Sustainable finance and green economic growth: Evidence from the Indonesian banking sector

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Abstract
Green economic growth has emerged as a global priority in pursuing sustainable development. This study examines the role of resource allocation efficiency in supporting green economic growth, as influenced by green financing practices, sustainable finance policies, and green financial products. A quantitative research approach was employed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The study population consisted of 107 financial institutions. A purposive sampling technique was used to select 168 respondents from 84 banks, comprising senior managers, division heads, and executives responsible for implementing sustainable finance policies—averaging two respondents per institution. The results reveal that green financing practices, sustainable finance policies, and green financial products directly and significantly impact green economic growth. Moreover, resource allocation efficiency plays a mediating role in strengthening these relationships. These findings underscore the importance of the banking sector in driving innovation in green financial products, implementing sustainable finance policies, and enhancing resource utilization efficiency. In conclusion, the banking sector holds a strategic position in advancing green economic growth. Future research could extend this framework by examining the role of non-financial sectors or exploring how digital technology transformation facilitates green financing to support sustainable development goals further.

Keywords: Green economic growth, Green financing practices, Green financial products, Resource allocation efficiency, Sustainable finance policies

JEL Classification: E44, G21, O44, Q56,

INTRODUCTION
The banking sector strategically promotes sustainable economic development in Indonesia through implementing sustainable finance (Cahyani, 2024). This initiative serves as a mechanism for integrating Environmental, Social, and Governance (ESG) principles into financing policies and practices to support green economic growth (Tifaona et al., 2024). Sustainable finance seeks to balance economic returns with environmental sustainability—an increasingly important objective in addressing global

challenges such as climate change and environmental degradation (Zairis et al., 2024; V & P, 2024).

As the most populous nation in Southeast Asia, Indonesia has made significant progress in implementing sustainable finance, marked by the development of the sustainable finance roadmap and the green taxonomy issued by the Financial Services Authority (OJK), both of which have been updated over the years (OJK, 2024). According to the OJK's 2024 report (OJK,2024), green financing in Indonesia experienced a threefold increase, reaching IDR 2,050 trillion in 2023—a rise of 28.13% compared to the previous year (Table 1).

Table 1. Growth of green financing in Indonesia

Year	Total green financing (Trillion IDR)	Growth (%)
2020	800	-
2021	1,200	50.00
2022	1,600	33.33
2023	2,050	28.13

Source: Otoritas Jasa Keuangan (OJK), February 2024

Table 1 illustrates Indonesia's year-on-year green financing growth trend over the past four years. In 2020, the total value of green financing stood at IDR 800 trillion. Although several green financing policies had been introduced, implementation was still in its early stages, and the banking sector's involvement remained limited. According to Dewi (2021), green financing during this period was primarily focused on projects already identified within the initial policy framework established by OJK and other relevant institutions.

In 2021, the total green financing value surpassed IDR 1,200 trillion, reflecting growth of over 50.00% compared to 2020. This increase coincided with the introduction of various policies and incentives to encourage Indonesian banks to invest in green projects. Key contributors to this growth included the issuance of green bonds and support for renewable energy initiatives (Sugiyarto, 2022).

Green financing continued its upward trend in 2022, reaching IDR 1,600 trillion—a 33% increase. Projects funded this year encompassed a broader range of sectors, including renewable energy, green infrastructure, and sustainable natural resource management. Although the growth rate declined slightly compared to 2021, it still signified a favorable response from the banking sector to government incentives and a growing awareness of the importance of sustainable finance (Pratama & Firmansyah, 2024).

In 2023, green financing in Indonesia reached IDR 2,050 trillion, reflecting a growth of 28.13%. Although this growth rate was lower than in the previous two years, the total volume of green financing demonstrated continued robustness. In particular, large banks have played an increasingly prominent role in financing projects that support the achievement of the Sustainable Development Goals (ADB, 2022).

Green financing was directed toward priority sectors critical to green economic growth.. As shown in Table 2, financing for renewable energy accounted for IDR 950 trillion, representing 46.34% of total green financing. Green infrastructure—including sustainable transportation and eco-friendly facilities—constituted 24.39% (IDR 500 trillion), while natural resource management accounted for 14.63% (IDR 300 trillion). Although the share allocated to other sectors was smaller, this distribution reflects a comprehensive approach to promoting green economic growth by ensuring efficient resource allocation.

Table 2. Allocation of green financing by sector in 2023

Sector	Total financing (Trillion IDR)	Percentage (%)
Renewable energy	950	46.34
Green infrastructure	500	24.39
Natural resource management	300	14.63
Environmentally friendly technology	200	9.76
Other sectors	100	4.88
Total	2.050	100.00

Source: Otoritas Jasa Keuangan (OJK), February 2024

Overall, the implementation of sustainable finance in Indonesia has been positively received. Nonetheless, challenges remain, particularly the low adoption of ESG principles among small and medium-sized banks. Expanding financing to additional sectors—especially green technology—is projected to accelerate the transition toward a low-carbon economy and strengthen national economic resilience in the face of climate change (Prabowo, 2023).

One of the primary challenges smaller banks face in adopting green finance practices is the limited resources and technical expertise, compounded by an underdeveloped regulatory framework that fails to incentivize their participation in green initiatives sufficiently. These banks often encounter financial barriers, such as the higher perceived risks associated with green investments, which may discourage full engagement with sustainable finance.

Institutional theories offer insight into the root of these challenges. According to Stakeholder Theory (Freeman, 2015), banks—including smaller institutions—are pressured by various stakeholders to adopt sustainable practices. However, they may lack the institutional capacity to do so effectively. Similarly, the Legitimacy Theory (Suchman, 2014) posits that smaller banks may struggle to establish legitimacy in the green finance domain, often lacking key signaling mechanisms such as green certifications or recognized partnerships to convey their commitment to sustainability.

To address these issues, regulatory reforms and targeted financial incentives—such as specialized green financing schemes for smaller banks—could promote broader participation in sustainable finance initiatives across Indonesia's banking sector.

