



## Sustainable Innovation and Financial Performance: The Roles of Green Process and Product Strategies

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### Abstract

This study aims to examine the effect of green process innovation, green product innovation, and green image on financial performance, with firm size, financial constraints, total asset turnover, and firm age as control variables. The research focuses on consumer non-cyclical companies listed on the Indonesia Stock Exchange during the period 2021–2022. The data employed are secondary data derived from companies' annual financial statements and sustainability reports. The sampling technique applied was purposive sampling, resulting in a final sample of 164 firm-year observations across two years. The findings reveal that green process innovation significantly influences green product innovation. However, green process innovation does not directly affect financial performance. Instead, green product innovation mediates the relationship between green process innovation and financial performance. Furthermore, green image is found to have no significant effect on financial performance, nor does it moderate the relationship between green product innovation and financial performance in consumer non-cyclical firms.

**Keywords:** financial performance, green process innovation, green product innovation, green image.

### 1. Introduction

The development and progress of a nation are significantly influenced by various factors, one of which is the presence of industries within the country. Globalization has transformed business practices and operational systems across all industrial sectors. However, industrial activities often generate problems, particularly environmental pollution arising from production processes such as industrial waste, which can severely contaminate air, water, and soil (Agustia et al., 2019). In the current industrial era, corporate growth continues to increase, accompanied by the rising volume of waste produced through industrial processes. Waste that is directly discharged without prior recycling can cause substantial water and soil pollution, both within company environments and surrounding communities. The manufacturing sector, in particular, is recognized as one of the largest contributors to environmental degradation. This sector produces hazardous waste that poses serious risks to human life (Sari et al., 2019). Thus, it is crucial for both society and businesses to raise awareness and adopt effective strategies to mitigate environmental pollution in order to create a healthier environment. One such strategy is the adoption of green innovation (Xie et al., 2019). Financial performance reflects a company's financial condition, measured through financial analysis tools to determine whether a firm's performance is favorable or unfavorable over a given period (Gani & Machmud, 2020). Investors often evaluate financial performance before making investment decisions. Maintaining financial performance requires firms to secure adequate funding and sustain operational efficiency, as strong financial performance enhances investor confidence and attracts capital inflows (Gede Suarjaya, n.d.). An illustrative case is reported by kontan.co.id in Jakarta: in 2021, stock prices in the consumer non-cyclical sector declined compared to the consumer cyclical index. Data from the Indonesia Stock Exchange (IDX) recorded that the consumer non-cyclical sector weakened by 7.43% year-to-date, while the consumer cyclical sector rose by 13.11%. This trend continued into 2022, when the IDX Consumer Non-Cyclical Sector Index fell by 7.99% year-to-date.

Further evidence from financial reports and annual reports published on [www.idx.id](http://www.idx.id) shows that several firms in the consumer non-cyclical sector experienced a decline in profitability. For example, PT Japfa Comfeed Indonesia Tbk (JPFA) reported a nearly 30% decrease in profit from 2021 to 2022, disappointing investors, with net income falling to IDR 1.49 trillion in December 2022. Its Return on Assets (ROA) was only 4.34% in 2022, below the 5.98% benchmark, indicating inefficiency in asset utilization. Similarly, in 2022, PT Charoen Pokphand Indonesia Tbk (CPIN) experienced a 3.42% decline in stock value, PT Unilever Indonesia Tbk (UNVR) reported a 6.83% drop in net income compared to 2021, and PT Gudang Garam Tbk (GGRM) recorded a sharp 50% decline in net profit, causing respective decreases in their stock prices. Declining profits and stock prices in the consumer non-cyclical sector inevitably affect investor perceptions, directly impacting corporate financial performance. As a formal measurement tool, financial performance serves to assess corporate success in generating profit, projecting growth, and leveraging available resources. Strong financial performance enhances firm prospects and attracts greater investor interest (Yuliyastri et al., 2021). Green innovation represents corporate strategies that emphasize energy conservation and efficiency throughout production processes, from raw material utilization to final products. This approach reduces resource consumption, lowers production costs, and enhances competitiveness. Xie et al. (2019) highlighted that green innovation is a critical tool for firms seeking to enhance productivity, reduce costs, improve products, and explore new market opportunities.



