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Environmental Innovation and Financial Performance: The Moderating Role of Environmental Performance in Indonesian Firms

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Abstract

This study aims to examine the effect of environmental innovation on financial performance, with environmental performance acting as a moderating variable in manufacturing companies listed on the Indonesia Stock Exchange during the 2019–2021 period. The research adopts a quantitative approach using secondary data derived from annual reports and financial statements. A purposive sampling technique is applied, resulting in a final sample of 57 companies that meet the specified criteria, including participation in PROPER and ESG disclosure. The data are analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS. The empirical findings indicate that environmental innovation has a positive and statistically significant effect on financial performance (β = 0.247; p = 0.040), suggesting that firms engaging in environmentally oriented innovation tend to achieve better profitability through improved efficiency and resource utilization. In contrast, environmental performance does not show a significant direct effect on financial performance (β = -0.190; p = 0.086), implying that higher environmental compliance alone may not immediately translate into financial gains. Furthermore, the moderating analysis reveals that environmental performance significantly weakens the relationship between environmental innovation and financial performance (β = -0.273; p = 0.030). This negative moderating effect indicates a potential trade-off, where higher environmental performance introduces additional costs and operational constraints that reduce the financial benefits of innovation. Overall, the study highlights the importance for firms to strategically balance environmental initiatives with financial efficiency to achieve sustainable performance.

Keywords*: Environmental Innovation, Environmental Performance, Financial Performance, Moderation, SmartPLS*

1. Introduction

Firms inevitably generate varying environmental impacts through their business operations, which may influence their financial performance depending on the environmental strategies they adopt. Companies that demonstrate strong environmental responsibility tend to gain competitive advantages compared to those that neglect environmentally friendly practices. The increasing urgency of environmental issues has encouraged policymakers, business practitioners, and researchers to intensify efforts to mitigate environmental degradation. In addition, growing stakeholder pressure has pushed firms to adopt sustainable practices that may affect both competitiveness and profitability. Nevertheless, engagement in environmental innovation is not solely driven by financial motives but also by the need to respond to societal expectations [1].

Environmental innovation has been widely recognized as a strategic mechanism for improving financial performance. It enables firms to enhance resource efficiency, reduce waste, lower production costs, and minimize environmental compliance expenses [2]–[5]. However, previous studies have not fully explained how firms manage risks and allocate resources efficiently across different levels of environmental innovation [6], [7], and the impact of sustainability initiatives may not be immediately reflected in financial performance due to time lag effects [8], while other studies have incorporated environmental performance as a moderating variable in examining the relationship between green innovation and firm value [9].

Empirical findings on the relationship between environmental innovation, environmental performance, and financial performance remain inconsistent. Some studies suggest that environmental innovation strengthens the relationship between environmental performance and financial performance [1]. However, other studies report mixed or even contradictory results across different contexts and measurement approaches[10]–[12], indicating the need for further investigation.

More importantly, while environmental innovation is generally associated with improved financial performance, the role of environmental performance in shaping this relationship remains unclear. Higher environmental performance may not always strengthen the impact of environmental innovation, as it can introduce additional costs, regulatory pressures, and operational constraints. This condition reflects a potential trade-off between environmental responsibility and financial efficiency, particularly in firms operating under resource limitations.

These inconsistencies highlight a research gap regarding the role of environmental performance as a moderating variable in the relationship between environmental innovation and financial performance, particularly in emerging economies such as Indonesia. Previous studies have primarily focused on direct effects, while limited attention has been given to moderating mechanisms, especially in the manufacturing sector.

Therefore, this study aims to examine the effect of environmental innovation on financial performance and to investigate the moderating role of environmental performance. Specifically, this study explores whether environmental performance strengthens or weakens the relationship between environmental innovation and financial performance in manufacturing companies listed on the Indonesia Stock Exchange during the 2019–2021 period. This study contributes to the literature by providing empirical evidence on the moderating role of environmental performance in an emerging market context, particularly by highlighting the possibility of a trade-off effect between environmental performance and financial outcomes.