Green financing, emphasizing the efficient allocation of resources, is increasingly vital in this context. Targeted green financing supports the productivity of the banking sector by promoting environmentally friendly financial products—such as green bonds and loans—that not only enhance outputs, such as shallot productivity but also attract investors and strengthen bank portfolios. A more inclusive and equitable implementation of sustainable finance policies across the entire banking sector, including small and medium-sized banks, could accelerate the transition toward a stronger and more sustainable green economy. Expanding the diversity of green financial products and improving fund distribution efficiency are expected to enable the banking sector to effectively contribute to Indonesia's green economic development and hasten the achievement of sustainable development goals (Bapang, 2023).

Effective, sustainable finance policies create economic value and promote environmental and social balance, thereby directly supporting the expansion of the green economy. This has become a global priority due to the increasing urgency of climate change and the natural resource crisis. In Indonesia—where more than 100 financial institutions operate, encompassing conventional, sharia, and regional development banks (BPD)—the banking sector is a key driver of the national economy (Ningrum et al., 2022). Major banks such as Bank Mandiri, BRI, and BCA have strategically integrated ESG

principles into their operations. These include the issuance of green bonds and the allocation of credit to environmentally sustainable projects. However, the limited adoption of ESG practices among smaller banks remains a pressing issue. Given the growing impact of climate change, such as intensified flooding and droughts, it is essential to accelerate the adoption of sustainable finance principles to mitigate environmental damage and foster economic resilience (Hartadinata & Farihah, 2023).

This study aims to analyze the implementation of sustainable finance in supporting green economic growth within Indonesia's banking sector. The primary areas of investigation include identifying patterns of voluntary and mandatory green financing, evaluating sustainable finance policies—specifically the sustainable finance roadmap and green taxonomy—and examining the development of new green financial products such as green bonds and green loans. In addition, the study assesses the effectiveness of resource allocation to priority sectors that support green development and evaluates whether adopting sustainable finance contributes positively to green economic growth. This research report seeks to consolidate recommendations for transforming conventional banking into sustainable banking, supported by empirical evidence to substantiate and generalize those recommendations.

METHODS

This study adopts a quantitative research approach to examine the relationships among key factors influencing green economic growth within Indonesia's banking sector. The study population consists of 107 banks operating in Indonesia, based on data from the Financial Services Authority (OJK, 2024). A purposive sampling technique included only those banks that have implemented sustainable finance principles. Using Slovin's formula with a 5% margin of error, a final sample of 84 banks was obtained.

From these institutions, 168 senior executives were selected as respondents. These included senior managers, heads of sustainable finance divisions, and executives responsible for implementing sustainable finance policies—averaging two respondents per bank. The purposive sampling ensured that only individuals with relevant expertise and experience in sustainable finance were included (Etikan et al., 2016).

Despite its strengths, purposive sampling may introduce selection bias, as the perspectives captured reflect those of individuals already involved in sustainability practices. Moreover, the focus on national private banks may limit the generalizability of the findings to state-owned or international banks. Additionally, the study's cross-sectional design limits its ability to track long-term trends in implementing green finance.

The study investigates five main variables: green financing practices (X1), sustainable finance policies (X2), green financial products (X3), resource allocation efficiency (M), and green economic growth (Y). Each variable is operationalized through relevant dimensions and indicators drawn from established literature. The indicators are measured using a Likert scale, as detailed in Table 3.

Table 3. Variable operationalization

Variable	Dimension	Indicator	Abbreviation	Source
Green financing practices (x1)	1. Green financing	1.1 Provision of financing for environmentally friendly projects	GF1	Ningrum et al. (2022)
		1.2 Financing of renewable energy projects	GF2	
		1.3 Environmental impact assessment in loan decisions	GF3	

Variable	Dimension		Indicator		Abbreviation	Source
	2.	Alignment with ESG Standards	2.1	Integration of ESG criteria in financing decisions	ESG1	Zairis et al. (2024)
			2.2	Implementation of sustainability principles in loan portfolios	ESG2	
Sustainable finance policies (x2	1.	Regulatory policies	1.1	Adoption of OJK sustainable finance policies	SP1	OJK (2024)
			1.2	Policies providing incentives for green projects	SP2	
	2.	Government Support	2.1	Government support for green projects through regulations	GS1	OJK (2022)
			2.2	Provision of green financing for the private sector	GS2	
Green financial products (x3)	1.	Green financing products	1.1	Issuance of green bonds	GFP1	Pratama & Firmansyah (2024)
			1.2	Loan products for renewable energy projects	GFP2	
	2.	Diversification of green products	2.1	Offering various financial products supporting sustainability	DGP1	V & P (2024)
			2.2	Environmentally friendly investment products	DGP2	
Resource allocation efficiency (m)	1.	Resource efficiency	1.1	Allocation of funds to the most promising projects	RE1	Ningrum et al. (2022)
			1.2	Optimal use of resources in financing green projects	RE2	
	2.	Risk Management	2.1	Risk assessment in green fund allocation	RM1	Bapang (2023)
			2.2	Management of risks associated with renewable energy projects	RM2	
Green economic growth (y)	1.	Green economic growth	1.1	Increase in the contribution of the green sector to GDP	GEG1	ADB (2022)
			1.2	Growth in environmentally friendly industries	GEG2	
	2.	Sustainable Development	2.1	Adoption of sustainable development models in industrial sectors	SD1	Hartadinata & Farihah 2023)
			2.2	Integration of environmentally friendly policies into the national economy	SD2	