Green process innovation refers to production activities that employ environmentally friendly technologies to minimize environmental damage (Wong et al., 2012). It plays a crucial role in supporting green product innovation, as environmentally conscious production processes lead to products that are more widely accepted by consumers. Consequently, public and investor trust may increase, ultimately benefiting firms financially (Salvatira Bibi & Narsa, 2022). In addition, green process innovation enhances product differentiation, thereby reinforcing corporate performance (Xie et al., 2019). Previous studies provide mixed findings regarding the relationship between green process innovation and financial performance. While several studies found a positive relationship (Xie et al., 2019; Salvatira Bibi & Narsa, 2022; Alviani et al., 2020; Vera et al., 2020), others reported no significant effect (Xie et al., 2022; Sari et al., 2020a). This discrepancy may arise because green innovation often entails high costs, such as scaling up production, upgrading machinery, and investing in innovation activities, which may burden firms and reduce financial performance in the short term. On the other hand, both green process and green product innovation can enhance financial performance by improving product quality, developing new products, and expanding market share (Sari et al., 2020a; Xie et al., 2022). Empirical evidence suggests that green product innovation mediates the relationship between green process innovation and financial performance (Xie et al., 2019). Moreover, green product innovation contributes to environmental sustainability by reducing excessive resource usage, improving operational efficiency, and consequently boosting profitability (Chen et al., 2006; Fitriani, 2015). Despite this, research results remain inconsistent. While some studies report positive effects of green product innovation on financial performance (Xie et al., 2019; Helmi & Widiastuty, 2023; Budi et al., 2021), others suggest no significant impact (Safitri, 2022).

Another factor considered in this study is green image, which reflects stakeholders' perceptions of a firm's environmental commitment. A positive corporate image enhances consumer confidence and investor trust, making green image a key determinant of market acceptance (Rohmatul Ulla et al., 2019). Prior studies suggest that green image positively influences green innovation and financial performance (Xie et al., 2019; Wu & Qu, 2021). However, implementing green strategies often requires substantial resources, which not all firms can afford. In Indonesia, environmental responsibility is also enforced through regulation. Law No. 24 of 2009 mandates environmental management in industries, with penalties ranging from fines to license revocation for violators. The consumer non-cyclical sector, particularly in manufacturing, is identified as a major contributor to environmental damage, especially through plastic waste (Murtanto, 2022). Indonesia is the world's second-largest producer of marine plastic waste, generating 1.29 million tons annually, with total waste projected at 68.5 million tons in 2021, of which 11.6 million tons (17%) was plastic (Ditjen PSLB3, 2022). Several high-profile cases underscore the environmental challenges in this sector. For example, PT Sekar Laut Tbk (SKLT) faced community protests in 2017 over water pollution, while PT Indofood Sukses Makmur Tbk (INDF) was implicated in improper disposal of hazardous industrial waste (Suparno, 2017; Lesmana et al., n.d.). Based on these considerations, this study investigates the effect of green process innovation and green product innovation on financial performance, with a focus on consumer non-cyclical companies listed on the Indonesia Stock Exchange during 2021–2022. The choice of this sector is motivated by its significant environmental impact, particularly in terms of plastic waste (Murtanto, 2022), and the urgency of addressing pollution in developing countries such as Indonesia.

## 2. Literature Review

### *Resource Based View Theory*

The Resource-Based View (RBV) Theory posits that firms can achieve competitive advantage by leveraging their resources, thereby enabling long-term sustainability (Barney, 1986). The central premise of RBV lies in understanding the relationship between resources, capabilities, competitive advantage, and profitability, particularly in explaining the mechanisms through which firms sustain their competitive edge over time (Jatmiko, 2020). Within this framework, two strategies of green innovation—green process innovation and green product innovation—are considered valuable resources. These innovations, whether in the form of modified processes or environmentally friendly products, contribute not only to environmental sustainability but also serve as effective strategies for maintaining and enhancing corporate financial performance (Novitasari, 2022). Empirical evidence supports this view, as studies by Xie et al. (2019), Novitasari (2022), and Hartanti (2021) demonstrate that the joint implementation of both green process and product innovation can improve financial performance, provided that firms successfully optimize their resources and capabilities. These two types of innovation are inherently complementary, influencing corporate outcomes in tandem. Thus, neither can be fully understood in isolation without acknowledging their interdependence (Damanpour, 2010). The success of green product innovation, for instance, depends heavily on sustainable business operations. Green process innovation, in turn, involves a transformation of production activities with the explicit aim of reducing the firm's environmental footprint from the source of its production processes (Gopalakrishnan et al., 1999).

### **Stakeholder Theory**



According to Rankin et al. (2012), stakeholder theory emphasizes that a firm must consider the interests of a broad range of stakeholders, not merely its shareholders. One way to address stakeholder needs and expectations is by disclosing comprehensive information about organizational activities and performance. Such disclosures demonstrate how the firm's strategies, mission, and objectives align with stakeholder expectations, as well as how its financial and environmental performance meet stakeholder demands. Monteiro and Guzman (2010) further argue that companies operating in environmentally sensitive industries must comply with environmental regulations, since pollution arising from corporate activities poses significant environmental risks. These firms also face greater social pressure due to heightened scrutiny regarding environmental issues. Failure to report on social and environmental responsibilities may result in public backlash and government sanctions because of the negative externalities caused by corporate operations (Kumalasari, 2016). In this context, green image is closely linked to stakeholder theory, as it reflects both environmental responsibility and the characteristics of green innovation. A positive green image is regarded as a critical determinant of consumer satisfaction and investor confidence. By cultivating a strong green image, firms not only mitigate potential risks associated with environmental protests and legal sanctions, but also enhance consumer perceptions of environmental friendliness and sustainability (Chen, 2010). Moreover, a positive green image strengthens public reputation, thereby potentially increasing sales and boosting stock value (Zhu, 2010). From the perspective of stakeholder theory, green image enables firms to secure trust and support from external institutions and key stakeholders (Prakas, 2007).