2. Research Methods

This study adopts a quantitative research approach to examine the relationship between environmental innovation, environmental performance, and financial performance. The quantitative method is used to test hypotheses and analyze causal relationships among variables using statistical techniques. This study is grounded in stakeholder theory, which suggests that firms must consider the interests of various stakeholders in their strategic decision-making processes. Increasing stakeholder pressure regarding environmental responsibility encourages companies to adopt environmentally friendly practices, which may influence their financial performance [1].

2.1. Data and Sample

This study uses secondary data obtained from annual reports and financial statements of manufacturing companies listed on the Indonesia Stock Exchange during the 2019–2021 period. The data are selected due to their relevance in measuring financial performance, environmental performance, and environmental innovation.

The sampling technique used is purposive sampling based on the following criteria: (1) manufacturing companies listed on the Indonesia Stock Exchange during 2019–2021; (2) companies participating in the PROPER program organized by the Ministry of Environment and Forestry; and (3) companies disclosing Environmental, Social, and Governance (ESG) information. The use of ESG disclosure as a proxy for environmental innovation is consistent with prior studies [1], [13].

Based on these criteria, a total of 57 companies were selected as the research sample.

2.2. Variable Measurement

This study includes three main variables: financial performance as the dependent variable, environmental innovation as the independent variable, and environmental performance as the moderating variable. In addition, the moderating effect is examined through an interaction term between environmental innovation and environmental performance.

Financial performance is measured using Return on Assets (ROA), calculated as net income divided by total assets. ROA reflects a firm's ability to generate profit from its assets and is widely used as a key indicator of financial performance [14]. To capture the delayed effect of environmental initiatives, ROA is measured at period $t+1$ [1], [15].

Environmental performance is measured using PROPER ratings, which are converted into a numerical scale ranging from 1 (black) to 5 (gold) [16]. This measurement reflects the firm's level of compliance and performance in environmental management as assessed by the Ministry of Environment.

Environmental innovation is measured using ESG scores disclosed in company reports, as ESG indicators capture firms' environmental initiatives and sustainability practices [1], [13]. Higher ESG scores indicate greater commitment to environmental innovation and sustainability practices.

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Table 1. Variable Measurement

Variable	Indicator	Measurement
Environmental Innovation	ESG Score	ESG diclosure score
Financial Performance	ROA	Net Income / Total Assets (*t*+1)
Environmental Performance	PROPER Rating	Score 1-5 (Black-Gold)

Table 1 presents the operationalization of variables used in this study, which are adopted from prior studies to ensure consistency and comparability [1], [16]. Each variable is measured using a single indicator derived from secondary data sources.

Environmental innovation is proxied by ESG disclosure scores, reflecting the extent to which firms implement environmentally oriented initiatives and sustainability practices. Higher ESG scores indicate a greater level of environmental innovation within the firm.

Financial performance is measured using Return on Assets (ROA), which captures the firm's ability to generate profit from its total assets. The use of ROA at period *t*+1 is intended to account for the lagged effect of environmental initiatives on financial outcomes.

Environmental performance is measured using PROPER ratings, which represent the firm's environmental compliance and performance level as assessed by the government. The rating scale ranges from 1 (black) to 5 (gold), indicating increasing levels of environmental responsibility.

Furthermore, to examine the moderating effect, an interaction term between environmental innovation and environmental performance (X × Z) is constructed within the SEM-PLS model. This interaction term is used to assess whether environmental performance strengthens or weakens the relationship between environmental innovation and financial performance.

2.3. Data Analysis

Data analysis is conducted using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS 3.0 software. SEM-PLS is suitable for analyzing complex models involving moderating variables and relatively small sample sizes [17].

The analysis is carried out in three stages: evaluation of the outer model, evaluation of the inner model, and hypothesis testing.

