NILAI BISNIS UNTUK MENJADI HIJAU: MENILAI DAMPAK INOVASI LINGKUNGAN DAN INDIKATOR KEUANGAN PADA PERUSAHAAN SEKTOR ENERGI DI INDONESIA

THE BUSINESS VALUE OF GOING GREEN: ASSESSING THE IMPACT OF ENVIRONMENTAL INNOVATION AND FINANCIAL INDICATORS IN INDONESIA'S ENERGY SECTOR COMPANIES

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ABSTRACT

This research aims to examine the effect of green innovation, profitability, and firm size on the firm value of Indonesian energy sector companies during the 2018–2023 period. The research is motivated by the growing importance of green innovation for encouraging environmental sustainability in energy sector companies. This research combine green innovation and financial indicators for increasing firm value. Using a sample of 66 data, the study employs panel regression analysis through Eviews software. The findings reveal that green product innovation have a significant positive impact on firm value. In contrast, green process innovation, profitability and firm size do not show a significant effect. The practical implications of this research related to the sustainability of energy sector companies are the importance of product innovation to optimize resources and minimize the negative impacts of carbon and pollution produced.

Keywords: Firm Value; Green process innovation; Green product innovation; Profitability; Corporate Sustainability

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh green innovation, profitabilitas, dan ukuran perusahaan terhadap nilai perusahaan sektor energi yang terdaftar di Bursa Efek Indonesia (BEI) periode 2018-2023. Penelitian ini dilakukan karena adanya pentingnya inovasi hijau terhadap keberlanjutan bisnis perusahaan sektor energi di Indonesia. Penelitian ini menggabungkan inovasi hijau dan kinerja keuangan untuk meningkatkan nilai perusahaan sektor energi di Indonesia Dengan menggunakan 66 sampel data, penelitian ini menggunakan analisis regresi data panel dengan software Eviews. Hasil penelitian ini menunjukkan bahwa green product innovation berpengaruh positif terhadap nilai perusahaan. Green process innovation, profitabilitas dan ukuran perusahaan tidak berpengaruh terhadap nilai perusahaan. Implikasi praktis dari penelitian ini terkait dengan keberlanjutan perusahaan sektor energi adalah pentingnya inovasi produk untuk optimalisasi sumber daya dan meminimalkan dampak negatif dari carbon dan polusi yang dihasilkan.

Kata Kunci: Nilai Perusahaan; Inovasi Proses Hijau; Inovasi Produk Hijau; Profitabilitas; Keberlanjutan Perusahaan

1. INTRODUCTION

Firm value is a key indicator that reflects a company's market perception, financial health, and future profitability potential. It plays a central role in attracting investment, especially in capital-intensive sectors such as energy (Nguyen & Song, 2021). In the energy sector industry, where firms face increasing scrutiny regarding environmental practices and sustainability, firm value is not only affected by financial performance, but also by how well a company aligns with environmental, social, and governance (ESG) standards (Amara *et al.*, 2023).

One of the strategic approaches to improving firm value is through green innovation, which integrates environmental considerations into corporate innovation process. (Bibi & Narsa, 2022) said that green innovation can increase the efficiency of material resources used, increasing product differentiation and reduce the carbon or pullution risk of the company. Green innovation is divided into two categories: Green product innovation refers to creating eco-friendly products designed to minimize environmental impact throughout their entire lifecycle. Meanwhile, green process innovation emphasizes improving production efficiency by reducing resource consumption and limiting emissions (Zhou *et al.*, 2022). These innovations not only contribute to achieving environmental objectives but also act as competitive strategies that can enhance a company's public reputation, boost operational efficiency, and ultimately increase its market value (Z. Zhang, 2022).

Talking about innovation, traditional financial indicators such as profitability and firm size are recognized as influential determinants of firm value. Profitability represents a firm's capacity to generate income in relation to its incurred costs and is frequently linked to increased market confidence and higher firm valuation (Hussain *et al.*, 2018). Firm size, which often reflects operational capacity, resource control, and market influence, may also enhance firm value by signaling stability and lower investment risk.

These relationships are especially relevant in the energy sector, where firms must simultaneously balance financial performance with compliance to environmental standards.

The growing global emphasis on sustainability has encouraged firms, particularly in environmentally sensitive industries such as energy, to adopt green innovation as a strategic response to stakeholder and regulatory pressures. According to stakeholder theory, firms are expected to fulfill not only shareholder interests but also broader societal and environmental expectations, while Legitimacy Theory argues that companies engage in environmentally friendly practices to align with societal norms and maintain their social license to operate (Garg & Gupta, 2022). Empirical studies consistently show that green innovation, especially process-based innovation, can enhance cost efficiency, operational performance, and ultimately firm value by improving investor confidence and public perception (Yi *et al.*, 2021). In the Indonesian context, research by Bahar & Lestari (2023) revealed that green innovation positively influences firm value, mediated by financial performance, which supports both stakeholder and legitimacy perspectives. However, evidence also suggests that the benefits of green innovation are contingent upon a firm's financial capacity and resource availability; larger firms with stronger profitability are better positioned to implement costly green initiatives, making firm size and profitability critical determinants of value creation (Lee *et al.*, 2025).

Despite this growing body of literature, significant research gaps remain. First, most prior studies on green innovation and firm value have been conducted in manufacturing and cross-sectoral contexts, with limited focus on the energy sector-an industry facing higher environmental scrunity and unique regulatory challenges (Dorothy & Endri, 2024). Second, while several studies have separately examined green innovation, profitability, and firm size, few have integrated these variables to understand their combined or interactive effects on firm value, particularly in emerging markets such as Indonesia (Garg & Gupta, 2022). Research in the context of emerging markets, particularly within Indonesia's energy sector, remains limited. Moreover, there is a lack of empirical distinction between the effects of green product versus green process innovation on firm value. This study aims to fill that gap by examining the combined of green innovation (both product and process), profitability, and firm size on firm value among energy sector firms listed on the Indonesia Stock Exchange between 2018 and 2023. This period was chosen because it encompasses a range of economic and regulatory dynamics affecting the energy sector, including the push for a cleaner energy transition. Finally, existing studies rarely apply stakeholder and legitimacy theories simultaneously to explain how green innovation initiatives serve as both a means of meeting stakeholder demands and a strategic tool to legitimize operations in high-impact industries. Therefore, this study aims to investigate the influence of green innovation, profitability, and firm size on firm value in Indonesia's emergy sector, providing theoretical contributions by integrating these two perpectives and practical implications for firms seeking to enhance sustainability-driven value creation.

This study is expected to provide an in-depth understanding of the factors that influence firm value and offer recommendations for corporate management in implementing green innovation strategies and improving financial performance. In addition to contributing to the literature on green innovation and corporate performance, this study also serves as a reference for companies in developing sustainable policies and strategies, which are relevant to academics, researchers, business practitioners, and policy makers interested in the development of the sustainable energy industry.

2. LITERATURE REVIEW

Grand Theory

Stakeholder theory posits that the attainment of specific objectives can be shaped by, or have an impact on various individuals or groups with a vested interest in the organization (Freeman, 1984). According to stakeholder theory, companies have an obligation to consider the consequences of their operations on each stakeholder, and that increasing profits should not be the sole focus of the company. According to this theory, each stakeholder has an important role in the survival of the company. Therefore, the company has a responsibility to manage its business by considering the needs and expectations of stakeholders, so that it is in line with the company's vision, mission, and goals. Stakeholder theory emphasizes the importance of addressing the needs of all stakeholders. Green innovation is aligned with this theory as it addresses environmental concerns and fulfills corporate social responsibilities. This alignment enhances a company's reputation and contributes to long-term sustainability.

Signaling theory begins with two parties who have different access to information (Spence, 1978). The function of this theory is to minimize information asymmetry. The method of sending signals must be considered by the sender, while the method of interpreting signals must be considered by the recipient. Signals can be found in the form of information from a company. A positive signal for stakeholders can be in the form of disclosure of information related to green innovation, because this information is provided voluntarily by the company. The conclusion according to the theory above is that trust will be obtained by the company when it can send signals effectively to its stakeholders. Signaling theory highlights how companies can reduce information asymmetry. Green innovation serves as a positive signal to investors, demonstrating a forward-thinking and strategic commitment to sustainability. This signal holds particular value in markets where reliable environmental information is limited.

Green Product Innovation on Firm Value

Green product innovation involves the design and development of environmentally friendly products that aim to reduce negative impacts on the environment by integrating functions and sustainability aspects (Xie *et al.*, 2019). Green product innovation focuses on improving product performance and minimizing negative effects on the environment, this involves making products that are energy efficient, use recycled materials, or have a minimal carbon footprint (Zhang *et al.*, 2020). Green product innovation has been increasingly recognized as strategic response to growing environmental concerns and regulatory pressures. Green product innovation refers to the development of environmentally friendly products that minimize ecological impact throughout their life cycle (Yi *et al.*, 2021)

According to stakeholder theory, firms engage in GPI to meet the expectations of environmentally conscious customers, investors, and regulators, thereby enhancing reputation, customer loyalty and market share, which ultimately contribute to higher firm value (Garg & Gupta, 2022). As stakeholder theory stated that company should give concern not only on financial performance but also sustainability of organization related to fulfill their responsibility of environment (Kartikasary *et al.*, 2023). From the lens of signalling theory, green product innovation serves as a signal mechanism, allowing firms to align their operations with societal norms and secure broader stakeholder support, which may translate into increased investor confidence and improved valuation in the capital market (Dorothy & Endri, 2024).

Previous studies by Xie *et al.* (2019) and Qiu *et al.* (2016) showed that green product innovation has a positive effect on financial performance and company value. Qing *et al.* (2024) found that green technology innovation positively influences corporate financial performance which turn can enhance firm value. Similarly, Asni & Agustia (2022) demonstrated that GPI can be significant driver of firm value, the result explained that firms who investing in GPI can achieve higher profitability and market valuation. Despite that some research have different results. Yi *et al.* (2021) examined green innovation as a board construct, giving less attention to the distinct effects of GPI, even though product innovation might influence investor perception and market valuation differently compared to process innovation. Finally few studies explicitly integrate Stakeholder Theory and Signalling Theory to explain dual strategic and symbolic roles of green product innovation in enhancing firm value. Addressing this gap is crucial particularly in the Indonesian energy sector, where the pressure to balance profitability, environmental sustainability, and public legitimacy is high. Based on the explanation above, the following hypotheses are formulated:
H_1: Green product innovation has a significant effect on firm value

Green Process Innovation on Firm Value

Green process innovation refers to the systematic improvement of all operational and management processes in an organization to utilize resources and energy more efficiently (Xie *et al.*, 2019). This can help reduce costs related to energy consumption and resource waste, improve cost efficiency and profitability, and increase the total value of the company. Green process innovation involves the implementation of environmental friendly processes in organization from production and operation to reduce environmental impacts and enhance sustainability. In contrast to green product innovation, green process innovation often generates cost-saving effects in the short to medium term, making it attractive to firms aiming to enhance financial performance and long-term firm value (Bahar & Lestari, 2023). From the perspective of Stakeholder Theory, the adoption of green process innovation is viewed as strategic action to meet the expectations of environmentally conscious investors, regulators, and communities, which strengthens stakeholder trust and indirectly drives firm valuation (Garg & Gupta, 2022). Meanwhile legitimacy theory argues that firms engage in green process innovation not only for operational efficiency but also to secure social approval by demonstrating compliance with environmental norms, thereby reducing institutional pressure and enhancing legitimacy in the eyes of capital markets (Dorothy & Endri, 2024).

Study by Xie *et al.* (2019) showed that green process innovation has a positive impact on financial performance and company value. Meanwhile, (Y. Chen *et al.*, 2022) found that green process innovation can lead to more stable financial performance. Similarly, research from Wang & Wang. (2025) explained that green process innovation has a significant positive impact on firm value. Prior studies dominated by evidence from development economies, and findings may not be fully generalizable to emerging market like Indonesia, where institutional pressure, regulatory enforcement, and investor preference differ (Garg & Gupta, 2022). Based on the explanation above, the following hypothesis is formulated:
H_2: Green process innovation has a significant effect on firm value

Profitability on Firm Value

Profitability refers to the company's ability to generate profits over a period of time, indicating how effectively management is running the company's operations (Heriansyah, 2024). According to stakeholder theory, higher profitability demonstrate management effectiveness in meeting shareholder and stakeholder expectations for sustainable returns which enhances investor confidence and market valuation (Garg & Gupta, 2022). Legitimacy theory also posits that profitable firms are more capable of fulfilling social and environmental obligations, thereby strengthening their legitimacy and improving firm value (Dorothy & Endri, 2024). High profitability is seen as a positive signal by investors, leading to increased demand for shares and higher company value. Th situation in line with signalling theory. A high level of profitability indicates good company prospects, resulting in a positive response from investors and increased company value (Husna & Satria, 2019). Research conducted by (Heriansyah, 2024) states that profitability affects company value. In line with research (Husna & Satria, 2019) profitability has a positive effect on company value. Based on the explanation above, the following hypothesis is formulated:

H_3: Profitability has a significant effect on firm value

Firm Size on Firm Value

The size of the total assets reflects the size of the company. The greater the total assets, the greater the size of the company, thus attracting the attention of investors. Firm size is measured by the total value of assets owned, with a higher asset count indicating a larger organizational scale. Large firms typically exhibit greater stability, which tends to attract increased interest from investors seeking to acquire shares. This situation in line with Signalling Theory that company stability increases the company's stock price on the stock market. Consequently, a positive relationship exists between firm size and firm value, as investors generally prefer larger and more stable companies Husna & Satria (2019) Research conducted by Hirdinis (2019) states that company size has a positive effect on company value.

Empirical evidence provide mixed findings. Research from Dorothy & Endri. (2024) said that larger firms face greater public scrutiny, compelling them to engage im visible corporate governance and environmental initiatives to maintain the legitimacy, which in turn affects firm value. However, research conducted by (Hasangapon *et al.*, 2021) states that company size does not affect company value. Meanwhile research from Dorothy & Endri (2024) dan Lee *et al.* (2025) had significant effect that firm size had significant effect on firm value. Due to inconsistency based on the result, based on the explanation above, the hypothesis formulated is as follows:

H_4 : Firm size has a significant effect on firm value

3. RESEARCH METHODOLOGY

Data and Analysis

The population in this study consists of energy sector companies listed on the Indonesia Stock Exchange (IDX) for the 2018-2023 period. This study uses 66 data samples for further analysis. Study from Jenkins & Quintana-Ascencio (2020) suggest ≥25 is sufficient for linear regression in panels with the assumptions met. Purposive sampling is used to select samples in this study with criteria all company who have declared their financial statement and sustainability report completely. The data is balanced because all observation units (cross-sections, for sample companies) have the

same number of observations (time series) throughout the research period. The analytical method utilized in this study is panel regression method. Initial test conducted to check the model (fixed effect, common effect, or random effect). After that, classical assumption tests will encompass examinations for data normality, multicollinearity, heteroscedasticity and autocorrellation. Upon meeting all assumption criteria, the analysis will advance to hypothesis testing to evaluate the acceptance of proposed hypothesis.

Definition and Operationalization of Variable

The dependent variable in this study is the firm value. The company value in this study is proxied by Price to Book Value (PBV). The formula used to calculate PBV is as follows (Arpan & Carolina Odjan, 2020):

$$\text{Price to Book Value (PBV)} = \frac{\text{Stock Price}}{\text{Book Value per Share}}$$

Green product innovation focuses on the design and development of environmentally friendly products that aim to reduce negative impacts on the environment by integrating product functions and green principles (M. Wang & Liu, 2022). Based on Xie *et al.* (2019), GPI1 measurement uses 3 indicators which are still qualitative variables, so dummy variable is used using two values, namely 1 and 0.

$$\text{GPI1} = \frac{\Sigma di}{M}$$

Description:
GPI1 : Green Product Innovation
Σdi : Total items disclosed
M : Maximum total items disclosed (3 items)

Green process innovation aims to reduce energy consumption during the production process or during the process of converting waste into valuable goods (Xie *et al.*, 2019). Based on research Xie *et al.* (2019), GPI2 measurements were carried out using 4 indicators which were still qualitative variables, so a dummy variable with two values, namely 1 and 0, was used.

$$\text{GPI2} = \frac{\Sigma di}{M}$$

Profitability (ROE) is the company's ability to generate profits to increase shareholder value. In this study, profitability is measured through Return on Equity (ROE). The formula for calculating ROE is as follows (Choiriyah *et al.*, 2021):

$$\text{Return on Equity (ROE)} = \frac{\text{Laba bersih}}{\text{Ekuitas}}$$

Firm size (FS) is a scale that reflects the profitability or profits that will be generated (Hasangapon *et al.*, 2021). Firm size is measured using the formula (Hirdinis, 2019)

$$\text{Ln} = (\text{Total Aset})$$

4. RESULT AND DISCUSSION

Descriptive Statistical Analysis

Descriptive statistical analysis of this study is presented in Table 1. Based on Table 1, it is known that the results of the descriptive test with a sample size of 66, the average value obtained for the Y variable (PBV) or company value in this study is 0,8653. The maximum value obtained is 2,83, and the minimum value obtained is -2,36. For the green product innovation variable (GPI1), the average value is 0,8737, the maximum value is 1,00 and the minimum value is 0,33. For the green process innovation variable (GPI2) the average value is 0,8182, the maximum value is 1,00 and the minimum value is 0,50. For the profitability variable (ROE), the average value is 0.1306, the maximum value is 0,62, the minimum value is -0,80. For the firm size variable (FS), the average value is 30,8212, the maximum value is 32,38, and the minimum value is 28,56

Table 1. Descriptive Statistics

Sample: 2018 2023

	Y (Firm Value)	X1 (GPI1)	X2 (GPI2)	X3 (Profitability)	X4 (Firm Size)
Mean	0,865152	0,874848	0,818182	0,130000	30,82152
Median	0,795000	1,000000	0,750000	0,120000	30,91000
Maximum	2,830000	1,000000	1,000000	0,620000	32,38000
Minimum	-2,360000	0,330000	0,500000	-0,800000	28,56000
Std. Dev.	0,802301	0,171861	0,161397	0,225811	1,082159
Skewness	-0,967985	-0,846337	-0,317121	-0,843875	-0,368739
Kurtosis	7,390724	2,487744	2,297599	6,739552	2,126006
Jarque-Bera	63,32270	8,600773	2,462984	46,29007	3,596286
Probability	0,000000	0,013563	0,291857	0,000000	0,165606
Sum	57,10000	57,74000	54,00000	8,580000	2034,220
Sum Sq. Dev.	41,83965	1,919848	1,693182	3,314400	76,11945
Observations	66	66	66	66	66

Sources: Eviews Data Processing

Model Estimation: Chow Test

The Chow test was conducted to determine the most appropriate model of the two models, namely the Common Effect Model (CEM) and fixed effect model (FEM) models.

Table 2. Results of Chow Test

Redundant Fixed Effects Tests
Equation: MODEL_FEM
Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	1,499037	(10,51)	0,1671
Cross-section Chi-square	17,007095	10	0,0742

Cross-section fixed effects test equation:
Dependent Variable: Firm Value
Method: Panel Least Squares
Sample: 2018 2023
Periods included: 6
Cross-sections included: 11
Total panel (balanced) observations: 66

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0,821738	2,406453	-0,341473	0,7339
GPI1	1,665644	0,587356	2,835836	0,0062
GPI2	0,475468	0,582352	0,816462	0,4174
Profitability	1,152338	0,418227	2,755293	0,0077
Firm Size	-0,010029	0,080841	-0,124064	0,9017
Root MSE	0,621700	R-squared		0,390298
Mean dependent var	0,865152	Adjusted R-squared		0,350318
S.D. dependent var	0,802301	S.E. of regression		0,646678
Akaike info criterion	2,038797	Sum squared resid		25,50972
Schwarz criterion	2,204680	Log likelihood		-62,28030
Hannan-Quinn criter.	2,104345	F-statistic		9,762221
Durbin-Watson stat	1,003806	Prob(F-statistic)		0,000004

Source: Data processed with Eviews

The test results presented obtained a probability value of 0,1671. Because the probability value is greater than 0,05 (>0.05), this means that the appropriate model to use is the common effect model than fixed effect model.

Model Estimation: Lagrange Multiplier Test

To determine whether the Random Effect model is better than the Common Effect model, the Lagrange Multiplier (LM) is used. This Random Effect Significance Test was developed by Breusch-Pagan.

Table 3. Results of Langrage Multiplier Test

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

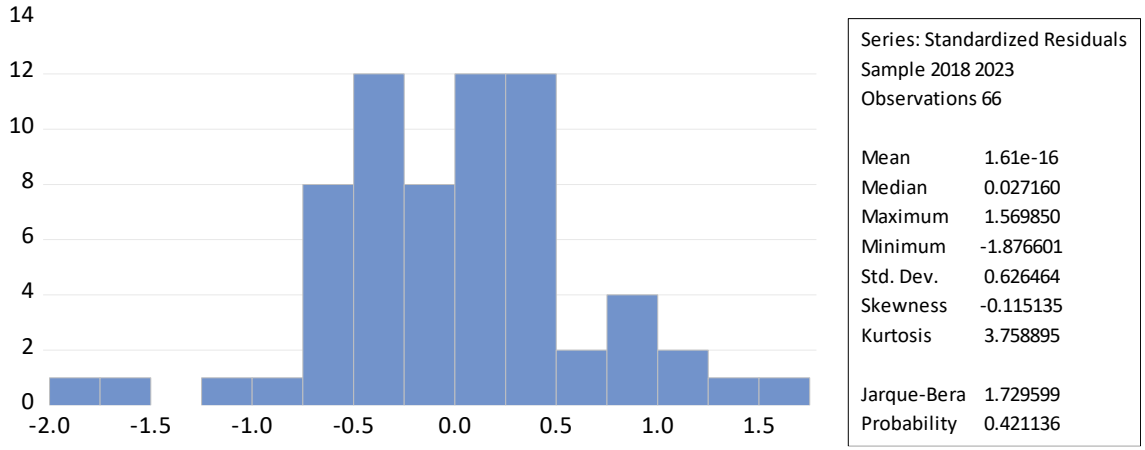
	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	0,158122	0,835857	0,993980
	(0,6909)	(0,3606)	(0,3188)
Honda	0,397646	-0,914252	-0,365296
	(0,3454)	(0,8197)	(0,6426)
King-Wu	0,397646	-0,914252	-0,516903
	(0,3454)	(0,8197)	(0,6974)
Standardized Honda	1,022650	-0,675676	-3,377196
	(0,1532)	(0,7504)	(0,9996)
Standardized King-Wu	1,022650	-0,675676	-3,410059
	(0,1532)	(0,7504)	(0,9997)
Gourieroux, *et al.*	--	--	0,158122
			(0,5764)

The test results presented obtained a Breusch-Pagan probability value of 0,6909. Since the probability value is greater than 0,05 (>0,05), the appropriate model to use is the common effect model. Because the common effect model was selected, a classical assumption test must be carried out.

Classical Assumption Test

Normality Test

The normality test is intedeed to assess whether the variables or residuals in the regression model are normally distributed. The following are the results of the normality test:



Source: Data processed with Eviews

Figure 1. Normality Test

The results of the normality test show that the residual data is normally distributed because the probability value is 0,421136 > 0,05, so the normality assumption of the regression model has been met.

Multicollinearity Test

The purpose of the Multicollinearity Test is to check whether there is a correlation between independent variables in the regression model. The following are the results of the Multicollinearity Test:

Table 4. Multicollinearity Test

Variance Inflation Factors
Sample: 1 66
Included observations: 66

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	5,798615	913,7624	NA
GPI1	0,339197	42,38334	1,577479
GPI2	0,339373	37,17217	1,371972
Profitability	0,173726	1,848540	1,381669
Firm Size	0,006551	981,9006	1,189645

Source: Data processed with Eviews

The results of the multicollinearity test show that the VIF (Variance Inflation Factor) value for all variables is below 10. VIF GPI1 (green product innovation) is 1,577, variable GPI2 (green process innovation) has a value of 1,371, variable ROE (profitability) has a value of 1,381, and variable FS (firm size) has a value of 1,189. These results indicate that there is no multicollinearity between the independent variables in the regression model of this study.

Heteroscedasticity Test

The heteroscedasticity test is conducted to examine whether there is a variance inequality of residuals across observations within the regression model. In this study, heteroscedasticity is assessed using Breusch Pagan Godfrey test. The results of the heteroscedasticity test can be concluded that H0 is accepted because the probability results (Obs*R-squared, Prob. Chi-Square) of 0,3524 are greater than 0,05. Thus, it can be said that there is no heteroscedasticity problem in this regression model.

Table 4. Heteroscedasticity Test Result

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1,093970	Prob. F(4,61)	0,3676
Obs*R-squared	4,417655	Prob. Chi-Square(4)	0,3524
Scaled explained SS	5,242960	Prob. Chi-Square(4)	0,2633

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample: 1 66
Included observations: 66

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2,576433	2,412405	-1,067994	0,2897
GPI1	-0,649185	0,583464	-1,112640	0,2702
GPI2	-0,421286	0,583615	-0,721856	0,4731
Profitability	0,343881	0,417561	0,823547	0,4134
Firm Size	0,124282	0,081088	1,532692	0,1305

R-squared	0,066934	Mean dependent var	0,387098
Adjusted R-squared	0,005750	S.D. dependent var	0,650216
S.E. of regression	0,648344	Akaike info criterion	2,043944
Sum squared resid	25,64135	Schwarz criterion	2,209827
Log likelihood	-62,45014	Hannan-Quinn criter.	2,109492
F-statistic	1,093970	Durbin-Watson stat	1,242922
Prob(F-statistic)	0,367630		

Source: Data processed with Eviews

Autocorrelation Test

The autocorrelation test aims to determine whether there is a correlation between the disturbance error in period t and the disturbance error in period t-1 in the linear regression model. If there is a correlation, then there is an autocorrelation problem.

Table 5. Autocorrelation Test Result

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	7,531703	Prob. F(2,59)	0,0012
Obs*R-squared	13,42343	Prob. Chi-Square(2)	0,0012

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Sample: 1 66
Included observations: 66
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0,857631	2,196925	0,390378	0,6977
GPI1	-0,353017	0,538015	-0,656148	0,5143
GPI2	0,282831	0,536216	0,527457	0,5999
Profitability	0,245370	0,383515	0,639793	0,5248
Firm Size	-0,026381	0,073879	-0,357079	0,7223
RESID(-1)	0,462773	0,126970	3,644758	0,0006
RESID(-2)	-0,315061	0,126105	-2,498397	0,0153
R-squared	0,203385	Mean dependent var		2,78E-16
Adjusted R-squared	0,122374	S.D. dependent var		0,626940
S.E. of regression	0,587328	Akaike info criterion		1,873537
Sum squared resid	20,35228	Schwarz criterion		2,105773
Log likelihood	-54,82671	Hannan-Quinn criter.		1,965304
F-statistic	2,510568	Durbin-Watson stat		2,159187
Prob(F-statistic)	0,031277			

Source: Data processed with Eviews

Based on the results of the Breusch-Godfrey test, the Chi-Square(2) Prob. value is 0,0012. Because this value is smaller than 0,05, H0 (null hypothesis: no autocorrelation) is rejected. Thus, it can be said that there is an autocorrelation problem in the regression model. Therefore, white period robust standard errors was applied to examine the effects of independent variable to dependent variable

Panel Regression Result with Robust Correction

After the classical assumption tests, a common effect model (pooled OLS) with White Period Robust standard errors was applied to examine the effects of green product innovation (GPI1), Green Process Innovation (GPI2), Profitability (ROE) and Firm Size (FS) on Firm Value (PBV).

Table 6. Regression Estimation

Variable	Coefficient	Robust Std. Error	t-statistic	Prob.
C	3,8641	10,7871	0,3582	0,7202
GPI 1	1,6648	0,6540	2,5450	0,0111
GPI 2	0,4916	0,6462	0,7607	0,4469
Profitability	0,7392	0,6026	1,2266	0,2200
Firm Size	-0,1576	0,3562	-0,4426	0,6581

The R-squared is 0,5288, adjusted R-squared 0,3994, and the F-Statistic is significant at $p<0,001$, confirming the model's overall significance

$$\mathbf{PBV_{it} = 3,8641 + 1,6648\ (GPI1_{it}) + 0,4916\ (GPI2_{it}) + 0,7392\ (ROE_{it}) - 0,1576\ (FS_{it}) + \varepsilon_{it}}$$

PBV = Firm Value (Price to Book Value)
GPI1 = Green Product Innovation
GPI2 = Green Process Innovation
ROE = Profitability (return on equity)
FS = Firm Size

Hypothesis Discussion

The Effect of Green Product Innovation on Firm Value

The first hypothesis tests the effect of green product innovation on firm value. The regression results show a t-count of 2,5450 with a significance level of 0,0111, which is smaller than 0,05. Thus, H1 is accepted, indicating that green product innovation has a significant effect on firm value. This finding supports research from (Xie *et al.*, 2019), (Qing *et al.*, 2024; Qiu *et al.*, 2016) that technology innovation positively influences corporate financial performance which can turn to firm value. This result in line with (Asni & Agustia, 2022) which show a positive impact of green product innovation on firm value through increased environmental performance, enhancing higher profitability and market valuation. Other factors that support this result include increasing consumer awareness of environmentally friendly products, which can increase consumer loyalty and firm value. This result also answer stakeholder theory and signalling theory by give signal for investor that innovation of product and technology can brings positive impact for business sustainability and leads to increase firm value. According to Stakeholder theory, eco-friendly product development demonstrates corporate responsiveness to environmental and social demands from customers, investors and regulators, which enhances trust, strengthens brand equity and ultimately increases market valuation (Y. Chen *et al.*, 2022). From the perspective of signalling theory, green product innovation enables firms to conform societal expectations and environmental regulations, strengthening their legitimacy and "license to operate" (Kuo *et al.*, 2016). From the managerial perspective, firms should also integrate their green product innovation into ESG disclosure to enhance visibility and maximize legitimacy gains. Companies can differentiate themselves in the competitive energy market, strengthen stakeholder trust, and secure long term financial benefit.

The Effect of Green Process Innovation on Firm Value

The second hypothesis tests the effect of green process innovation on firm value. The regression results show a t-count of 0,7607 with a significance value of 0,4469, greater than 0,05. Thus, H2 is rejected, indicating that green process innovation has no significant effect on firm value. This findings was contrary with studies from (Y. Chen *et al.*, 2022; D. Wang & Wang, 2025; Xie *et al.*, 2019). This may indicate that innovation in the process does not immediately affect the value of the company. It takes enough time to ensure the impact of a process innovation on the value of the company because the process change requires time for adaptation, implementation and evaluation, so that the impact on the value of the company may not be seen quickly and directly. According to stakeholder theory, this may occur because stakeholders especially investors prioritize visibility sustainability initiatives over operational improvements, which are often internal and less observable (P. A. Khan *et al.*, 2023). From the signalling theory perspective, while process innovation reduces environmental impact and operational risks, its legitimacy signalling is weaker because stakeholders may not perceive or value this improvement without proper disclosure (Khalil *et al.*, 2022).

Other reason can be explained from Helmi & Widiastuty (2023), which shows that green process innovation has no positive effect on firm value. Global economic uncertainty and changes in environmental regulations during the study period may explain this lack of positive impact, as firms face challenges in implementing green process innovation. Another factors can be explain related to innovation is the long process and takes time to see the result, this may be one reason that their effect in firm

value needs to be waited for long period. This findings implies that energy firm should not only implement green process innovations but also communicate them strategically through sustainability reports, ESG disclosure, and third-party certifications. Managers need to translate technical improvements (e.g., energy efficiency, emission reductions) into comprehensible narratives that resonate with investors and regulators. Furthermore, integrating process innovations with product-level innovations can create a holistic sustainability strategy that maximizes both operational efficiency and stakeholder legitimacy.

The Effect of Profitability on Firm Value

The third hypothesis tests the effect of profitability on firm value using Return on Equity (ROE). The regression results show a t-count of 1,2266 with a significance level of 0,2200, which is bigger than 0,05. Thus, H3 is rejected. This finding is consistent with prior research, (Khan *et al.*, 2022) observed that financial performance alone does not significantly drive firm value unless combined with credible green innovation efforts. Similarly, (Khalil *et al.*, 2022) demonstrated that environmental legitimacy plays a stronger role than profitability in determining market valuation in emerging Asian markets. The results also resonate with (Bahar & Lestari, 2023), who noted that investors in environmentally sensitive industries may perceive profitability without sustainability initiatives as a potential legitimacy risk.

This finding implies that improving profitability should be accompanied by sustainability-oriented investment to maximize firm value. Manager should allocate profits strategically toward R&D in green innovations, ensuring that financial success translates into visible legitimacy gains. From an investor relations perspective, communicating how profits are reinvested in sustainable initiatives can also enhance stakeholder trust and support higher valuations.

The Effect of Firm Size on Firm Value

The fourth hypothesis tests the effect of firm size on firm value using the natural logarithm of total assets. The regression results show a T-count of -0,4426 with a significance value of 0,6581, greater than 0,05. Thus, H4 is rejected, indicating that firm size does not have a significant effect on firm value. This result indicates that firm scale alone does not guarantee higher market valuation in energy sector. According to stakeholder theory, large firm face greater stakeholder scrutiny, and their size may even become a liability if they fail to demonstrate environmental responsibility (Rahim, 2021). Legitimacy theory supports this by emphasizing that legitimacy is achieved through responsible actions, not simply organizational scale (Khalil *et al.*, 2022)

This finding is consistent with studies (Hasangapon *et al.*, 2021), which show that company size does not affect firm value, perhaps because large assets do not always mean better efficiency. In addition, large companies may experience complexity that can reduce managerial and operational effectiveness, negatively impacting firm value. Prior study also highlight this nuance. (Yi *et al.*, 2021) found that larger firms gain valuation benefits only when they actively engage in sustainability practices. (Hirdinis, 2019; Husna & Satria, 2019) further demonstrated that firm size positively moderates the ESG disclosure-firm value relationship, implying that size enhances valuation only when combined with transparent sustainability reporting. Without such initiatives, large firms may even face reputational risks that negatively affect investor perceptions.

5. CONCLUSION

This study aimed to examine the effect of Green Product Innovation (GPI1), Green Process Innovation (GPI2), Profitability (ROE), and Firm Size (FS) on Firm Value (PBV) in the Indonesian energy sector companies, grounded in stakeholder theory and legitimacy theory. The empirical findings reveal that only green product innovation has positive and significant impact on firm value, confirming that the hypothesis that environmentally friendly products enhance market valuation. This result underscores the role of green product innovation as a strategic legitimacy-building mechanism that signals corporate environmental responsibility, thereby gaining investor trust and competitive differentiation.

Conversely, green process innovation, profitability and firm size do not significantly influence firm value. The insignificant effect of green process innovation suggests that operational implements, although critical for efficiency, are less visible to external stakeholders and thus provide weaker legitimacy signals in capital market. The lack of significance for profitability and firm size indicates a paradigm shift in investor evaluation criteria, where traditional financial indicators and firm size are less influential than visible and credible sustainability initiatives. These findings collectively support the argument that legitimacy derived from environmental innovation has become a more critical determinant of firm valuation than financial or structural attributes in environmentally sensitive industries.

This research brings several implications. For managerial perspective, energy firms should prioritize green product innovation as a strategic initiative to enhance firm value. Managers are advised to allocate resources for developing eco-friendly products, such as renewable energy solutions or low-carbon fuels, and communicate these initiatives through ESG disclosures, sustainability reports, and marketing campaigns to strengthen legitimacy and stakeholder trust. Additionally, while green process innovation does not directly influence firm value, managers should integrate process innovations into transparent reporting to convert operational improvements into visible legitimacy signals. A balance approach combining product and process innovations is essential for building long-term competitive advantage.

In the other side, regulators and policymakers should encourage green innovation by providing fiscal incentives, tax reductions, or subsidies for firms adopting green product and process innovations. Establishing mandatory ESG disclosure standards can also enhance transparency, enabling investors to evaluate firms based on their environmental legitimacy. Moreover, government recognition programs, such as green innovation awards or public certifications, can increase stakeholder awareness and amplify the positive impact of sustainability initiatives on firm value.

For academics, the findings reinforce the need to explore the evolving role of stakeholder theory and legitimacy theory in explaining firm value determinants in environmentally sensitive industries. Future research can expand on the mediating or moderating effects of ESG disclosure quality, institutional ownership, or market environmental awareness in the relationship between green innovation and firm value. The results also open new avenues for developing sustainability-oriented corporate valuation models.

REFERENCES

Amara, D. Ben, Qiao, J., & Zada, M. (2023). How to reconcile the climate change issue with economic growth? Spatial dual mediating effects of carbon emissions and foreign investment. *Journal of Cleaner Production*, *411*, 137285. https://doi.org/10.1016/j.jclepro.2023.137285

Arpan, Y., & Carolina Odjan, M. A. (2020). Faktor Penentu yang Berdampak Terhadap Nilai Perusahaan: Studi Perusahaan Manufaktur di Bursa Efek Indonesia. *ECo-Fin*, *2*(2), 81–91. https://doi.org/10.32877/ef.v2i2.318

Asni, N., & Agustia, D. (2022). The mediating role of financial performance in the relationship between green innovation and firm value: Evidence from ASEAN countries. *European Journal of Innovation Management*, *25*(5), 1328–1347. https://doi.org/10.1108/EJIM-11-2020-0459

Bahar, H., & Lestari, E. (2023). Green innovation, financial performance, and firm value: A content analysis method. *Journal of Business Research*, *153*, 113–128.

Bibi, Y. S., & Narsa, N. P. D. R. H. (2022). The impact of environmental management toward financial performance with green innovation as a mediating variable. *Jurnal Akuntansi Universitas Jember*, *20*(2), 90–105. https://doi.org/10.19184/jauj.v20i2.34896

Chen, W.-J. (2022). Toward Sustainability: Dynamics of Total Carbon Dioxide Emissions, Aggregate Income, Non-Renewable Energy, and Renewable Power. *Sustainability (Switzerland)*, *14*(5). https://doi.org/10.3390/su14052712

Chen, Y., Tang, G., Jin, J., Li, J., & Paillé, P. (2022). Green process innovation and financial performance: The role of green social capital and customers' tacit green needs. *Journal of Innovation & Knowledge*, *7*(1), 100150. https://doi.org/10.1016/j.jik.2021.100150

Choiriyah, C., Fatimah, F., Agustina, S., & Ulfa, U. (2021). The Effect Of Return On Assets, Return On Equity, Net Profit Margin, Earning Per Share, And Operating Profit Margin On Stock Prices Of Banking Companies In Indonesia Stock Exchange. *International Journal of Finance Research*, *1*(2), 103–123. https://doi.org/10.47747/ijfr.v1i2.280

Dorothy, P., & Endri, E. (2024). Environmental, social and governance disclosure and firm value in the energy sector: The moderating role of profitability. *Problems and Perspectives in Management*, *22*(4), 588. http://dx.doi.org/10.21511/ppm.22(4).2024.44

Freeman, R. E. (1984). Strategic management: a stakeholder approach, Pitman. *Boston, MA*.

Garg, M., & Gupta, M. P. (2022). Impact of ESG performance on firm value and profitability: Evidence from global energy firms. *Journal of Cleaner Production*, *350*, 131467. https://doi.org/10.1016/j.jclepro.2022.131467

Hasangapon, M., Iskandar, D., Purnama, E. D., & Tampubolon, L. D. (2021). The Effect Of Firm Size And Total Assets Turnover (Tato) On Firm Value Mediated By Profitability In Wholesale And Retail Sector Companies. *Primanomics: Jurnal Ekonomi & Bisnis*, *19*(3), 49–63. https://doi.org/10.31253/pe.v19i3.635

Helmi, W. M., & Widiastuty, E. (2023). Effect of Green Innovation and Green Process Innovation on Firm Performance. *Jurnal Riset Akuntansi Aksioma*, *22*(1), 55–69. https://doi.org/10.29303/aksioma.v22i1.203

Heriansyah, D. (2024). The Effect of Corporate Governance, Profitability, Liquidity, and Solvency on Corporate Social Responsibility (CSR) Disclosure: A Literature Review. *Management Studies and Entrepreneurship Journal*, *5*(2), 5062–5080. http://journal.yrpipku.com/index.php/msej

Hirdinis, M. (2019). Capital structure and firm size on firm value moderated by profitability. *International Journal of Economics and Business Administration*, *7*(1), 174–191. https://doi.org/10.35808/ijeba/204

Husna, A., & Satria, I. (2019). Effects of Return on Asset, Debt To Asset Ratio, Current Ratio, Firm Size, and Dividend Payout Ratio on Firm Value. *International Journal of Economics and Financial Issues*, *9*(5), 50–54. https://doi.org/10.32479/ijefi.8595

Hussain, N., Rigoni, U., & Orij, R. P. (2018). Corporate governance and sustainability performance: Analysis of triple bottom line performance. *Journal of Business Ethics*, *149*(2), 411–432. https://doi.org/10.1007/s10551-016-3099-5

Kartikasary, M., Paramastri Hayuning Adi, M., Marojahan Sitinjak, M., Hardiyansyah, & Yolanda Sari, D. (2023). Environmental, Social and Governance (ESG) Report Quality and Firm Value in Southeast Asia. *E3S Web of Conferences*, *426*. https://doi.org/10.1051/e3sconf/202342602087

Khalil, M. A., Khalil, R., & Khalil, M. K. (2022). Environmental, social and governance (ESG)-augmented investments in innovation and firms' value: a fixed-effects panel regression of Asian economies. *China Finance Review International*, *ahead-of-print*. https://doi.org/10.1108/CFRI-05-2022-0067

Khan, H. R., Usman, B., Zaman, K., Nassani, A. A., Haffar, M., & Muneer, G. (2022). The impact of carbon pricing, climate financing, and financial literacy on COVID-19 cases: go-for-green healthcare policies. *Environmental Science and Pollution Research*, *29*(24), 35884–35896. https://doi.org/10.1007/s11356-022-18689-y

Khan, P. A., Johl, S. K., Kumar, A., & Luthra, S. (2023). Hope-hype of green innovation, corporate governance index, and impact on firm financial performance: a comparative study of Southeast Asian countries. *Environmental Science and Pollution Research*, *30*(19), 55237–55254. https://doi.org/10.1007/s11356-023-26262-4

Kuo, T. C., Hong, I.-H., & Lin, S. C. (2016). Do carbon taxes work? Analysis of government policies and enterprise strategies in equilibrium. *Journal of Cleaner Production*, *139*, 337–346. https://doi.org/10.1016/j.jclepro.2016.07.164

Lee, C. L., Ming, K. L. Y., & Yee, L. C. (2025). ESG: Its Threshold Effect on Asian Energy Company Profitability. *International Journal of Energy Economics and Policy*, *15*(2), 692. https://doi.org/10.32479/ijeep.18430

Nguyen, T. T. H., & Song, W. (2021). Carbon Pricing and Income Inequality: An Empirical Investigation. *Journal of Economic Development*, *46*(2), 155–182. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85111545592&partnerID=40&md5=4a066497c13a27fb4828d15f2bc64ae1

Qing, L., Alnafrah, I., & Dagestani, A. A. (2024). Does green technology innovation benefit corporate financial performance? Investigating the moderating effect of media coverage. *Corporate Social Responsibility and Environmental Management*, *31*(3), 1722–1740. https://doi.org/10.1002/csr.2659

Qiu, Y., Shaukat, A., & Tharyan, R. (2016). Environmental and social disclosures: Link with corporate financial performance. *The British Accounting Review*, *48*(1), 102–116. https://doi.org/10.1016/j.bar.2014.10.007

Rahim, I. (2021). Environmental disclosure and firm efficiency: a study of Pakistani firms. *Asian Review of Accounting*. https://doi.org/10.1108/ARA-05-2019-0100

Spence, M. (1978). Job market signaling. In *Uncertainty in economics* (pp. 281–306). Elsevier. https://doi.org/10.1016/B978-0-12-214850-7.50025-5

Wang, D., & