate that the model is statistically significant at the 5% level. However, based on the Hausman and Breusch–Pagan LM tests, the Random Effects model with robust clustered standard errors was selected as the main estimation model. The Random Effects estimation produced a

Wald $\chi^2$ value of 207.63 with a probability value of 0.000, indicating that the model is fit.

The regression results show that green banking does not have a significant linear effect on profitability ($\beta = -0.003$; $p > 0.10$). In contrast, the quadratic term of green banking is positive and significant at the 5% level ($\beta = 0.159$; $p < 0.05$). These findings suggest a nonlinear relationship between green banking and profitability, indicating that the positive impact of green banking becomes stronger as the level of green banking implementation increases. Although the results are significant, these results are not consistent in raw data RE and robust regression (see table 7). Therefore, H1 and H2 are rejected.

Meanwhile, board diversity does not have a significant linear effect on profitability ($\beta = -0.009$; $p > 0.10$). However, the quadratic term of board diversity shows a positive and significant effect at the 5% level ($\beta = 0.020$; $p < 0.05$), indicating evidence of a U-shaped relationship between board diversity and profitability. This implies that at lower levels of board diversity, the effect on profitability tends to be negative, but after reaching a certain threshold, the effect becomes positive. Inflection point of Board Diversity = 2.136 (within data range 0.469–3.247). Therefore, H3 is rejected, while H4 is accepted.

Regarding the control variables, bank age has a negative and significant effect on profitability ($\beta = -0.015$; $p < 0.05$), indicating that older banks tend to experience lower profitability. In addition, BOPO has a negative and highly significant effect on profitability ($\beta = -0.354$; $p < 0.01$), suggesting that higher operational inefficiency reduces bank profitability. Likewise, LDR negatively affects profitability ($\beta = -0.073$; $p < 0.01$). Meanwhile, bank size, CAR, NPL, BI Rate, and exchange rate do not significantly influence profitability in the Random Effects model.

The model demonstrates relatively strong explanatory power, with an overall R-squared value of 0.7288, indicating that approximately 72.88% of the variation in profitability can be explained by the independent and control variables included in the model.

Table 7
Regression Results

| Variable | Pooled OLS | | RE Model | | Decision |
|---|---|---|---|---|---|
| | Coef | SE | Coef | SE | |
| Green Banking | 0.079* | (0.0400) | -0.003 | (0.028) | **H1 rejected** |
| Green Banking$^2$ | 0.149 | (0.1188) | 0.159** | (0.077) | **H2 rejected** |
| Board Diversity | -0.008 | (0.0052) | -0.009 | (0.006) | **H3 rejected** |
| Board Diversity$^2$ | 0.018*** | (0.0061) | 0.020**$^+$ | (0.010) | **H4 accepted** |
| Bank Size | 0.003 | (0.0039) | 0.008 | (0.005) | |
| Bank Age | -0.011** | (0.0040) | -0.015** | (0.006) | |
| CAR | -0.050* | (0.0257) | -0.003 | (0.029) | |
| NPL | -0.168 | (0.3600) | -0.030 | (0.313) | |
| BOPO | -0.337*** | (0.0326) | -0.354*** | (0.039) | |
| LDR | -0.034*** | (0.0105) | -0.073*** | (0.012) | |
| BI Rate | 0.022 | (0.6883) | 0.129 | (0.161) | |
| Exchange Rate | 0.000 | (0.0000) | 0.000 | (0.000) | |
| Constant | 0.309 | (0.2363) | 0.198 | (0.193) | |
| **Model Fit Statistics** | | | | | |
| R-squared | 0.770 | | 0.727 | | |
| R-sq (overall) | — | | 0.729 | | |
| R-sq (within) | — | | 0.695 | | |
| Wald $\chi^2$ | — | | 207.63 | | |
| Prob > $\chi^2$ | — | | 0.000 | | |
| Observations | 117 | | 117 | | |
| Number of Groups | — | | 39 | | |
| SE Type | Robust | | Robust Cluster | | |
| Method | OLS | | Random Effects | | |

*Note: Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01.*

$^+$*Inflection point BD = 2.136 (within data range 0.469–3.247).*

Source(s): Authors' own work

## Discussion

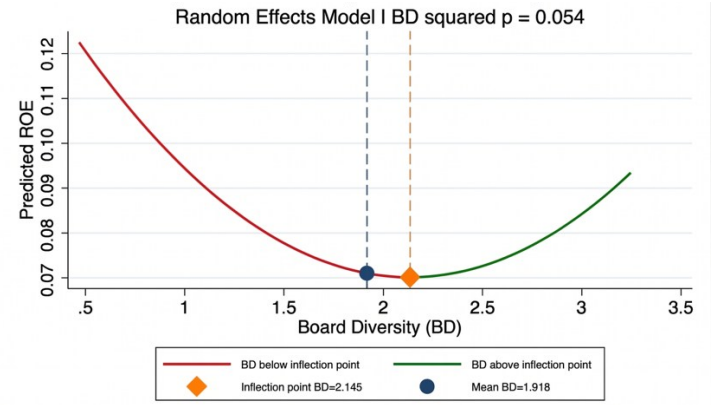
The results show that green banking has not influence on profitability (H1), and there is insufficient evidence to support the nonlinear relationship of green banking (H2). Although board diversity does not have a significant linear effect (H3), board diversity shows a U-shaped pattern towards profitability (H4). The main discussion uses a random effects model based on panel effects and inconsistencies of fixed

effects models. Meanwhile, Heteroskedasticity problem are anticipated with robust clustered standard errors.