The first stage is the evaluation of the outer model (measurement model), which aims to assess the validity and reliability of the constructs. Convergent validity is evaluated using outer loading values, where a threshold of 0.70 is considered acceptable. In addition, Average Variance Extracted (AVE) is used with a minimum criterion of 0.50, indicating that the construct explains more than half of the variance of its indicators. Reliability is assessed using composite reliability, with a threshold of 0.70, indicating adequate internal consistency.

The second stage is the evaluation of the inner model (structural model), which examines the relationships between variables. This evaluation includes assessing the coefficient of determination (R^2) to measure the explanatory power of the model, as well as analyzing path coefficients to determine the direction and strength of the relationships between variables.

The third stage is hypothesis testing, which is conducted using the bootstrapping method. This procedure is used to evaluate the significance of both direct and moderating effects based on t-statistics and p-values. A significance level of 5% ($p < 0.05$) is used to determine whether the hypotheses are supported.

Furthermore, the moderating effect is analyzed by constructing an interaction term between environmental innovation and environmental performance (X × Z) within the SEM-PLS model. This interaction term is used to assess whether environmental performance strengthens or weakens the relationship between environmental innovation and financial performance.

3. Results and Discussions

3.1. Descriptive Statistics

Table 2. Descriptive Statistics (n = 57)

Variable	Mean	Min	Max	Std. Dev
Environmental Innovation	43.676	23.640	59.330	10.381

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Financial Performance	0.077	-0.002	0.349	0.067
Environmental Performance	3.509	3.000	5.000	0.630

Based on Table 2, the descriptive statistics provide an overview of the characteristics of the variables used in this study, based on 57 sample companies.

Environmental innovation (X) has an average value of 43.676, with a minimum value of 23.640 and a maximum value of 59.330. The standard deviation of 10.381 indicates a moderate level of variation among firms in implementing environmental innovation. This suggests that while some companies have adopted relatively high levels of environmental innovation, others still exhibit lower levels of ESG-related practices.

Financial performance (Y), proxied by Return on Assets (ROA), shows an average value of 0.077, indicating that, on average, firms generate a return of 7.7% on their total assets. The minimum value of -0.002 implies that some firms experienced slight losses, while the maximum value of 0.349 reflects relatively strong profitability in certain companies. The standard deviation of 0.067 indicates low variability, suggesting that financial performance among firms tends to be relatively stable.

Environmental performance (Z), measured using PROPER ratings, has an average value of 3.509, which lies between the "blue" and "green" categories. This indicates that, on average, firms demonstrate good environmental performance. The minimum value of 3.000 and maximum value of 5.000 show that all sampled firms meet at least the "good" environmental standard, with some achieving excellent performance. The relatively low standard deviation (0.630) suggests that environmental performance is fairly homogeneous across the sample.

Overall, the descriptive results indicate that environmental performance among firms is relatively stable, while environmental innovation shows greater variability. This variation may influence differences in financial performance across firms, which will be further examined in the subsequent analysis using SEM-PLS.

3.2. Measurement Model (Outer Model Evaluation)

Table 3. Outer Loadings

Variable	Outer Loading
Environmental Innovation (X)	1.000
Financial Performance (Y)	1.000
Environmental Performance (Z)	1.000
Moderating Effect (X x Z)	0.931

Table 3 presents the outer loading values of each construct used in this study. All variables exhibit outer loading values above the recommended threshold of 0.70, indicating that the indicators have strong correlations with their respective constructs.

Environmental innovation (X), financial performance (Y), and environmental performance (Z) each have an outer loading value of 1.000. This is because these constructs are measured using single indicators derived from secondary data sources. Meanwhile, the moderating effect (X × Z) shows an outer loading value of 0.931, which also exceeds the acceptable threshold.

These results indicate that all constructs meet the criteria for convergent validity, meaning that each indicator is able to adequately represent its corresponding latent variable. The high loading values further confirm that the measurement model is valid and suitable for subsequent structural model analysis.

Given that all variables are measured using single indicators, the perfect loading values are expected and reflect the direct representation of each construct by its respective measurement.

Table 4. Construct Reliability and Validity

Variable	AVE
Environmental Innovation (X)	1.000
Financial Performance (Y)	1.000
Environmental Performance (Z)	1.000
Moderating Effect (X x Z)	1.000

Table 4 presents the Average Variance Extracted (AVE) values for each construct used in this study. All variables show AVE values of 1.000, which exceed the minimum threshold of 0.50. This indicates that each construct is able to explain more than 50% of the variance of its indicators, thereby meeting the criteria for convergent validity.

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The perfect AVE values observed in this study are attributable to the use of single indicators for each construct, derived from secondary data sources. In such cases, the indicator fully represents the construct, resulting in maximum variance explanation.

Therefore, all constructs in this study satisfy the requirements for convergent validity and are considered well represented by their respective indicators. This confirms that the measurement model is appropriate for further analysis in the structural model.

Table 5. Composite Reliability

Variable	Composite Reliability
Environmental Innovation (X)	1.000
Financial Performance (Y)	1.000
Environmental Performance (Z)	1.000
Moderating Effect (X x Z)	1.000

Table 5 presents the composite reliability values for each construct used in this study. All variables show composite reliability values of 1.000, which exceed the recommended threshold of 0.70. This indicates that all constructs demonstrate a high level of internal consistency reliability.

The perfect composite reliability values observed in this study can be explained by the use of single indicators for each construct. Since each construct is directly represented by a single measurement derived from secondary data, no measurement error is assumed within the construct, resulting in maximum reliability values.

Therefore, all constructs in this study are considered reliable, as the indicators consistently measure their respective constructs. This confirms that the measurement model meets the reliability criteria and is suitable for further analysis in the structural model.

3.3. Structural Model (Inner Model Evaluation)

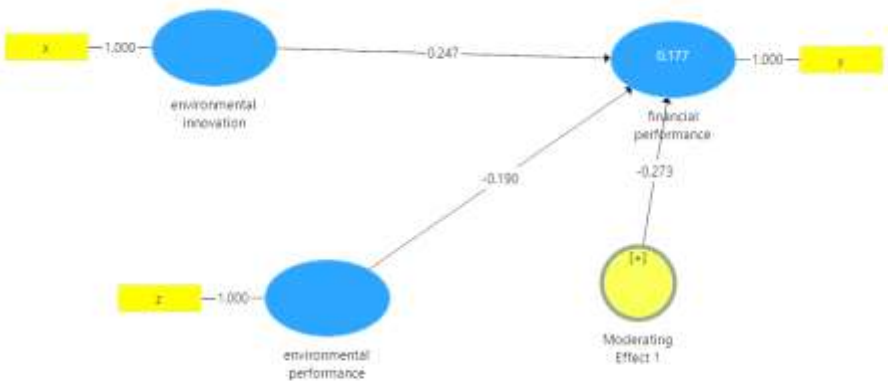

Figure 1. Structural Model Results

Figure 1 illustrates the structural relationships between environmental innovation, environmental performance, and financial performance, including the moderating effect.

The results show that environmental innovation has a positive relationship with financial performance, with a path coefficient of 0.247. This finding indicates that firms implementing higher levels of environmental innovation tend to achieve better financial performance. This result supports stakeholder theory, which suggests that firms adopting environmentally friendly innovations can enhance their reputation, meet stakeholder expectations, and improve competitiveness, ultimately leading to better financial outcomes. Environmental innovation enables firms to increase efficiency, reduce waste, and optimize resource utilization, thereby contributing to improved financial performance. This finding is consistent with previous studies showing that environmental innovation enhances efficiency and reduces costs [2], [6].

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In contrast, the relationship between environmental performance and financial performance shows a coefficient of -0.190, indicating a negative and insignificant effect. This suggests that environmental performance does not have a direct impact on financial performance. From the perspective of legitimacy theory, firms may engage in environmental activities primarily to gain social acceptance rather than to achieve immediate financial benefits. In addition, maintaining high environmental performance often requires substantial costs, such as compliance expenses, environmental investments, and operational adjustments, which may reduce short-term financial performance. This finding is in line with prior studies indicating that environmental initiatives may impose additional costs that weaken short-term profitability [10], [16], [18].

