Role of bank financing and progressive green growth in Indonesia

Ciplis Gema Qori'ah[a*], M Abd Nasir[a], Bagus Maulana Irkham[b]
[a]*Faculty of Economic and Business, Universitas Jember*
[b]*Pusat Riset Sosial dan Ekonomi Indonesia (PRESISI)*

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Abstract

Green growth is an essential issue for many countries due of climate change and global warming. The complexity of environmental problems is increasing along with the rate of economic growth that ignores ecological sustainability. The financial sector is of key supporting factor for green growth. Likewise, Indonesia, as a developing country, requires the financial sector to play of role in achieving sustainable green development. This study aims to analyze the banking performance sector and green growth in Indonesia during the period 1990Q1-2023Q4. This study uses time-series data and the Vector Error Correction Model (VECM) to analyse the data. The results of the analysis show that the banking performance sector has a positive and significant influence on green growth in both the short and long terms.

Keywords: banking sector; green growth; renewable energy consumption
JEL Classification: L22; O3; O4; Q2

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*Corresponding Author : ciplis.qoriah@unej.ac.id

1. Introduction

The banking sector serves as a key catalyst in intermediating between financial development and economic sectors experiencing either a shortage or surplus of funds for a country's economic growth (Beck et al., 2000). Theoretically, it provides mechanisms that explain information asymmetry in the relationship between the financial sector and economic growth (Greenwood & Jovanovic, 1990). Neoclassical perspectives explain economic development through two major views: Exogenous Growth Theory and Endogenous Growth Theory. The former explains that a country's economic growth is influenced by capital accumulation, labour, and other factors, with long-term growth determined exogenously from outside the economic system (Solow, 1956; Swan, 1956).

However, this view has been challenged by Endogenous Growth Theory, which emerged from dissatisfaction with earlier models, emphasizing innovation and technological development as internal drivers of long-term growth within the economic system (Bardhan, 1995; Barro & Martin, 1995; Pomfret, 2001; Romer, 1994). At present, countries worldwide recognize the growing complexity of environmental issues and the importance of strategies that can mitigate the consequences of increasing economic activity (Yin et al., 2022).

Therefore, environmentally friendly efforts are required through effective policy and strategy design to ensure that nature continues to provide intergenerational resources and environmental services while promoting sustainable economic growth, known as green economic growth (OECD, 2010). In essence, green growth is a strategy to address the negative impacts of economic growth.

The theoretical debate and global awareness regarding financial development and the environmental consequences of economic growth have spurred research to understand their impacts better. Empirical evidence suggests that financial sector regulation can increase productivity, stimulate economic growth, promote renewable energy use, and support green growth (Khan & Rehan, 2022; King & Levine, 1993; Tripathy, 2019; Yin et al., 2022). However, limited attention has been given to its potential negative effects (Aghion et al., 2004; Ullah et al., 2021).

The banking sector has been shown to have a negative and significant impact on economic growth in East African countries, and no bank in Bangladesh fully complies with environmentally friendly banking policy requirements (Barfi, 2020; Julia & Kassim, 2019). In the long run, failure to implement such policies may worsen environmental degradation by increasing carbon emissions, leading to rising temperatures.

In 2020, the OECD emphasized that achieving the 2030 Sustainable Development Goals requires global leaders to act immediately to improve environmental quality for both present and future generations (Yin et al., 2022). Consequently, countries continue to seek solutions to mitigate climate change and achieve environmentally friendly and sustainable economic development, with sustainable banking being one of the key approaches.

Many countries have adopted sustainable banking practices to prevent environmental degradation. In Indonesia, however, the implementation of sustainable banking remains relatively low. This is primarily due to the limited availability of environmentally friendly financing, as many banks remain unfamiliar with sustainable banking practices.

The lack of clear regulations and standards further necessitates stronger guidance and frameworks from policymakers This study builds upon previous research by investigating the effects of green technological innovation, renewable energy sources, and financial sector development on green growth in carbon-emitting countries such as Japan, China, the United States, Russia, and India during the period 1990–2020 (Ahmed et al., 2022).

According to the World Resources Institute (2019), Indonesia ranks as the world's fifth-largest carbon emitter, with emissions of 1,841.14 $MtCO_2e$, accounting for approximately 5 percent of global emissions (Khusna, 2020). Therefore, this study focuses on Indonesia as one of the most significant contributors to global emissions.