Green banking is not associated with profitability, in line with Muchiri et al. (2025) in the meta-analysis study, there was no overall effect between green banking and profitability, suspected because green initiatives depend on geographical context, regulation, bank size, and financial market maturity. Although the level of green banking reporting is relatively high (mean = 0.912), the small standard deviation (0.132) indicates that variation among banks is limited. Nearly all banks report sustainability reports as a regulatory requirement rather than as a strategic initiative. When all banks act in unison due to regulations, green banking loses its ability to differentiate itself, resulting in an undetectable effect on ROE. Stakeholder pressure drives green banking adoption, but the resulting legitimacy is not immediately reflected in short-term ROE, there is a lag between sustainability investments and financial returns (Freeman, 2018). Based on NRBV, green banking capabilities are intangible and take time to develop into financially measurable competitive advantages (Hart, 1995).

The linear effect of board diversity on profitability was not significant, similar to prior research (Kusuma et al. 2018; Pham et al., 2025), but at the level of 5% board diversity, the quadratic term proved to be significantly positive with a turning point of 2.145 (see Figure 1), indicating the existence of a U-shaped pattern. At a low level, diversity can hinder communication and cause friction and conflict in the meeting room, which can be detrimental to the bank's performance (Kusuma et al., 2021). Once a certain point has passed (Wang, 2024), the benefits of diversity become positive as the quality of oversight improves, strategic perspectives are richer, decisions are more mature, and governance legitimacy is stronger (Aureli et al., 2026; Kampoowale et al., 2025). This result proves that the benefits of board diversity on profitability are suspected to be felt after reaching a certain level of diversity. Based on the logic of self-categorization theory, in the early stages of group formation, homogeneous boards report better processes and performance because they do not face conflicts; however, after some time, heterogeneous groups begin to get used to each other such that their negative impact decreases

significantly, and a point of equilibrium with homogeneous groups is reached and can even exceed it through the exploration of new perspectives and the generation of strategic alternatives (Milliken & Martins, 1996). The essence of upper echelons reveals that diversity of opinions, knowledge, and backgrounds allows for a thorough evaluation and review of alternative strategies; therefore, in a turbulent environment, team diversity will be positively related to increasing a company's profitability (Hambrick & Mason, 1984).




Source(s): Authors' own work

**Figure 1. U-Shaped Relationship: Board Diversity and Profitability**

The results of the study indicate that the control variables, namely bank age, BOPO and LDR, are negative significant explanations of profitability. Kramaric & Miletic (2017) said older banks tend to have more rigid administrative processes, complicated bureaucracy, increased costs, slower growth, and assets and strategies that may be obsolete compared to their younger competitors, and ultimately negatively impact profitability. High Operating Expense Ratio (BOPO) will burden banks and cut revenues from financing allocations, and will ultimately lower profits, in line with the findings Insani & Muflih (2019). Meanwile, the high LDR indicates that banks are aggressively disbursing financing compared to third-party funds, thereby disrupting liquidity (high risk), and ultimately reducing profitability (Insani & Muflih, 2019). Therefore, bank size, CAR, NPL, BI Rate, and exchange rate do not significantly influence profitability.

This study contributes to the literature by demonstrating that the relationship between governance mechanisms and bank profitability is neither uniform nor linear. The rejection of linear green banking effects suggests that compliance-driven

adoption, as observed in the Indonesian context, does not automatically translate into improved financial performance. Meanwhile, the nonlinear effect of board diversity indicates that governance benefits are threshold-dependent, emerging only at sufficient levels of diversity. These findings reinforce the need to move beyond linear assumptions when examining governance-performance dynamics in emerging markets.

For bank management, green banking should not be treated as a mere compliance exercise. The U-shaped pattern of board diversity implies that token representation yields limited financial benefit; meaningful diversity requires achieving a critical level across multiple dimensions. For regulators, these results suggest that mandating sustainability reporting is a necessary but insufficient condition; the quality and depth of implementation matter more than formal compliance.

**Robustness Check**

To examine the sensitivity of the main findings to alternative outlier-treatment methods, Table 8 presents three estimation specifications. Model (1) replicates the main Random Effects estimation using winsorised data at the 1st–99th percentiles. Model (2) applies the same Random Effects specification using raw data without winsorization, while Model (3) employs robust regression (IRLS/MM-estimator) on winsorised data to reduce the influence of extreme observations without removing them.