The conceptual framework is presented in Figure 1, illustrating the direct and indirect relationships among the study variables. Specifically, the model examines how green financing practices (X1), sustainable finance policies (X2), and green financial products (X3) influence green economic growth (Y)—both directly and indirectly—through the mediating role of resource allocation efficiency (M).
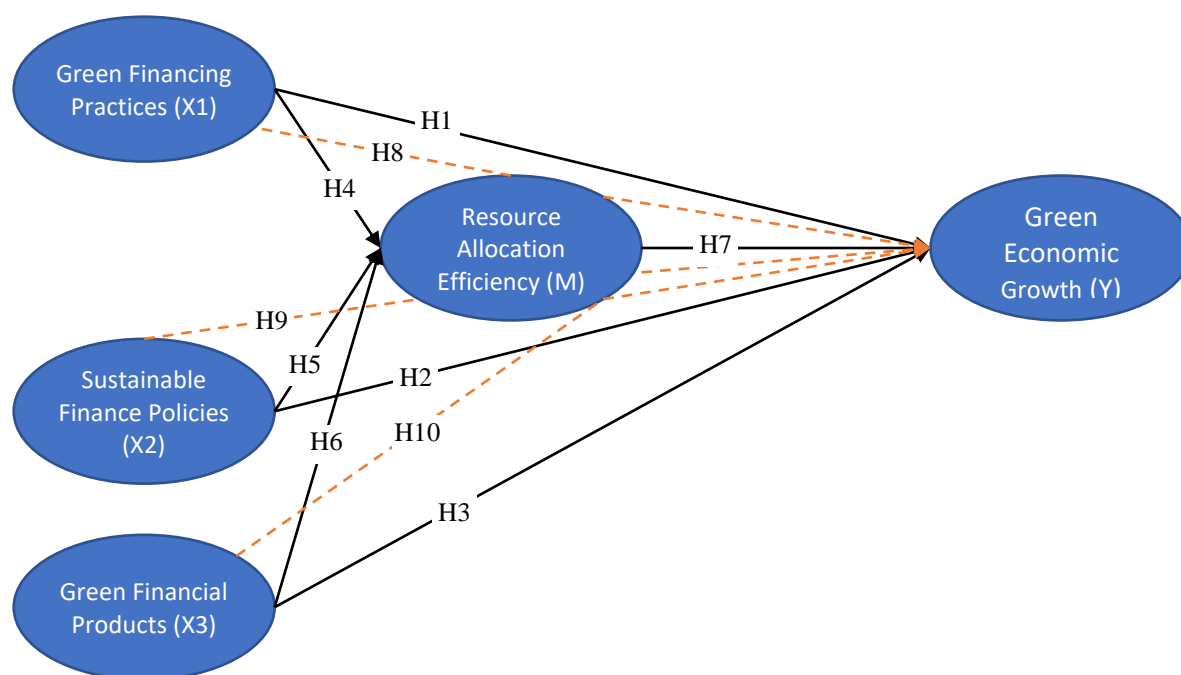
Figure 1. Research framework

This model is grounded in the assumption that the efficient allocation of financial resources plays a critical role in maximizing the impact of green finance on economic outcomes (De la Torre-Torres et al., 2024; Ouyang et al., 2023). The selection of green financing practices (X1), sustainable finance policies (X2), and green financial products (X3) as independent variables are based on their fundamental roles in shaping sustainable financial ecosystems.

Green financing practices are crucial as they reflect financial institutions' direct involvement in funding environmentally sustainable projects, ensuring that capital flows are aligned with sustainability objectives (Amran et al., 2022). Sustainable finance policies function as regulatory and strategic frameworks guiding banks to incorporate environmental, social, and governance (ESG) principles into financial decision-making, thus fostering responsible and accountable banking practices (Permadani et al., 2022). In parallel, green financial products, such as green bonds and sustainability-linked loans, are instrumental tools that facilitate the transition toward a green economy by incentivizing investments in environmentally responsible ventures (Flammer, 2021).

These three variables were prioritized over other potential factors due to their direct relevance to implementing sustainable banking practices and their empirically supported influence on green economic growth in previous research (Xu et al., 2023).

The inclusion of resource allocation efficiency (M) as a mediating variable is founded on the premise that the impact of green financing is significantly enhanced when financial resources are allocated efficiently. In the banking context, the ability of financial institutions to allocate funds effectively toward sustainable initiatives directly influences how substantially green financing contributes to economic performance (De la Torre-Torres et al., 2024). Prior studies have demonstrated that optimal resource allocation reinforces the relationship between sustainable finance instruments and broader economic sustainability, ensuring that financial flows target impactful, high-potential green projects

(Panagopoulos & Tzionas, 2023). Accordingly, resource allocation efficiency is positioned as a key mechanism in this model, as inefficient resource allocation may diminish the intended benefits of green finance interventions (Ouyang et al., 2023).

Based on the conceptual framework, the following hypotheses are proposed:

H1:   Green financing practices (X1) directly affect green economic growth (Y).
H2:   Sustainable finance policies (X2) directly affect green economic growth (Y).
H3:   Green financial products (X3) directly affect green economic growth (Y).
H4:   Green financing practices (X1) positively influence resource allocation efficiency (M).
H5:   Sustainable finance policies (X2) positively influence resource allocation efficiency (M).
H6:   Green financial products (X3) positively influence resource allocation efficiency (M).
H7:   Resource allocation efficiency (M) positively affects green economic growth (Y).
H8–H10: Resource allocation efficiency (M) mediates the effects of X1, X2, and X3 on Y, respectively.

The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), a statistical technique suitable for small to medium sample sizes, complex models, and exploratory research (Hair et al., 2021). All analyses were performed using SmartPLS 3.0 software. This method allows for estimating both direct and indirect effects through path analysis.

The analytical procedure consists of two primary stages:

1. Measurement Model Evaluation: This stage assesses the reliability and validity of the measurement model, focusing on convergent validity, discriminant validity, and composite reliability of the constructs.
2. Structural Model Evaluation: This stage tests the hypothesized relationships among variables through bootstrapping procedures, enabling robust inference of path coefficients and mediation effects.

RESULTS AND DISCUSSION

Respondent characteristics

The respondents in this study include individuals holding managerial, executive, and professional roles, each contributing specific expertise to developing and implementing green financial policies and instruments. The distribution of respondents is presented in Table 3.