### 3. Conceptual Framework

#### **Green Process Innovation and Green Product Innovation**

Green process innovation serves as an initial step for firms to assess and evaluate whether their production processes are conducted appropriately by fully utilizing available environmental resources. By implementing green process innovation, companies are able to create high-quality products that reflect their distinct corporate identity, thereby enhancing market share and attracting investors (Xie et al., 2019). In addition, green process innovation helps firms improve product quality, expand product variety, and develop new products that can further strengthen market competitiveness. Thus, green process innovation plays a pivotal role in facilitating green product innovation. Drawing upon the Resource-Based View (RBV) Theory, corporate resources and capabilities are considered the primary determinants of competitive advantage and long-term success. Efficient resource utilization provides firms with significant advantages, as green process innovation enables and reinforces green product innovation. Firms may initially adopt green process innovation strategies in order to optimize their internal resources (Xie et al., 2019). This view is supported by prior studies, including Xie et al. (2019) and Chen and Chang (2013), which demonstrate a positive relationship between green process innovation and green product innovation. Based on this reasoning, the following hypothesis is proposed: H1: Green process innovation positively influences green product innovation.

#### **Green Process Innovation and Financial Performance**

From the perspective of the Resource-Based View (RBV) Theory, implementing green process innovation provides firms with distinctive advantages, such as reducing operational expenses, minimizing fuel consumption, conserving electricity, and improving machine efficiency, which collectively lead to lower manufacturing costs. These reductions in production costs ultimately decrease overall operating expenses, thereby contributing to higher profitability. Green process innovation also benefits firms that are unable to develop new products. For companies facing stagnant sales volumes, cost minimization through process efficiency allows them to sustain profitability and improve overall performance. As highlighted by Xie et al. (2019), when green process innovation and green product innovation are applied simultaneously, firms are likely to achieve superior financial outcomes. This finding is further supported by studies conducted by Xie et al. (2019), Sari et al. (2020), and Widiastuty (2023), all of which conclude that green process innovation enhances corporate performance. Based on these arguments, the following hypothesis is proposed: H2: Green process innovation positively influences financial performance.

#### **Mediation of Green Product Innovation in the Relationship between Green Process Innovation and Financial Performance**

In recent years, eco-friendly product innovation has been recognized as a key factor in achieving both business growth and environmental sustainability. Investment in green product innovation helps firms mitigate environmental risks while seizing new market opportunities. Green process innovation often serves as the foundation for producing high-quality and environmentally responsible products, thereby influencing market share and investor perceptions. According to RBV theory, corporate resources and capabilities are primary determinants of sustainable competitive advantage. Efficient resource utilization thus enables firms to optimize green process innovation, which in turn facilitates green product innovation (Xie et al., 2019). This argument is supported by empirical evidence. Studies by Xie et al. (2019), Salvatira Bibi and Narsa (2022), and Vera et al. (2020) demonstrate that green product innovation



mediates the relationship between green process innovation and financial performance. Accordingly, the following hypothesis is proposed: H3: Green product innovation mediates the relationship between green process innovation and financial performance.

#### **Green Image and Financial Performance**

According to Astini et al. (2016), a product's image plays a critical role, as it shapes consumer perceptions and leaves lasting impressions. Green image, in particular, represents an important criterion for evaluating product quality and strengthening consumer trust. A positive corporate image not only assures stakeholders of product quality but also strongly influences consumer purchasing decisions (Chen, 2010). From the lens of Stakeholder Theory, green image is regarded as a determinant of both consumer satisfaction and investor confidence. By cultivating a strong green image, firms can avoid potential risks such as environmental protests and legal sanctions, while simultaneously enhancing consumer expectations of environmental friendliness and sustainability (Chen, 2010). Furthermore, a positive green image fosters stronger public reputation, which may result in higher sales and increased stock value (Zhu & Sarkis, 2006). Empirical studies by Xie et al. (2019), Astini et al. (2016), and Rohmatul Ulla et al. (2019) confirm that green image positively influences financial performance. Considering that customer loyalty and corporate reputation are crucial factors affecting financial returns (Dangelico, 2016), companies with a stronger green image are more likely to achieve higher profitability and stronger financial performance. Hence, the following hypothesis is formulated: H4: Green image positively influences financial performance.