Furthermore, the moderating effect between environmental innovation and financial performance is found to be negative, with a coefficient of -0.273. This indicates that environmental performance weakens the positive impact of environmental innovation on financial performance. In other words, higher levels of environmental performance reduce the effectiveness of environmental innovation in improving financial outcomes. This result can be explained using trade-off theory, where firms must balance environmental responsibility with financial efficiency. Although environmental innovation provides economic benefits, higher environmental performance may introduce additional constraints and costs that reduce the effectiveness of such innovations in generating financial returns. This finding supports the trade-off perspective between environmental responsibility and financial efficiency [11], [12].

The coefficient of determination (R^2) is 0.177, indicating that 17.7% of the variation in financial performance is explained by environmental innovation, environmental performance, and their interaction. This suggests that the model has moderate explanatory power, while the remaining 82.3% is influenced by other factors not included in this study.

Table 6. Path Coefficients and Hypothesis Testing

Variable	Coefficient	T-Statistic	P-Value	Result
Environmental Innovation → Financial Performance	0.247	2.055	0.040	Supported
Environmental Performance → Financial Performance	-0.190	1.720	0.086	Not Supported
Environmental Innovation x Environmental Performance	-0.273	2.178	0.030	Supported

Table 6 presents the results of hypothesis testing based on the path coefficients obtained from the SEM-PLS analysis.

First, environmental innovation has a positive and statistically significant effect on financial performance ($\beta = 0.247$; $t = 2.055$; $p = 0.040 < 0.05$). This finding indicates that firms implementing higher levels of environmental innovation tend to achieve better financial performance. Environmental innovation enables firms to improve efficiency, reduce operational costs, and enhance competitive advantage, which ultimately leads to improved financial outcomes. This result is consistent with previous studies that demonstrate a positive relationship between environmental innovation and financial performance [2], [6], [11]. Therefore, this hypothesis is supported.

Second, environmental performance shows a negative coefficient ($\beta = -0.190$) but is not statistically significant ($t = 1.720$; $p = 0.086 > 0.05$). This result indicates that environmental performance does not have a direct effect on financial performance. One possible explanation is that environmental performance requires substantial costs, such as environmental investments and compliance expenses, which may not immediately translate into financial benefits. This finding is in line with prior studies suggesting that environmental initiatives may not directly improve short-term financial performance [10], [16], [18]. Thus, this hypothesis is not supported.

Third, the interaction between environmental innovation and environmental performance has a negative and statistically significant effect on financial performance ($\beta = -0.273$; $t = 2.178$; $p = 0.030 < 0.05$). This indicates that environmental performance significantly moderates the relationship between environmental innovation and financial performance in a negative direction. In other words, higher environmental performance weakens the positive impact of environmental innovation on financial performance. This finding can be explained by the trade-off perspective, where firms face a balance between environmental responsibility and financial efficiency. Although environmental innovation provides economic benefits, higher environmental performance may impose additional constraints and costs that reduce its effectiveness in generating financial returns. This result supports previous findings related to the moderating role of environmental factors in corporate performance [11], [12].

Discussion

The findings of this study provide important insights into the relationship between environmental innovation, environmental performance, and financial performance in manufacturing firms. The positive and significant effect

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of environmental innovation on financial performance confirms that environmentally oriented strategies can serve as a source of competitive advantage. Firms that actively engage in environmental innovation tend to improve operational efficiency, reduce waste, and optimize resource utilization, which ultimately enhances profitability. This result is consistent with previous studies that highlight the role of environmental innovation in improving firm performance [2], [6].

From the stakeholder theory perspective, firms are encouraged to respond to stakeholder demands by adopting environmentally responsible practices. Environmental innovation not only improves internal efficiency but also strengthens corporate reputation, increases customer trust, and enhances market competitiveness. As a result, firms that successfully integrate environmental innovation into their business strategies are more likely to achieve superior financial performance [1], [12].

However, the results show that environmental performance does not have a significant direct effect on financial performance. This finding suggests that achieving high environmental performance alone is not sufficient to directly improve financial outcomes, particularly in the short term. One possible explanation is that environmental performance requires substantial investments, such as costs related to environmental compliance, pollution control, and sustainability initiatives, which may reduce short-term profitability. This finding is consistent with prior research indicating that environmental performance may not immediately translate into financial gains [10], [16], [18].

From the legitimacy theory perspective, firms may engage in environmental practices primarily to maintain legitimacy and social acceptance rather than to achieve direct financial benefits. Environmental performance can be viewed as a strategic response to regulatory pressures and societal expectations, where the primary objective is to sustain corporate legitimacy rather than maximize short-term profits [18].

Furthermore, the moderating effect of environmental performance on the relationship between environmental innovation and financial performance is found to be negative and significant. This indicates that higher environmental performance weakens the positive impact of environmental innovation on financial performance. This finding provides an important contribution to the literature, as it contrasts with studies that report a positive moderating effect [1], and highlights the potential downside of excessive environmental performance in certain contexts.

This result can be explained using the trade-off theory, which suggests that firms must balance environmental responsibility with financial efficiency. While environmental innovation can generate cost savings and efficiency improvements, maintaining high environmental performance often requires additional resources and stricter compliance measures. These additional costs may reduce the net financial benefits obtained from environmental innovation [11], [12].

Moreover, firms operating in emerging markets such as Indonesia may face greater financial constraints, limited technological capabilities, and stricter regulatory pressures, which can further intensify the trade-off between environmental performance and financial performance. As a result, although environmental innovation contributes positively to financial performance, its effectiveness may be reduced when firms simultaneously pursue high environmental performance standards.

Overall, this study highlights the complexity of the relationship between environmental strategies and financial outcomes. It suggests that while environmental innovation is beneficial, firms must carefully manage the costs associated with environmental performance to ensure that sustainability initiatives do not undermine financial efficiency. These findings also emphasize the importance of aligning environmental strategies with financial capabilities to achieve sustainable and balanced performance.

4. Conclusion

This study examines the effect of environmental innovation on financial performance, with environmental performance acting as a moderating variable in manufacturing companies listed on the Indonesia Stock Exchange during the 2019–2021 period. The findings reveal that environmental innovation has a positive and significant effect on financial performance, indicating that firms implementing higher levels of environmentally oriented innovation are able to enhance their profitability. This result highlights the strategic role of environmental innovation in improving operational efficiency, reducing costs, and strengthening competitive advantage. However, environmental performance does not have a significant direct effect on financial performance, suggesting that achieving higher environmental performance alone does not necessarily lead to immediate financial benefits. This may be due to the additional costs associated with environmental compliance, sustainability initiatives, and operational adjustments. Furthermore, environmental performance is found to negatively moderate

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the relationship between environmental innovation and financial performance. This indicates that higher environmental performance weakens the positive impact of environmental innovation on financial outcomes. These findings support the trade-off perspective, emphasizing that firms must balance environmental responsibility with financial efficiency. This study contributes to the literature by providing empirical evidence on the moderating role of environmental performance in an emerging market context, particularly in Indonesia. Unlike most prior studies that report a positive moderating effect, this study identifies a negative moderating relationship, offering a new perspective on the complexity of sustainability strategies and financial performance. From a practical perspective, firms are encouraged to implement environmental innovation strategically while carefully managing the associated costs of environmental performance. Policymakers are also advised to provide incentives and regulatory support to facilitate the adoption of sustainable practices without undermining firms' financial stability. Despite its contributions, this study has several limitations. The sample is limited to manufacturing companies and a relatively short observation period. Future research is recommended to include broader industry sectors, longer time horizons, and additional variables such as corporate governance, firm size, and market conditions to provide a more comprehensive understanding of the relationship between environmental and financial performance.

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