Based on respondents' roles, 38.7% are managers (n = 65), 34.5% are executives (n = 58), and 26.8% are professionals (n = 45). This distribution indicates that the data were collected from individuals with strategic and operational responsibilities in sustainable finance decision-making. As such, their perspectives are expected to reflect institutional priorities and on-the-ground realities in advancing green economic growth.

In terms of institutional affiliation, 63.1% of respondents are employed by major banks—including both state-owned and national private commercial banks—while the remaining 36.9% represent other financial institutions, such as leasing and multi-finance companies, insurance providers, venture capital firms, and fintech or peer-to-peer (P2P) lending platforms. This composition reflects the dominant role of the banking sector in financing Indonesia's green economic transition.

Regarding educational background, the majority of respondents hold degrees in economics (32.7%), finance (29.8%), and management (23.8%), with the remaining

13.7% having qualifications in other fields, including law, environmental studies, and engineering. This academic profile suggests a solid foundation in financial and economic disciplines relevant to implementing sustainable finance practices.

Table 3. Respondent distribution

No	Category	Sub-category	Quantity
1.	Role	Manager	65
		Executive	58
		Professional	45
		Total	168
2.	Institutional affiliation	Major banks	53
		Other financial institutions	31
		Total	84
3.	Educational background	Economics	55
		Finance	50
		Management	40
		Other	23
		Total	168
4.	Professional experience	0-5 years	35
		6-10 years	48
		11-20 years	55
		20+ years	30
		Total	168

Regarding professional experience, 32.7% of respondents (n = 55) have 11 to 20 years of experience, followed by 28.6% (n = 48) with 6 to 10 years. Respondents with over 20 years of experience account for 17.9% (n = 30), while those under 6 years represent 20.8% (n = 35). The predominance of mid-to senior-level professionals underscores the study's focus on capturing insights from individuals with a mature, practice-based understanding of sustainable finance, institutional transformation, and the challenges associated with aligning financial systems to environmental objectives.

Descriptive statistics

A descriptive analysis was conducted to examine the distributional characteristics of the main variables in this study. The statistical indicators assessed include the mean, standard deviation, range, and skewness, which collectively provide insights into the responses' central tendency, dispersion, and distributional shape (Table 5).

Table 5. Descriptive statistics

Variable	Mean	Highest Value	Lowest Value	Standard Deviation	Variation (Range)	Skewness
Green financing practices (X1)	3.92	5	1	0.91	4	-0.91
Sustainable finance policies (X2)	3.95	5	1	0.82	4	-1.12
Green financial products (X3)	3.89	5	1	0.84	4	-1.10
Resource allocation efficiency (M)	3.91	5	1	0.84	4	-1.07
Green economic growth (Y)	3.98	5	1	0.83	4	-1.05

The results indicate that the mean scores for all core variables fall within a relatively narrow range—from 3.89 to 3.98—suggesting generally favorable perceptions among respondents regarding implementing sustainable finance practices and their contribution to green economic growth. The range of responses is consistent across all variables, from 1 to 5, resulting in a variation value of 4.

The standard deviations, which range from 0.82 to 0.91, reflect a moderate degree of variability, indicating that while responses varied to some extent, participants had a reasonable level of consensus. This suggests shared perspectives without excessive uniformity.

All variables display negative skewness values (ranging from -0.91 to -1.12), implying that the distribution of responses is skewed toward the higher end of the scale. This reflects a tendency among respondents to evaluate the variables positively, although a smaller proportion provided lower ratings.

These descriptive patterns highlight a general alignment across financial institutions toward the adoption and perceived effectiveness of sustainable finance principles. Nevertheless, the observed variation in responses also points to institutional differences in the degree of implementation or understanding, which may reflect varying levels of capacity, policy enforcement, or strategic emphasis in adopting green finance practices.

Outer model evaluation

The outer model was evaluated to assess the reliability and validity of the measurement instruments used for each construct. This evaluation followed the guidelines established in the PLS-SEM literature, focusing on three main aspects: convergent validity, discriminant validity, and internal consistency reliability (Hair et al., 2021; Henseler et al., 2015). The results of the outer model assessment are presented in Figure 2 and Table 6.
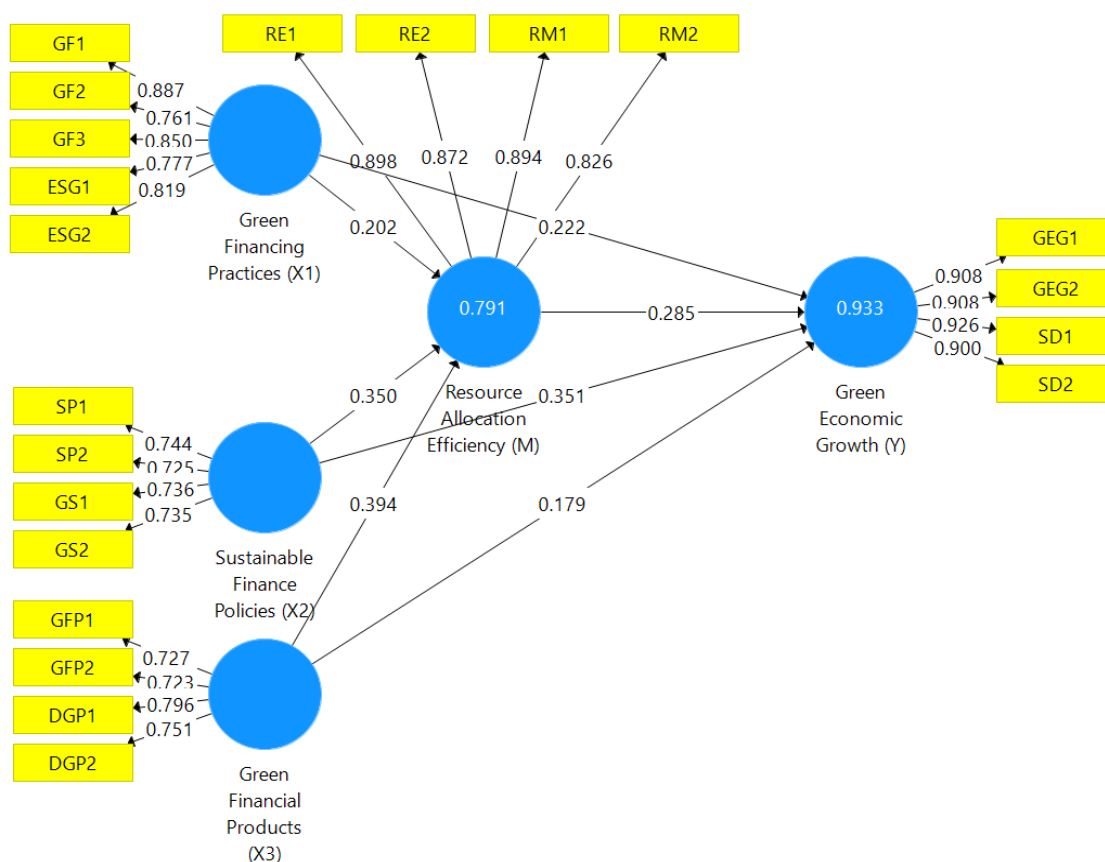