#### **Moderating Role of Green Image in the Relationship between Green Product Innovation and Financial Performance**

Green image is also considered an important criterion in evaluating product quality and shaping consumer trust. A positive corporate image enhances consumer perceptions of product reliability and strengthens overall corporate reputation (Chen et al., 2010; Heinberg et al., 2018). Given that customer loyalty and corporate reputation are significant drivers of financial returns (Dangelico, 2016), firms with a stronger green image can generate greater profitability from their green product innovations. This argument is consistent with findings by Xie et al. (2019), Rohmatul Ulla et al. (2019), and Tjahjadi et al. (2020), which indicate that green image moderates the relationship between green product innovation and financial performance. Thus, the following hypothesis is proposed: H5: Green image moderates the relationship between green product innovation and financial performance.

#### **4. Research Questions**

The research questions formulated in this study are as follows:

- a. Does green process innovation influence green product innovation?
- b. Does green process innovation affect financial performance?
- c. Does green product innovation mediate the relationship between green process innovation and financial performance?
- d. Does green image moderate the relationship between green product innovation and financial performance?

#### **5. Significance of Study**

In Indonesia, relatively few studies have examined the influence of green process innovation and green product innovation on financial performance. This gap is noteworthy given the increasing urgency of environmental issues, which remain critical challenges that companies and businesses must address in order to create a healthy organizational environment and achieve sustainable growth.

#### **6. Research Method**

This study employs a quantitative research design using secondary data. The population consists of consumer non-cyclical companies listed on the Indonesia Stock Exchange (IDX) during the period 2021–2022. Out of 123 firms, only 82 met the sampling criteria, resulting in a total of 164 firm-year observations drawn from annual financial reports and sustainability reports of consumer non-cyclical companies for 2021–2022. The operationalization of the variables—green process innovation, green product innovation, and green image—was measured using a scoring system ranging from 0 to 2. A score of 0 was assigned if no relevant disclosure was provided, a score of 1 if only a general description without implementation details was available, and a score of 2 if detailed disclosure and implementation were reported (Xie et al., 2019). The total score for each firm was then summed and divided by the total number of indicators (Xie et al., 2019). This study employs several variables measured using data obtained from annual reports and sustainability reports. The control variables include firm size, financial constraints, total asset turnover, and firm age. Firm size is measured as the natural logarithm of total assets, while financial constraints are proxied by the Debt to Assets Ratio (DAR). Total asset turnover (TATO) is calculated as the ratio of total sales to total assets, and firm age is measured as



the number of years since the company was first listed up to the period of this study. In addition, the main variables of this research consist of green process innovation, green product innovation, green image, and financial performance. Green process innovation is assessed through five indicators: efforts to reduce resource and energy consumption and improve efficiency; the use of recycled materials, recycling techniques, and environmental technologies; the introduction of new technologies to reduce hazardous emissions and waste generated during processing; the utilization of pollution-control equipment; and the adoption of pollution-control projects and technologies. Green product innovation, meanwhile, is measured using three indicators: product design modifications aimed at avoiding pollution or toxic substances in production, the development of environmentally friendly packaging for both existing and new products, and product design modifications intended to improve energy efficiency during usage. Green image is evaluated based on three indicators: compliance with environmental regulations and a high level of awareness of environmental risks, the ability to improve energy efficiency through appropriate environmental performance, and the ability to reduce waste through proper environmental practices. Finally, financial performance is measured using the Return on Assets (ROA) ratio, as reported in company annual reports.

## 7. Findings

### Model 1: Green Process Innovation and Green Product Innovation

Table 1. Multicollinearity Test

	PROC	FS	FC	TATO	FA
PROC	1	0.2512701	-0.251298	-0.0165186	0.0191919
FS	0.251270	1	0.161342	-0.059196	0.3386110
FC	-0.2512980	0.161342	1	0.080780	0.2935162
TATO	-0.0165186	-0.0591966	0.080780	1	0.0722807
FA	0.0191919	0.3386110	0.293516	0.072280	1

Source: EViews 10 Output, 2024

Based on the results presented in Table 1, it can be observed that none of the independent variables in this study suffer from multicollinearity problems. This is indicated by the correlation matrix values for each variable, all of which are below the threshold of 0.8. As shown in Table 2, the significance values of all independent variables are greater than 0.05, indicating that no heteroskedasticity problems are present in the regression model.

Table 2. Heteroskedasticity Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.122895	3.31E-12	3.72E+10	0.0000
PROC	-3.97E-14	3.70E-14	-1.073704	0.2863
FS	-1.05E-12	1.20E-13	-8.760740	0.0000
FC	-5.86E-13	1.76E-13	-3.326004	0.0014
TATO	-1.05E-13	4.53E-14	-2.326541	0.0226
FA	5.81E-14	1.67E-14	3.481504	0.0008

  

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	1.000000	Mean dependent var	0.122895
Adjusted R-squared	1.000000	S.D. dependent var	0.127191
S.E. of regression	9.63E-14	Akaike info criterion	-56.80015
Sum squared resid	7.14E-25	Schwarz criterion	-55.15571
Log likelihood	4744.613	Hannan-Quinn criter	-56.13257
F-statistic	3.31E+24	Durbin-Watson stat	3.951807
Prob(F-statistic)	0.000000		