The novelty of this study lies in examining the interaction between financial sector development, renewable energy consumption, and green growth using the Vector Error Correction Model. This study also evaluates sustainable banking performance and green growth from the perspective of endogenous growth theory.

The study period spans from 1990 to 2023, referring to the 1992 Rio de Janeiro Conference in Brazil, which marked global efforts to minimize environmental damage in support of green growth. Accordingly, this study aims to measure the short- and long-term effects of banking sector performance on green economic growth in Indonesia.

2. Methodology

Theoretical Framework: Endogenous growth theory in neoclassical economics holds that economic growth arises from internal factors rather than external influences (Romer, 1994). One perspective is the Simple Endogenous Growth Model, which does not explicitly distinguish between capital accumulation and technological progress (Frankel, 1962). The second perspective emphasizes human capital, where capital includes both physical and human capital, with human capital acquired through learning processes that enhance skills (Lucas, 1988).

The third perspective focuses on endogenous growth with research and development (R&D), assuming that savings result from intertemporal utility maximization rather than fixed savings rates (Romer, 1986). The transmission of endogenous growth theory to green growth can be observed in the objectives of economic development, which aim for stable growth and equitable income distribution, while often neglecting environmental damage (Aghion et al., 2004). Green growth serves as a mechanism to promote economic growth while preventing environmental degradation and supporting welfare (Hallegatte et al., 2012).

One key supporting indicator of green growth is banking sector performance. The transmission of the banking sector to green growth can be seen through banking technologies, such as electronic money, and through efficient financial services that respond to rising consumer needs (Ahmed et al., 2022).

Banks also provide financing for projects that support green growth by using renewable energy rather than conventional energy sources (Amuakwa & Näsström, 2022). Khan & Rehan (2022) show that in China, banking sector development, financial inclusion, and related factors play an essential role in promoting renewable energy consumption, green growth, and reducing carbon emissions. This study uses secondary time series data consisting of 144 quarterly observations from 1990Q1 to 2023Q4.

The variables include Green Growth (GG), Deposit Money Bank (DMB), Financial Development (FD), and Renewable Energy Consumption (REC). DMB and FD represent banking-sector performance, while REC serves as a proxy for green technological innovation and as a control variable.

Table 1.
Research Variables

Variable	Unit	Data Source	Period
Green Growth (GG)	Percentage	OECD	1990Q1–2023Q4
Bank Deposit Money (DMB)	Percentage	World Bank	1990Q1–2023Q4
Financial Development (FD)	Percentage	IMF	1990Q1–2023Q4
Renewable Energy Consumption (REC)	Percentage	World Bank	1990Q1–2023Q4

Source: Processed by Author

This study uses secondary time series data consisting of 144 quarterly observations from 1990Q1 to 2023Q4. The variables include Green Growth (GG), Deposit Money Bank (DMB), Financial Development (FD), and Renewable Energy Consumption (REC). DMB and FD represent banking-sector performance, while REC serves as a proxy for green technological innovation and as a control variable.

This study applies the Vector Error Correction Model (VECM) to analyze both short-term and long-term relationships among variables. The VECM requires stationarity testing, optimal lag selection, cointegration testing, Impulse Response Function (IRF) analysis, and Variance Decomposition (VD) to ensure robust estimation and dynamic interpretation. This study is inspired by the Simple Endogenous Growth Model, which can be expressed as follows:

$$Y = A \cdot K \tag{1}$$

Where Y denotes output, A represents the level of technology, and K denotes capital. Based on this framework, the functional form of the model can be written as:

$$Y = f(A \cdot K) \tag{2}$$

Adapting this model to the context of green growth and banking sector performance, the empirical specification is formulated as:

$$GG = f(DMB.FD.REC) \tag{3}$$

Where GG represents Green Growth, DMB denotes Deposit Money Banks, FD represents Financial Development, and REC refers to Renewable Energy Consumption. The econometric model is estimated using the Vector Error Correction Model (VECM), which allows the analysis of both short-term dynamics and long-term equilibrium relationships among variables. The VECM specification can be written as:

$$\Delta GG_t = a + \sum_1^K = 1\,\Delta\beta 1 DMB_{t-1} + \sum_1^K = 1\,\Delta\beta 2 FD_{t-1} + \sum_1^K = 1\,\Delta\beta 3 REC_{t-1} + \varepsilon_t \quad (4)$$

In this equation, GG represents *green growth*, the dependent variable. The symbol Δdenotes the first difference of each variable at time period t. The constant term is denoted by a, while β_1, β_2, and $\beta_3$are the coefficients that measure the impact of the explanatory variables on green growth.