Figure 2. Outer Model

Table 6. Construct reliability and validity

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Green economic growth (Y)	0.931	0.951	0.829
Green financing practices (X1)	0.877	0.911	0.673
Sustainable finance policies (X2)	0.716	0.825	0.540
Green financial products (X3)	0.739	0.837	0.562
Resource allocation efficiency (M)	0.896	0.928	0.763

All constructs in the model demonstrate strong convergent validity, as indicated by Average Variance Extracted (AVE) values exceeding the recommended threshold of 0.50. This suggests that each construct explains a sufficient proportion of the variance in its corresponding indicators.

As illustrated in Figure 2, most indicator loadings exceed 0.70, further confirming convergent validity. Notably, all indicators under the green financing practices (X1) and green economic growth (Y) constructs show high loading values (e.g., GF1 = 0.887, GEG1 = 0.908), indicating that each observed variable contributes meaningfully to its underlying latent construct.

In terms of internal consistency, all constructs have Cronbach's Alpha and Composite Reliability (CR) values above 0.70, meeting the standards for acceptable reliability. For example, green economic growth (Y) exhibits robust reliability, with Cronbach's Alpha = 0.931 and CR = 0.951, indicating high consistency among the measurement items.

These findings confirm that the measurement model employed in this study is valid and reliable, providing a robust foundation for evaluating the inner (structural) model in the subsequent analysis phase.

Inner model evaluation

The structural model was assessed to examine the hypothesized relationships among the constructs using Partial Least Squares Structural Equation Modeling (PLS-SEM), with bootstrapping performed using 5,000 subsamples. This evaluation focused on key structural model indicators, including path coefficients, R-squared (R^2) values, and effect sizes (F^2), as presented in Tables 7, 8, and 9.

Table 7. R-Square

	R Square	R Square Adjusted
Green economic growth (Y)	0.933	0.931
Resource allocation efficiency (M)	0.791	0.787

Table 7 presents the R-squared values for the endogenous variables. The R^2 value for green economic growth (Y) is 0.933, indicating that 93.3% of the variance in this variable can be explained by green financing practices (X1), sustainable finance policies (X2), green financial products (X3), and resource allocation efficiency (M). Meanwhile, the R^2 value for resource allocation efficiency (M) is 0.791, suggesting that the three exogenous variables account for 79.1% of its variance (X1, X2, X3). Although a very high R-squared value, such as 0.933 for green economic growth (Y), may raise concerns about potential overfitting, the adjusted R-squared values of 0.931 for (Y) and 0.787 for (M) demonstrate that the model is stable. The small difference between the R^2 and adjusted R^2 values indicates that the model's explanatory power remains strong even when adjusting for the number of predictors, reducing the likelihood of overfitting due to unnecessary complexity.

Table 8. F-Square

	Green economic growth (Y)	Resource allocation efficiency (M)
Green economic growth (Y)		
Green financial products (X3)	0.089	0.159
Green financing practices (X1)	0.255	0.073
Resource allocation efficiency (M)	0.253	
Sustainable finance policies (X2)	0.307	0.109

Table 8 shows the f-squared effect sizes, which assess the individual contribution of each exogenous variable to the endogenous variables. Sustainable finance policies (X2) have the most substantial effect on green economic growth (Y), with an f² value of 0.307, suggesting a moderate-to-large effect. Green financing practices (X1) and resource allocation efficiency (M) also moderate green economic growth, with f² values of 0.255 and 0.253, respectively. Green financial products (X3) have a smaller effect on economic growth, with an F² value of 0.089. However, green financial products (X3) and sustainable finance policies (X2) both demonstrate moderate effect sizes on resource allocation efficiency (M), with values of 0.159 and 0.109, respectively. Green financing practices (X1) have a smaller effect on resource allocation efficiency (M), with an f² value of 0.073. These results suggest varying levels of influence among the predictor variables, with sustainable finance policies (X2) emerging as the most impactful factor on green economic growth.

Table 9. Path coefficients

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Green financing practices (X1) -> Green economic growth (Y)	0.222	0.220	0.036	6.084	0.000
Sustainable finance policies (X2) -> Green economic growth (Y)	0.351	0.345	0.071	4.964	0.000
Green financial products (X3) -> Green economic growth (Y)	0.179	0.179	0.079	2.282	0.023
Green financing practices (X1) -> Resource allocation efficiency (M)	0.202	0.192	0.055	3.649	0.000
Sustainable finance policies (X2) -> Resource allocation efficiency (M)	0.350	0.346	0.107	3.267	0.001
Green financial products (X3) -> Resource allocation efficiency (M)	0.394	0.411	0.107	3.684	0.000
Resource allocation efficiency (M) -> Green economic growth (Y)	0.285	0.292	0.082	3.482	0.001

The path coefficients and their significance levels are presented in Table 9. All paths in the model are statistically significant, with t-statistics exceeding the threshold of 1.96 and p-values below 0.05. Green financing practices (X1) significantly directly affect green economic growth (Y), with a path coefficient of 0.222, a t-statistic of 6.084, and a p-value of 0.000. Sustainable finance policies (X2) exert the strongest direct effect on green economic growth (Y), with a coefficient of 0.351, a t-statistic of 4.964, and a p-value of 0.000. Green financial products (X3) also have a significant effect, with a coefficient of 0.179, a t-statistic of 2.282, and a p-value of 0.023. In terms of their influence on the mediating variable, green financing practices (X1), sustainable finance policies (X2), and green financial products (X3) all significantly influence resource

allocation efficiency (M), with respective coefficients of 0.202, 0.350, and 0.394. These relationships are supported by t-statistics of 3.649, 3.267, and 3.684 and p-values of 0.000, 0.001, and 0.000, respectively. Furthermore, the path from resource allocation efficiency (M) to green economic growth (Y) is also significant, with a coefficient of 0.285, a t-statistic of 3.482, and a p-value of 0.001.

These findings confirm that all exogenous variables, as well as the mediating variable, significantly contribute to the endogenous constructs in the research model. The variation in the strength of the path coefficients suggests that different constructs exert different levels of influence on green economic growth. For instance, while green financing practices (X1) may directly promote green growth through increased capital allocation to environmentally friendly projects, sustainable finance policies (X2) appear to have a stronger influence due to their regulatory nature and ability to shape institutional behavior. Additionally, the significant mediating role of resource allocation efficiency (M) emphasizes the importance of optimal resource utilization in enhancing the impact of green finance strategies. When taken together, the results support the validity of the structural model and highlight the interconnected roles of finance, policy, and efficiency in advancing green economic growth in the Indonesian banking sector.

Testing mediation effects

Mediation analysis was conducted to examine the role of resource allocation efficiency (M) as an intervening variable in the relationship between the green financing mechanisms—green financing practices (X1), sustainable finance policies (X2), and green financial products (X3)—and the outcome variable, green economic growth (Y). The results of the total and specific indirect effects are presented in Tables 10 and 11.

Table 10. Total effects

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics ($|O/STDEV|$)	P Values
Resource allocation efficiency (M) -> Green economic growth (Y)	0.285	0.292	0.082	3.482	0.001
Green financing practices (X1) -> Green economic growth (Y)	0.279	0.276	0.040	7.000	0.000
Sustainable finance policies (X2) -> Green economic growth (Y)	0.450	0.447	0.072	6.256	0.000
Green financial products (X3) -> Green economic growth (Y)	0.292	0.298	0.072	4.027	0.000
Green financing practices (X1) -> Resource allocation efficiency (M)	0.202	0.192	0.055	3.649	0.000
Sustainable finance policies (X2) -> Resource allocation efficiency (M)	0.350	0.346	0.107	3.267	0.001
Green financial products (X3) -> Resource allocation efficiency (M)	0.394	0.411	0.107	3.684	0.000

Table 11. Specific Indirect Effects

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Green financing practices (X1) -> Resource allocation efficiency (M) -> Green economic growth (Y)	0.057	0.056	0.022	2.656	0.008
Sustainable finance policies (X2) -> Resource allocation efficiency (M) -> Green economic growth (Y)	0.100	0.103	0.046	2.160	0.031
Green financial products (X3) -> Resource allocation efficiency (M) -> Green economic growth (Y)	0.112	0.120	0.046	2.421	0.016

The results presented in Tables 10 and 11 confirm the significance of resource allocation efficiency (M) as a mediating variable between each of the exogenous constructs (X1, X2, X3) and the endogenous construct (Y). The specific indirect effects indicate statistically significant mediation, with all t-statistics exceeding the critical value of 1.96 and p-values below 0.05. Specifically, the indirect effect of green financing practices (X1) on green economic growth (Y) through resource allocation efficiency is 0.057, with a p-value of 0.008. The mediation effect of sustainable finance policies (X2) on green economic growth (Y) via resource allocation efficiency is 0.100 (p = 0.031). Similarly, the indirect effect of green financial products (X3) through resource allocation efficiency is 0.112 (p = 0.016).

These findings support the conclusion that resource allocation efficiency (M) partially mediates the relationship between green financing mechanisms and economic growth. The significance of the total effects in Table 10, alongside the significant indirect paths in Table 11, confirms that while X1, X2, and X3 exert direct effects on Y, their influence is amplified through the mediating role of M.

The implications of these findings are both theoretical and practical. Theoretically, they reinforce the importance of including mediating mechanisms in models that seek to explain the effectiveness of green financing frameworks. Practically, they emphasize the need for financial institutions and policymakers to promote green financial practices, policies, and products and ensure that these financial flows are allocated efficiently to sectors and projects with the greatest potential for sustainable impact. Enhancing the efficiency of resource allocation—by prioritizing renewable energy, green infrastructure, and sustainable technologies—can significantly magnify the positive outcomes of green finance on economic growth.

For financial institutions, this entails embedding resource allocation criteria into green finance decision-making processes and developing performance-tracking systems to ensure funds are effectively deployed. For policymakers, it underscores the importance of designing supportive regulations and incentive structures that promote sustainable finance instruments and efficient allocation mechanisms. Together, these strategies can accelerate the transition to a green economy and contribute to achieving national and global sustainable development goals.

Discussion

The influence of green financing practices on green economic growth

Green financing practices positively and statistically significantly influence green economic growth. This finding suggests that financing mechanisms for environmental

projects and sustainable investments are instrumental in promoting green economic development. These results are consistent with the work of Kwilinski et al. (2023), who emphasize the importance of green financing in improving resource efficiency and addressing environmental challenges. Similarly, Wang et al. (2024) highlight that green financing catalyzes low-carbon economic transitions, thereby supporting long-term sustainable growth.