The results indicate that the nonlinear effect of green banking remains relatively sensitive across estimation methods. In the main Random Effects model with winsorised data, the squared term of green banking is positive and statistically significant ($\beta = 0.159$; $p < 0.05$), suggesting a nonlinear positive relationship between green banking and profitability. However, this effect becomes statistically insignificant in both the raw-data Random Effects model ($\beta = 0.518$; $p > 0.10$) and the robust regression model ($\beta = 0.038$; $p > 0.10$). Likewise, the linear green banking coefficient remains insignificant across all specifications. These findings indicate that the effect of green banking on profitability is not fully robust to alternative outlier treatments and estimation approaches.

In contrast, the nonlinear effect of board diversity demonstrates stronger consistency. The squared term of board diversity remains positive and statistically significant across all models, with coefficients ranging from 0.020 to 0.025. This finding provides consistent evidence of a U-shaped relationship between board diversity and profitability. Meanwhile, the linear board diversity coefficient is insignificant in both Random Effects specifications but becomes negative and significant in the robust regression model ($\beta = -0.011$; $p < 0.05$), indicating that lower levels of board diversity may reduce profitability before the positive nonlinear effect emerges.

Among the control variables, BOPO and LDR consistently exhibit negative and highly significant effects on profitability across all estimation methods, confirming that operational inefficiency and excessive lending intensity reduce bank profitability. Bank age also consistently shows a negative and significant effect. In contrast, CAR, NPL, BI Rate, and exchange rate remain statistically insignificant in all specifications.

Table 8

Sensitivity Analysis: Robustness to Outlier Treatment

| Variable | RE+Winsor | | RE Raw | | Robust Reg | |
|---|---|---|---|---|---|---|
| | Coef | SE | Coef | SE | Coef | SE |
| Green Banking | -0.003 | (0.028) | 0.125 | (0.109) | 0.009 | (0.040) |
| Green Banking$^2$ | 0.159** | (0.077) | 0.518 | (0.365) | 0.038 | (0.135) |
| Board Diversity | -0.009 | (0.006) | -0.005 | (0.008) | -0.011** | (0.005) |
| Board Diversity$^2$ | 0.020** | (0.010) | 0.020** | (0.009) | 0.025*** | (0.005) |
| Bank Size | 0.008 | (0.005) | 0.002 | (0.005) | 0.015*** | (0.002) |
| Bank Age | -0.015** | (0.006) | -0.015*** | (0.005) | -0.014*** | (0.005) |
| CAR | -0.003 | (0.029) | -0.021 | (0.022) | -0.012 | (0.016) |
| NPL | -0.030 | (0.313) | -0.133 | (0.527) | 0.407 | (0.309) |
| BOPO | -0.354*** | (0.039) | -0.439*** | (0.084) | -0.304*** | (0.022) |
| LDR | -0.073*** | (0.012) | -0.059*** | (0.016) | -0.037*** | (0.009) |
| BI Rate | 0.129 | (0.161) | 0.742 | (0.609) | 0.077 | (0.561) |
| Exchange Rate | 0.000 | (0.000) | -0.000 | (0.000) | 0.000 | (0.000) |
| Constant | 0.198 | (0.193) | 0.471* | (0.248) | -0.133 | (0.176) |

*Note: Standard errors in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01. Model (1): main model, RE with robust cluster SE, winsorized at 1st–99th percentiles. Model (2): RE with robust cluster SE, raw data without*

*winsorizing. Model (3): Robust regression (IRLS/MM-estimator), pooled OLS, winsorized data — does not control for panel effects.*
Source(s): Authors' own work

## 5. CONCLUSSION

This study examines the linear and nonlinear effects of green banking and board diversity on bank profitability among Indonesian listed banks over 2022–2024. The results show that green banking does not exert a significant linear effect on profitability, suggesting that compliance-driven adoption in the Indonesian context has yet to translate into measurable financial gains. Board diversity exhibits a U-shaped nonlinear relationship with profitability, consistent with upper echelon and social categorisation theories, indicating that governance benefits are threshold-dependent rather than uniformly positive. Operational efficiency, as proxied by BOPO, bank age and LDR, emerges as the dominant determinant of profitability, underscoring the primacy of internal efficiency over governance and sustainability variables in the short term.

This study has several limitations. The three-year observation window limits generalisation, as green banking effects may require longer horizons to materialise. The sample is confined to IDX-listed banks, excluding non-listed institutions. Additionally, the nonlinear effect of board diversity, while statistically present, shows sensitivity to model specification and should be interpreted cautiously. Future research should extend the observation period, expand the sample to include Islamic and non-listed banks, using moderating variables such as CAR or bank size, and apply formal nonlinearity tests such as the Lind–Mehlum test to verify U-shaped relationships more rigorously.

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