Source: EViews 10 Output, 2024

The regression model testing the effect of green process innovation on green product innovation can be expressed as follows:

$$PROD_{it} = \beta_0 + \beta_1PROC_1 + \beta_2FS + \beta_3FC + \beta_4TATO + \beta_5FA + \varepsilon... (1)$$

$$PROD = 4.8064 + 0.4103PROC - 0.0364FS - 1.0248FC + 0.0270TATO - 0.0654FA$$

The results indicate that green process innovation explains 51% ( $R^2 = 0.51$ ) of the variation in green product innovation, while the remaining 49% is explained by other variables not included in the model. The probability value of PROC (X) is 0.0000, which is less than 0.05. Therefore, the alternative hypothesis ( $H_a$ ) is supported, and the null



hypothesis (Ho) is rejected. This finding confirms that green process innovation has a significant positive effect on green product innovation. Accordingly, the first hypothesis (H1) is supported.

**Model 2: The Mediating Role of Green Product Innovation between Green Process Innovation and Financial Performance**

Table 3. Multicollinearity Test

	ROA	PROC	PROD	FS	FC	TATO	FA
ROA	1	0.644912	0.666935	0.276773	-0.190850	-0.000815	0.105390
PROC	0.644912	1	0.773304	0.251270	-0.251298	-0.016518	0.019191
PROD	0.666935	0.773304	1	0.222632	-0.218600	0.100113	0.077628
FS	0.276773	0.251270	0.222632	1	0.161342	-0.059196	0.338611
FC	-0.190850	-	-	0.161342	1	0.080780	0.293516
TATO	-0.000815	-	0.100113	-	0.080780	1	0.072280
FA	0.105390	0.019191	0.077628	0.338611	0.293516	0.072280	1

Source: EViews 10 Output, 2024

Based on the results shown in Table 3, it can be concluded that the independent variables in this model are free from multicollinearity problems. This is evidenced by the correlation matrix values for all variables being below the threshold of 0.8. As presented in Table 4, the significance values of green process innovation and green product innovation are greater than 0.05, indicating that no heteroskedasticity issues exist in this regression model.

Table 4. Heteroskedasticity Test

Dependent Variable: ABS(RESID)				
Method: Panel Least Squares				
Date: 04/18/24 Time: 14:10				
Sample: 2021 2022				
Periods included: 2				
Cross-sections included: 82				
Total panel (balanced) observations: 164				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.019487	1.04E-12	1.87E+10	0.0000
PROD	4.70E-15	1.34E-14	0.350497	0.7269
PROC	1.82E-14	1.29E-14	1.410764	0.1624
FS	3.29E-13	3.78E-14	8.707419	0.0000
FC	1.91E-13	5.72E-14	3.342487	0.0013
TATO	3.14E-14	1.43E-14	2.202163	0.0307
FA	-1.80E-14	5.33E-15	-3.378494	0.0012
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	1.000000	Mean dependent var	0.019487	
Adjusted R-squared	1.000000	S.D. dependent var	0.023226	
S.E. of regression	3.03E-14	Akaike info criterion	-59.11165	
Sum squared resid	6.99E-26	Schwarz criterion	-57.44831	
Log likelihood	4935.155	Hannan-Quinn criter.	-58.43640	
F-statistic	1.10E+24	Durbin-Watson stat	3.951807	
Prob(F-statistic)	0.000000			

Source: EViews 10 Output, 2024

The regression model testing the mediating role of green product innovation between green process innovation and financial performance is specified as follows:

$$ROA_{it} = \beta_0 + \beta_1PROC_{lit} + \beta_2PROD_{it}^2 + \beta_3FS + \beta_4FC + \beta_5TATO + \beta_5FA + \varepsilon \dots(2)$$

$$ROA = -0.8514 + 0.0071PROC + 0.0521PROD + 0.0282FS + 0.0722FC + 0.0508TATO - 0.0027FA$$

The results indicate that green process innovation and green product innovation jointly explain 78% ( $R^2 = 0.78$ ) of the variation in financial performance, while the remaining 22% is explained by other variables not included in the model. The probability value of PROC (X) is 0.7078, which is greater than 0.05. Therefore, the alternative hypothesis (Ha) is not supported, and the null hypothesis (Ho) is accepted, indicating that green process innovation has no significant effect on financial performance. Accordingly, the second hypothesis (H2) is not supported. By contrast, the probability value of PROD (mediator) is 0.0097, which is less than 0.05. This confirms that green product innovation has a significant effect on financial performance. The probability value of the overall model is 0.0000, which is less than 0.05. This suggests that green process innovation and green product innovation collectively exert a significant influence on financial performance. The mediation hypothesis was further tested using the Sobel test, which evaluates the strength of indirect or mediating effects (Ghozali, 2018). The decision rule is based on comparing the calculated t-value with the critical t-table value: if the calculated t-value exceeds the critical threshold, mediation is confirmed. In this study, the mediation tested is the indirect effect of green process innovation (X) on financial performance (Y) through green product innovation (M).