The variable DMB refers to *Deposit Money Banks (M2), which serve* as an indicator of monetary development and liquidity in the economy. FD represents *financial development*, reflecting the level of advancement and efficiency of the financial system. Meanwhile, REC denotes *renewable energy consumption*, which captures the extent of environmentally friendly energy use in economic activities.

The subscript $t$indicates the time series dimension, while Krepresents the optimal lag length included in the model. Finally, $\varepsilon_t$is the error term, which captures the influence of other factors not explicitly included in the model that may affect green growth.

3. Results and Discussion

Since this study employs the VECM approach, the first step is to examine the stationarity properties of the data. Stationarity testing is required to ensure that the variables satisfy the necessary conditions for VECM estimation. The results of the unit root tests are presented in Table 2.

Table 2.
Stationarity Test

Variabel	Level	First Different	Second Different
	P-value	*P-value*	*P-Value*
GG	1.000	0.227	0.000*
DMB	0.547	0.000*	0.000*
FD	0.170	0.000*	0.000*
REC	0.275	0.009*	0.000*

Source: Processed by Author

The results indicate that all variables are stationary at the second-difference level, as their p-values are less than 0.05. This confirms that the variables are integrated of the same order and suitable for further VECM analysis. The determination of the optimal lag length is a crucial step in VECM specification, as it ensures robust and efficient estimation by minimizing autocorrelation and capturing the dynamic structure of the model (Koondhar et al., 2021). The results of the lag selection test are presented in Table 3.

Table 3.
Optimal Lag Length Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-272.516	NA	2,250.015	19.070	19.258	19.129
1	-232.422	66.362	433.040	17.408	18.351	17.703
2	-199.155	45.884*	141.284*	16.217*	17.914*	16.749*

3	-185.550	15.012	201.416	16.382	18.834	17.150

Source: Processed by Author

Furthermore, the results of the optimal lag analysis presented in Table 3 indicate that, for the VECM model, most of the selection criteria (LR, FPE, AIC, SC, and HQ) identify lag two as the optimal lag length. This finding suggests that the model needs to account for dynamics from the previous two periods.

Since most of the criteria consistently support lag 2, this lag length is selected as the most appropriate specification for the VECM model. After optimal lag selection, the next step is to conduct the cointegration test; the results of which are presented in the subsequent table.

Table 4.

Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.188	55.893	40.174	0.000
At most 1 *	0.107	28.160	24.275	0.015
At most 2 *	0.064	13.053	12.320	0.037
At most 3 *	0.031	4.195	4.129	0.048

Source: Processed by Author

Based on the results of the Johansen cointegration test presented in Table 4, the trace statistics indicate the existence of cointegration among the variables in the model. At the 4 percent significance level, the test results suggest the presence of four cointegrating relationships, as the trace statistics at all levels (from "None" to "At most 3") exceed their respective critical values, with minimal probability values (< 0.05).

These findings confirm the existence of a significant long-run relationship among the model's variables. Consequently, the model is valid for identifying long-term equilibrium relationships and justifies the use of the Vector Error Correction Model (VECM) to analyze both short-run and long-run dynamics. Therefore, the estimation results are presented in the following table.

Based on Table 5, the short-run VECM estimation results for Indonesia indicate a significant cointegrating relationship among the macroeconomic variables under study. In the first short-run lag, Deposit Money Banks (DMB) and Financial Development (FD) exhibit positive effects on Green Growth (GG), with coefficients of 0.056 and 0.121 and corresponding t-statistics of 2.032 and 3.817, respectively. These effects are statistically significant, as the t-statistics exceed the critical t-value of ±1.978 at the 1.9 percent significance level.

In contrast, in the first lag, Renewable Energy Consumption (REC) shows an adverse effect on GG, with a coefficient of −0.104 and a t-statistic of −3.055. However, REC is statistically insignificant, as the absolute value of the t-statistic does not meet the critical threshold.

Furthermore, in the second short-run lag, DMB and FD continue to exert positive and significant effects on GG, with coefficients of 2.774 and 1.865 and t-statistics of 2.872 and 2.321, respectively. These results remain statistically significant, as the t-statistics exceed the critical t-value of ±1.978 at the 1.9 percent significance level.