Within the Indonesian context, the banking sector has made considerable progress in adopting and promoting green financing initiatives. Institutions such as Bank Mandiri and BRI have actively funded renewable energy projects by issuing green bonds and providing green loans. According to the Financial Services Authority (OJK, 2024), the total value of green financing in Indonesia reached IDR 2,050 trillion in 2023, underscoring the financial sector's growing contribution to economic sustainability. Nevertheless, challenges remain particularly the limited ESG literacy among small and medium-sized banks and the absence of comprehensive fiscal incentives that hinder broader implementation (Khoiriyah, 2024). Policymakers must strengthen regulatory frameworks and introduce targeted incentives to enhance the effectiveness of green financing in driving economic growth and to support the integration of ESG principles across all levels of the banking system.

The influence of sustainable finance policies on green economic growth

Sustainable finance policies also exhibit a strong positive effect on green economic growth. This indicates that well-designed policy frameworks—such as fiscal incentives for green investments and mandatory sustainability reporting—play a pivotal role in fostering a green economy. These findings are supported by Tariq and Hassan (2023), who argue that such policies facilitate the flow of capital toward environmentally sustainable projects. Ding & Liu (2023) further affirm that instruments like carbon taxation and ESG disclosure requirements significantly encourage investment in renewable energy and other green sectors.

In Indonesia, the Financial Services Authority (OJK) has taken concrete steps to advance sustainable finance by implementing the Sustainable Finance Roadmap Phase II (2021–2025). This roadmap promotes the alignment of banking operations with ESG principles and encourages adopting sustainability-oriented practices. Major financial institutions, including BRI and Bank Mandiri, have responded by issuing green bonds and channeling credit toward renewable energy initiatives, demonstrating institutional commitment to sustainability goals. However, the continued success of such initiatives depends on the strengthening of policy enforcement and the provision of robust incentives. These measures are essential for accelerating green economic growth and achieving Indonesia's Sustainable Development Goals (SDGs) commitments.

The influence of green financial products on green economic growth

Green financial products positively and statistically significantly impact green economic growth. This finding indicates that instruments such as green bonds, green credit, and sustainable mutual funds are vital in accelerating environmentally sustainable economic development. Empirical evidence from studies by Aneja et al. (2023) and Dzwigol et al. (2023) supports this conclusion, noting that green bonds and loans facilitate the flow of capital into renewable energy and sustainable infrastructure projects, fostering green innovation and economic transformation. Likewise, Jahanger et al. (2024) argue that sustainable mutual funds contribute to capital efficiency and long-term economic competitiveness by directing investments toward environmentally responsible assets.

In Indonesia, financial institutions such as Bank Mandiri and BRI have launched various green financial products, including green bonds and loans tailored for renewable energy initiatives. These products have become important vehicles for promoting sustainable investments. However, the expansion of green financial products faces certain obstacles. Among these are limited public awareness and the absence of supporting mechanisms, such as interest rate subsidies or tax incentives. Addressing these challenges is essential to ensuring broader adoption and maximizing the impact of green financial products on sustainable economic growth.

The influence of green financing practices on resource allocation efficiency

Green financing practices exert a positive and significant influence on resource allocation efficiency. This suggests that green financing channels capital into sustainable sectors and improves the overall efficiency with which financial resources are distributed—particularly in areas such as renewable energy, sustainable agriculture, and waste management. These findings are consistent with the studies of Geng et al. (2023), and Anas et al. (2024), who emphasize that green financing reduces capital misallocation, minimizes environmental externalities, and improves the return on investment in sustainability-driven projects.

In Indonesia, the Financial Services Authority (OJK), through its Sustainable Finance Roadmap Phase II (2021–2025), has played an important role in encouraging banks to allocate funding toward green sectors. For instance, BRI and Bank Mandiri have launched green financing programs for small and medium-sized enterprises (SMEs) operating in environmentally sustainable industries. These initiatives contribute to improving the efficiency of capital allocation and facilitating Indonesia's broader transition to a low-carbon and inclusive economy.

The influence of sustainable finance policies on resource allocation efficiency

Sustainable finance policies also demonstrate a positive and statistically significant effect on resource allocation efficiency. This finding indicates that implementing sustainability-oriented policy frameworks contributes to more efficient financial resource deployment, particularly in key sectors such as renewable energy, sustainable transportation, and eco-friendly manufacturing. Research by Udeagha and Ngepah (2023) and Sadiq et al. (2024) affirms that sustainable finance policies encourage financial institutions to prioritize investment decisions based on environmental performance, thus promoting optimal resource utilization and reducing inefficiencies.

The OJK has taken proactive steps to institutionalize sustainable finance policies in the Indonesian context through instruments such as the Sustainable Finance Roadmap. This regulatory guidance encourages banks to shift capital away from carbon-intensive industries and toward greener alternatives. Banks like BNI and Bank Mandiri have responded by developing green financing products in alignment with these policies, contributing to more effective resource allocation and reinforcing the country's commitment to achieving the Sustainable Development Goals (SDGs).

The influence of green financial products on resource allocation efficiency

Green financial products positively and significantly impact resource allocation efficiency. This indicates that products like green bonds and sustainable loans improve the efficiency of resource allocation by channeling funds into environmentally friendly projects. Studies by Afzal et al. (2023) and Ouyang et al. (2023) support these findings, noting that green financial products enhance resource employment efficiency, particularly in renewable energy and green infrastructure sectors.

The OJK's Sustainable Finance Guidelines (2017) have encouraged banks to develop green financial products in Indonesia. For example, Bank Mandiri and BRI have introduced green bonds and loans for renewable energy projects. These products promote environmental sustainability and ensure that resources are allocated efficiently, supporting Indonesia's green economic growth.