$$t = \frac{ab}{\sqrt{(b^2 SE a^2) + (a^2 SE b^2)}}$$

$$t = \frac{0,035}{\sqrt{8,4430 + 0,000175}}$$

$$t = \frac{0,035}{\sqrt{0,0001827}}$$

$$t = \frac{0,01351}{0,035}$$

$$t = 2,5928$$

Thus, the Sobel test produced a t-value of 2.5928, which is greater than the critical t-table value of 1.9748. This result indicates that green product innovation significantly mediates the relationship between green process innovation and financial performance. Based on the above calculation, the obtained t-value of 2.5928 is greater than the critical t-table value of 1.9748. Therefore, the alternative hypothesis (Ha) is accepted and the null hypothesis (H0) is rejected. This result indicates that green process innovation affects financial performance through green product innovation as an intervening variable. Accordingly, the third hypothesis (H3) is supported.

**Model 1 Without Moderating Variable**

Table 5. Multicollinearity Test

	ROA	PROD	FS	FC	TATO	FA
ROA	1	0.666667	0.277030	-	-	0.105390
PROD	0.666667	1	0.222370	0.191244	0.001087	0.076719
FS	0.277030	0.222370	1	0.219417	-	0.338425
FC	-	-	0.160188	1	0.059582	0.293174
TATO	-	0.100526	-	0.080340	1	0.072009
FA	0.105390	0.076719	0.338425	0.293174	0.072009	1

Source: EViews 10 Output, 2024

Based on the results presented in Table 5, it can be concluded that the independent variables in this study do not suffer from multicollinearity issues. This is indicated by the correlation matrix values of all variables being below the threshold of 0.8. As shown in Table 6, the significance values for green process innovation and green product innovation are greater than 0.05. This suggests that heteroskedasticity is not present in the regression model.

Table 6. Heteroskedasticity Test

Source: EViews 10 Output, 2024

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.33E-16	6.13E-18	54.37787	0.0000
PROD	-1.52E-20	5.94E-19	-0.025588	0.9797
FS	-4.89E-21	2.19E-21	-2.235979	0.0283
FC	9.80E-19	1.02E-18	0.960257	0.3400
TATO	2.09E-19	3.86E-19	0.540745	0.5903
FA	-4.84E-21	1.75E-20	-0.275914	0.7834

  

Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.999962	Mean dependent var	3.20E-16	
Adjusted R-squared	0.999918	S.D. dependent var	3.11E-16	
S.E. of regression	2.82E-18	Akaike info criterion	-77.67593	
Sum squared resid	6.05E-34	Schwarz criterion	-76.01258	
Log likelihood	6457.426	Hannan-Quinn criter.	-77.00067	
F-statistic	22726.10	Durbin-Watson stat	4.000000	
Prob(F-statistic)	0.000000			

The regression model without the moderating variable is formulated as follows:



$$ROA_{it} = \beta_0 + \beta_1PROD_{it} + \beta_2FS + \beta_3FC + \beta_4TATO + \beta_5FA + \varepsilon \dots(1)$$

$$ROA_{it} = -0.301534 + 0.102525PROD + 7.031773FS - 0.044661FC - 0.0190588TATO + 0.001041FA + \varepsilon$$

The results show that green product innovation explains 47% ( $R^2 = 0.47$ ) of the variation in financial performance, while the remaining 53% is explained by other variables not included in the model. The probability value of PROD (mediator) is 0.0000, which is less than 0.05. Thus, the alternative hypothesis ( $H_a$ ) is accepted and the null hypothesis ( $H_0$ ) is rejected. This indicates that green product innovation has a significant effect on financial performance. The probability value of the F-test is 0.000015, which is less than 0.05. Therefore, the alternative hypothesis ( $H_a$ ) is accepted and the null hypothesis ( $H_0$ ) is rejected. This confirms that green product innovation, together with the control variables, has a significant joint effect on financial performance.

**Model 2: The Moderating Role of Green Image in the Relationship between Green Product Innovation and Financial Performance**

The selected model for testing the moderating role of green image is the Random Effect Model (REM). According to Gujarati (2012), when REM is selected, classical assumption tests are not required.

$$ROA_{it} = \beta_0 + \beta_1PROD_{it} + \beta_2GI + \beta_3PROD*GI + \beta_4FS + \beta_5FC + \beta_6TATO + \beta_7FA + \varepsilon \dots(2)$$

$$ROA_{it} = -0.332728 + 0.085280PROD + 0.0382300GI - 0.005400INTERAKSI + 7.471184FS - 0.022109FC - 0.004660TATO + 0.000193FA + \varepsilon$$

Table 7. Coefficient of Determination ( $R^2$  Test)

R-squared	0.484917
Adjusted R-squared	0.461804
S.E. of regression	0.069864
F-statistic	20.98051Ba

Source: EViews 10 Output, 2024

Based on Table 7, the results show that green product innovation and green image together explain 47% of the variation in financial performance, while the remaining 53% is explained by other factors not included in the model.

Table 8. t-Test Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.332728	0.100070	-3.324945	0.0011
PROD	0.085281	0.041607	2.049656	0.0421
GI	0.038230	0.030191	1.266290	0.2073
INTERAKSI	-0.005401	0.025431	-0.212362	0.8321
FS	7.47E-05	3.54E-05	2.108713	0.0366
FC	-0.022110	0.018524	-1.193540	0.2345
TATO	-0.004660	0.006514	-0.715405	0.4754
FA	0.000194	0.000263	0.736584	0.4625

Source: EViews 10 Output, 2024

To further examine the role of green image as a moderating variable, a t-test was conducted on green product innovation, green image, and their interaction term. The purpose of this test is to evaluate the direct effects of green product innovation and green image on financial performance, as well as to determine whether green image strengthens the relationship between green product innovation and financial performance. The results of the t-test analysis are presented as follows:

- The t-test results for the green product innovation variable show a calculated t-value of 2.049656, which is greater than the critical t-table value of 1.97471, with a significance level of  $0.0421 < 0.05$ . Therefore, the null hypothesis ( $H_0$ ) is rejected and the alternative hypothesis ( $H_a$ ) is accepted, indicating that green product innovation has a significant effect on financial performance.
- The t-test results for the green image variable indicate a calculated t-value of 1.266290, which is lower than the critical t-table value of 1.97471, with a significance level of  $0.2073 > 0.05$ . Thus,  $H_a$  is not supported and  $H_0$  is accepted, meaning that green image does not have a significant effect on financial performance. Accordingly, hypothesis four ( $H_4$ ) is not supported.
- For the interaction term ( $PROD \times GI$ ), the calculated t-value is 0.212362, which is lower than the critical t-table value of 1.97471, with a significance level of  $0.8321 > 0.05$ . Hence,  $H_a$  is not supported and  $H_0$  is accepted, suggesting that green image does not moderate the relationship between green product innovation and financial



performance. Consequently, hypothesis five (H5) is not supported. The F-test results further demonstrate that the probability value of the model is  $0.0000 < 0.05$ , indicating that the null hypothesis (H0) is rejected and the alternative hypothesis (Ha) is accepted. This implies that green product innovation, green image, and their interaction collectively have a significant effect on financial performance. Moreover, the F-statistic of 20.98051 is greater than the f-table value of 2.1, with a significance level of  $0.0000 < 0.05$ , confirming the joint significance of green product innovation, green image, and the interaction term in explaining financial performance. Finally, to further assess the moderating effect of green image on the relationship between green product innovation and financial performance, a Moderated Regression Analysis (MRA) was conducted. The interaction test results from the MRA are presented in the following table.

Table 9. Results of Moderated Regression Analysis (MRA)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.332728	0.100520	-3.310055	0.0012
PROD	0.085281	0.041794	2.040477	0.0430
GI	0.038230	0.030326	1.260619	0.2093
INTERAKSI	-0.005401	0.025545	-0.211411	0.8328
FS	7.47E-05	3.56E-05	2.099269	0.0374
FC	-0.022110	0.018608	-1.188195	0.2366
TATO	-0.004660	0.006543	-0.712201	0.4774
FA	0.000194	0.000264	0.733286	0.4645

Source: EViews 10 Output, 2024

Based on the results shown in Table 9, the probability value of the interaction between green product innovation and green image is 0.8328, which is greater than the significance threshold of 0.05, with a coefficient value of  $-0.0054$ . This indicates that green image does not moderate or strengthen the relationship between green product innovation and financial performance. Therefore, it can be concluded that green image does not serve as a moderating variable in this relationship. Accordingly, the fifth hypothesis (H5) is not supported.

## 8. Discussion

### The Effect of Green Process Innovation on Green Product Innovation

The regression analysis indicates that for the variable green process innovation, the probability value of PROC (X) is  $0.0000 < 0.05$ . Thus, the alternative hypothesis (Ha) is accepted and the null hypothesis (H0) is rejected, meaning that the independent variable significantly affects the dependent variable. Green process innovation has a significant positive effect on green product innovation. Accordingly, the first hypothesis (H1) is supported. This finding can be explained by the fact that green process innovation enables firms to succeed in producing new product innovations by enhancing their competitiveness. Moreover, green process innovation helps companies improve product quality, expand product options, and generate new products that can increase market share (Li et al., 2017). From the perspective of the Resource-Based View (RBV) Theory, corporate resources and capabilities are the key determinants of competitive advantage and long-term success. Efficient utilization of resources provides significant benefits, as green process innovation facilitates green product innovation in enhancing financial performance. This result is consistent with prior studies (Xie et al., 2019; Chen & Chang, 2013), which also confirmed the positive relationship between green process innovation and green product innovation.

### The Effect of Green Process Innovation on Financial Performance

The regression analysis reveals that for green process innovation, the probability value of PROC (X) is  $0.7078 > 0.05$ . Thus, Ha is rejected and H0 is accepted, indicating that green process innovation does not significantly affect financial performance. Accordingly, the second hypothesis (H2) is not supported. Green process innovation may not influence financial performance due to several inhibiting factors, such as the high costs of production, the absence of strict regulations, and the need for additional budgets for research and development. Recycling processes also require specific expertise, which may limit their financial benefits. As a result, although theoretically green process innovation is expected to lower operational costs and improve profitability (Novitasari, 2022), in this study it does not significantly enhance financial performance. This outcome contrasts with the RBV perspective, which argues that green process innovation provides advantages through cost savings, fuel efficiency, electricity conservation, and machinery



utilization. The findings are not consistent with previous studies (Xie et al., 2019; Salvatira Bibi & Narsa, 2022; Alviani et al., 2020; Vera et al., 2020), which reported that green process innovation has a positive effect on financial performance.

### **The Mediating Effect of Green Product Innovation on the Relationship between Green Process Innovation and Financial Performance**

The Sobel test was employed to examine the mediating role of green product innovation. The test results show that the calculated t-value of 2.5928 is greater than the t-table value of 1.9748, with a p-value of  $0.0095 < 0.05$ . This indicates that green process innovation significantly affects financial performance through green product innovation as an intervening variable. Hence, the third hypothesis (H3) is supported. This finding implies that the increasing demand for environmentally friendly products can enhance company profitability and financial performance, as reflected in higher Return on Assets (ROA). Expanding market share through green products allows firms to cover production costs, which are often high due to energy and raw material expenses, while simultaneously maximizing profitability (Vera et al., 2020). This result aligns with RBV theory, which emphasizes that green process and green product innovation are sustainable competitive capabilities for financial growth. The result is also consistent with prior studies (Xie et al., 2019; Salvatira Bibi, 2022; Vera et al., 2020), which found that green product innovation mediates the relationship between green process innovation and financial performance.

### **The Effect of Green Image on Financial Performance**

The regression analysis shows that for green image, the calculated t-value of 1.266290 is lower than the t-table value of 1.97471, with a significance level of  $0.2073 > 0.05$ . Thus,  $H_a$  is rejected and  $H_0$  is accepted, meaning that green image does not significantly affect financial performance. Accordingly, the fourth hypothesis (H4) is not supported. The absence of a significant effect may be due to the fact that a positive corporate image does not necessarily guarantee consumer loyalty. Consumers and investors today are not only concerned with reputation or popularity, but rather with convenience and reliability, which encourage repeat usage and investment. A positive image alone may not directly influence financial outcomes. This finding does not support stakeholder theory, as investors tend to prioritize financial returns (Oktafiani, 2022), while consumers seek satisfaction and comfort rather than reputation alone. This finding is inconsistent with previous studies (Xie et al., 2019; Wu & Qu, 2021; Ahmad Chairis, 2019), which reported that green image positively affects financial performance.

### **The Moderating Effect of Green Image on the Relationship between Green Product Innovation and Financial Performance**

The results of the Moderated Regression Analysis (MRA) show that the probability value of the interaction term between green product innovation and green image is 0.8328, which is greater than the significance threshold of 0.05, with a coefficient of  $-0.0054$ . This indicates that green image does not moderate or strengthen the relationship between green product innovation and financial performance. Thus, the fifth hypothesis (H5) is not supported. This result does not support stakeholder theory. The inability of green image to act as a moderator may be due to the fact that corporate image is not a decisive factor in improving financial performance or in driving product innovation. A good reputation alone does not guarantee consumer or investor loyalty. At present, consumers and investors prefer firms that provide practical benefits and user comfort, which encourages repeat purchases and investment (Arief Widjati, 2019). This finding is inconsistent with previous studies (Xie et al., 2019; Rohmatul Ulla et al., 2019; Tjahjadi et al., 2020), which concluded that green image moderates the relationship between green product innovation and financial performance.

## **9. Conclusion**

Based on the results of the panel data regression analysis, several conclusions can be drawn. First, green process innovation significantly influences green product innovation. Second, green process innovation does not have a significant effect on financial performance. Third, green product innovation is able to mediate the relationship between green process innovation and financial performance. Fourth, green image does not significantly affect financial performance. Finally, green image does not moderate the relationship between green product innovation and financial performance. The limitation of this study lies in the inconsistency between the findings and those of previous research, highlighting the existence of a research gap. In addition, not all companies included in the research sample published corporate sustainability reports, which may have limited the comprehensiveness of the analysis. Future research is expected to expand the research objects beyond companies listed on the Indonesia Stock Exchange, in order to provide broader insights into financial performance. Further studies should also extend the observation period and consider additional variables to enrich the analysis of the relationship between green innovation strategies and corporate financial outcomes.



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