Meanwhile, in the second lag, REC continues to have an adverse effect on GG, with a coefficient of −0.705 and a t-statistic of −0.911. This effect is statistically insignificant, as the absolute t-statistic is smaller than the critical t-value.

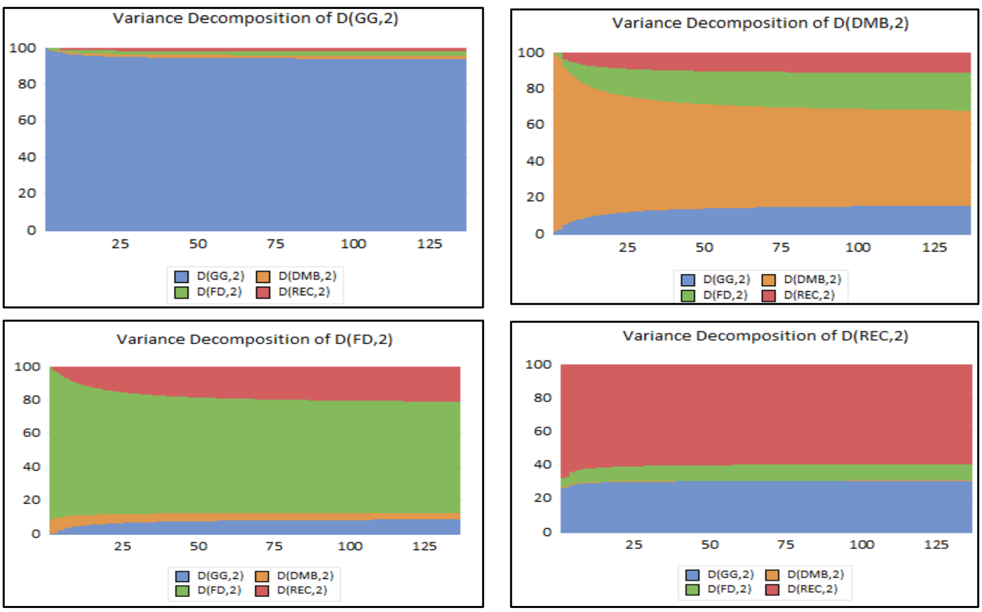
Table 5.
Short-Run VECM Estimation Results

Variabel	Coefficient	t-Statistic	Direction	Significance
Lag 1				
DMB	4.285	3.446*	Positive	Significant
FD	3.346	3.234*	Positive	Significant
REC	-0.948	-0.915	Negative	Not Significant
Lag 2				
DMB	2.774	2.872*	Positive	Significant
FD	1.864	2.320*	Positive	Significant
REC	-0.704	0.910	Negative	Not Significant

Source: Processed by Author

Based on Table 6 for Indonesia, the long-run VECM estimation results indicate a significant cointegrating relationship among the macroeconomic variables examined. In the long run, Deposit Money Banks (DMB) and Financial Development (FD) have positive effects on Green Growth (GG), with coefficients of 0.056 and 0.121, respectively, and corresponding t-statistics of 2.032 and 3.817, respectively.

Figure 1.
Variance Decomposition of Banking Sector Performance and Green Growth in Indonesia



Source: Processed by Author

These effects are statistically significant, as the t-statistics exceed the critical t-value of ±1.978 at the 1.9 percent significance level. In the long run, Deposit Money Banks (DMB) and Financial Development (FD) have positive effects on Green Growth (GG), with coefficients of 0.056 and 0.121, respectively, and corresponding t-statistics of 2.032 and 3.817, respectively. These effects are statistically significant, as the t-statistics exceed the critical t-value of ±1.977 at the 1.9 percent significance level.

Renewable Energy Consumption (REC), on the other hand, hurts green growth, with a coefficient of −0.104 and a t-statistic of −3.054. This effect is statistically significant, as the absolute value of the t-statistic exceeds the critical t-value. The adjusted R-squared of 0.557 indicates that the model performs reasonably well at explaining variations in the data, reflecting the complexity of the relationships among macroeconomic variables, with some variables exerting stronger, more significant influences.

This finding underscores the importance of a holistic, well-coordinated policy approach to promoting banking-sector financial performance, dedicated to financing environmentally friendly projects that support green growth. Figure 1 presents the Variance Decomposition results over 136 periods for the variables Green Growth (GG), Deposit Money Banks (DMB), Financial Development (FD), and Renewable Energy Consumption (REC).

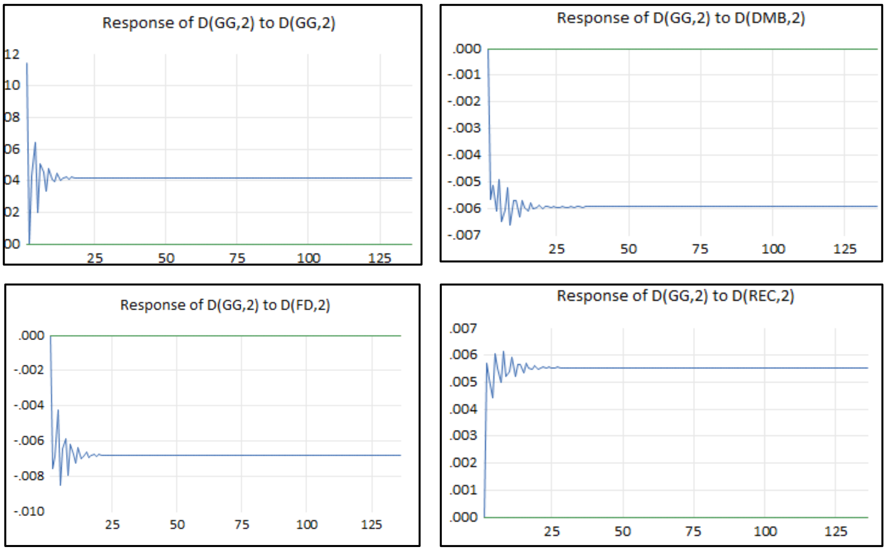
In the short run, as observed in period 2, shocks to Green Growth itself account for 99.07 percent of the variation in green growth, indicating substantial short-term fluctuations driven primarily by its own innovations. However, in the long run, as observed in period 136, the contribution of shocks originating from Green Growth itself gradually declines to 94.25 percent. Meanwhile, the proportion of green growth fluctuations explained by shocks from the other three variables begins to increase.

Furthermore, the Variance Decomposition results for Deposit Money Banks (DMB) show that in the short run, specifically in period 2, shocks to DMB itself account for only 0.23 percent of the fluctuations in bank deposits. In the long run, at period 136, the contribution of own shocks declines further to 1.80 percent. In contrast, the proportion of fluctuations in bank deposits explained by shocks from the other three variables increases.

For Financial Development (FD), the short-run results indicate that in period 2, shocks to FD itself account for 0.43 percent of the variation in financial development. In the long run, at period 136, the contribution of own shocks to financial development gradually increases to 2.38 percent. Similarly, for Renewable Energy Consumption (REC), the short-run results in period 2 show that shocks to REC itself account for 0.43 percent of the variation in renewable energy consumption. However, in the long run, at period 136, the contribution of own shocks declines to 1.56 percent, indicating that renewable energy consumption becomes increasingly influenced by shocks from other variables.

Figure 2 presents the Impulse Response Function (IRF) results in the form of four graphs, providing a visual representation of the responses of Green Growth (GG) over a 134-period horizon to shocks originating from itself and from other variables, namely Deposit Money Banks (DMB), Financial Development (FD), and Renewable Energy Consumption (REC). The first graph shows that the response of green growth to its own shocks fluctuates during the initial periods and converges to equilibrium at period 18, with an average stability level of approximately 0.041 percent.

Figure 2.
Impulse Response Function (IRF) of Banking Sector Performance and Green Growth in Indonesia



Source: Processed by Author

The subsequent graphs illustrate the responses of green growth to shocks from itself and the three explanatory variables, which exhibit initial fluctuations and converge to equilibrium at different periods. Specifically, the response of green growth to shocks in bank deposit levels reaches equilibrium at period 21 with a stability level of −0.005 percent. In comparison, the response to shocks in financial development converges at period 18 with a stability level of 0.0068 percent. Meanwhile, the response to shocks in renewable energy consumption stabilizes at period 26 with an average level of 0.005 percent.

The VECM estimation results in this study analyze the effects of the variables on both short-run and long-run dynamics, with a particular focus on statistical significance, the direction of relationships, and the consistency of empirical findings with theoretical expectations.

Table 8.
Summary of Shor-Run VECM Results in Indonesia

Banking Sector Performance	**Significance**	**Direction**	**Empirical Evidence**	**Theory**	**Results**
Deposit Money Bank (DMB)	Significant	Positive	Li (2023), Liu (2023), dan Wang (2023)	(Marfin Frankel, 1962)	Consistent
Financial Development (FD)	Significant	Positive	Abuatwan (2023)	(Lucas, 1988)	Consistent

*Renewable Energy Consumption (*REC)	Not Significant	Negative	Gorji & Martek (2023)	(P. Romer, 1997)	Consistent

Source: Processed by Author

The table summarizes the tests of key variables, the significance of their relationships, and comparisons with relevant economic theories. The VECM results for Indonesia reveal a complex dynamic relationship between banking sector performance and green growth. In the short run, banking sector performance variables, Deposit Money Banks (DMB) and Financial Development (FD), exert significant effects on green growth.

These findings confirm previous empirical studies (Abuatwan, 2023; Li, 2023; Wang et al., 2023), indicating that the impact of financial initiatives requires time to materialize. In contrast, Renewable Energy Consumption (REC) does not exert a significant effect in the short run, as banking sector financing for industrial projects may still be heavily dependent on traditional energy sources (such as fossil fuels), implying that the transition toward renewable energy has not yet been substantial enough to influence green growth in the short term.

In the long run, Deposit Money Banks (DMB) and Financial Development (FD) exert positive effects on green growth. This finding suggests that an increase in DMB promotes innovation within the banking sector, such as the development of environmentally friendly financial products.

This result is consistent with the Simple Endogenous Growth Model, in which economic growth is driven by capital accumulation (Frankel, 1962). Furthermore, Financial Development (FD) encourages banks to develop innovative financial instruments for environmentally friendly projects, such as electronic payment systems.

Although empirical evidence indicates that the use of electronic money does not generate inflationary effects in either the short or long run, this finding aligns with endogenous growth theory with R&D, where knowledge investment fosters technological progress (Romer, 1990).

Empirical studies further demonstrate that financial development attracts private sector investment into sustainable projects, which in the long run enhances economic growth while mitigating environmental degradation (Bovenberg & Smulders, 1996). Conversely, Renewable Energy Consumption (REC) exhibits a negative and statistically significant relationship with green economic growth.

This result is consistent with the findings of Gorji and Martek (2023), who argue that banks may perceive renewable energy–consuming projects as riskier due to their early-stage development and potential fluctuations in energy output. Such perceptions may lead to higher financing costs or investment reluctance, thereby constraining green growth and ultimately reducing economic growth (Rahmadani, 2023).

Moreover, a transition toward renewable energy may devalue fossil-fuel–based assets held by banks, potentially resulting in financial losses or instability and thereby exerting negative effects (Li & Haneklaus, 2021). Based on this empirical evidence, renewable energy consumption in Indonesia remains at an early stage and requires further development to generate long-term benefits.

Additionally, bank-financed projects face challenges in transitioning from fossil fuels to renewable energy sources. This finding is consistent with endogenous growth theory emphasizing human capital development (Lucas, 1988), where limited human capital at the initial stage constrains the learning process necessary for technological advancement.

4. Conclusion

This study demonstrates that the dynamics between banking-sector performance and green growth in Indonesia are complex and closely interconnected in both the short and long run. Based on the empirical results and discussion, it can be concluded that, in the short run, Deposit Money Banks (DMB) and Financial Development (FD) have significant and positive effects on Indonesia's green growth (GG). At the same time, Renewable Energy Consumption (REC) does not exert a significant influence on green growth.

However, in the long run, DMB, FD, and REC significantly affect green growth in Indonesia. Notably, REC exhibits a negative impact, as the transition from fossil energy to renewable energy may reduce the value of bank-held assets, potentially leading to financial losses or instability.

The Indonesian government and relevant institutions are therefore encouraged to prioritize policies that support bank deposits, financial development, and renewable energy technologies, such as green financing initiatives and the expansion of access to sustainable financial services, to attract firms engaged in sustainable projects.

Although DMB, FD, and REC do not yet yield fully satisfactory outcomes, further research is required to identify additional factors influencing the relationship between banking performance and green growth. Strengthening measurement indicators or adopting alternative methodological approaches may contribute to a more comprehensive understanding of this relationship.

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