The influence of resource allocation efficiency on green economic growth

Resource allocation efficiency exerts a positive and significant effect on green economic growth. This suggests that the efficient allocation of financial resources is critical in driving sustainable economic development, as it ensures that capital is directed toward projects with high environmental and economic returns. The findings are supported by research conducted by Yahya and Lee (2023) and Challoumis (2024), which emphasize that optimal allocation of resources in sectors such as renewable energy and green infrastructure reduces environmental externalities and enhances overall economic performance.

In Indonesia, financial institutions have increasingly aligned their funding strategies with sustainability objectives by directing capital toward green sectors such as renewable energy and sustainable agriculture. For instance, Bank Mandiri has financed renewable energy projects by issuing green bonds, thereby improving resource allocation efficiency and supporting the country's efforts toward green economic growth. Such initiatives underscore the strategic importance of efficient financial flows in supporting environmentally responsible development.

The mediating role of resource allocation efficiency

The analysis of Specific Indirect Effects reveals that resource allocation efficiency significantly mediates the relationship between green financing mechanisms—namely green financing practices, sustainable finance policies , and green financial products—and green economic growth. The results show that each financing mechanism indirectly affects green economic growth through the intermediary role of resource allocation efficiency. This indicates that effective resource allocation is a critical pathway through which green finance contributes to sustainable economic outcomes.

These findings are aligned with the studies of Jiao et al. (2024), Zhang et al. (2023), and Udemba et al. (2024), who argue that efficient allocation of financial resources is central to achieving sustainable development. Directing funds to environmentally beneficial projects, such as renewable energy infrastructure and low-carbon technologies, enhances economic efficiency and environmental and social outcomes.

In the Indonesian context, the banking sector has played a pivotal role in advancing resource allocation efficiency by integrating sustainability objectives into lending and investment practices. Banks like Bank Mandiri and BRI have allocated capital toward renewable energy projects and other green initiatives through green bonds and sustainable loans. These actions have been guided by the OJK's Sustainable Finance Roadmap, which encourages the financial sector to align resource flows with national sustainability goals. As a result, improved efficiency in resource allocation has accelerated the country's transition toward a green economy, contributing meaningfully to achieving the Sustainable Development Goals (SDGs) and reinforcing long-term green economic growth.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study examines the role of green financing—encompassing green financing practices, sustainable finance policies, and green financial products—in promoting green economic growth through the mediating effect of resource allocation efficiency. The findings reveal that green financing mechanisms significantly influence economic growth both directly and indirectly by improving the allocation of financial resources. For example, green financing practices, such as funding renewable energy and low-carbon projects, and policy instruments like carbon taxes and investment incentives help direct capital toward sustainable development objectives. In parallel, green financial products, including green bonds and sustainable loans, are shown to play a pivotal role in advancing environmental goals by facilitating more effective and targeted financial flows.

In the Indonesian context, the banking sector, supported by strategic government initiatives and the Financial Services Authority (OJK), has been instrumental in fostering green economic growth. Banks such as Bank Mandiri and BRI have introduced various green financial products—particularly green bonds and loans—aimed at renewable energy projects and other sustainability-focused sectors. These initiatives contribute significantly to resource allocation efficiency and, in turn, to the nation's green development agenda. However, key challenges persist, including limited ESG awareness among smaller financial institutions and insufficient fiscal incentives to stimulate broader adoption of sustainable finance.

In conclusion, the study underscores the critical importance of green financing practices, effective policy frameworks, and innovative financial instruments in driving resource efficiency and green economic growth. Policymakers must strengthen regulatory frameworks—such as mandatory ESG disclosures—expand fiscal incentives and foster public-private collaboration to maximize the impact of green financing initiatives. Financial institutions should also design and implement sector-specific green financial products, targeting areas such as sustainable agriculture and low-emission transport. These insights guide policymakers, financial institutions, and stakeholders in designing more effective strategies to advance sustainable economic development.

Recommendations

Based on the findings, several strategic recommendations are proposed to enhance green economic growth through more efficient resource allocation:

First, financial institutions—particularly banks—should intensify developing and promoting green financial products. Collaboration with the government is crucial in creating and scaling innovative instruments such as green bonds, green sukuk, and project-based financing for renewable energy and sustainable infrastructure. These tools can enhance the banking sector's contribution to green economic transformation in Indonesia.

Second, through the Financial Services Authority (OJK) and other relevant institutions, the government should strengthen sustainable finance policies by introducing clear regulations and incentive mechanisms that encourage private sector investment in green initiatives. Fiscal incentives, such as tax relief, subsidies, and credit guarantees, can significantly accelerate the shift toward a more environmentally friendly and resilient economy.

Third, financial institutions should invest in stakeholder education and training programs to improve the understanding of the long-term value of green investments. These programs should focus on environmental risk assessment, measuring the impact of

green projects, and identifying investment opportunities in sustainable finance. Equipping stakeholders with this knowledge is essential to overcoming barriers and maximizing the benefits of green financing.

Fourth, stronger collaboration between the government and private sector is needed to design green financial products that are inclusive and accessible, particularly for micro, small, and medium enterprises (MSMEs), which often struggle to access sustainable financing. Tailored financial instruments and support mechanisms for MSMEs can broaden the reach of green finance and promote a more inclusive green economy.

In addition to these practical recommendations, future research should explore the impact of green financing within specific sectors—such as renewable energy, sustainable agriculture, and low-emission transportation—to gain deeper insights into how green financing can be customized to address sector-specific challenges and opportunities.

Finally, the role of digital banking and financial technology (fintech) should be further leveraged to support green finance. Fintech solutions and digital banking platforms can improve accessibility to green financial products, especially for underserved populations and small businesses. Technologies such as AI-driven risk assessments, blockchain for transparent green investments, and mobile platforms for green lending and carbon credit trading can enhance financial inclusion and resource allocation efficiency. Embracing these innovations will be essential in driving Indonesia's sustainable and technologically advanced green economy.

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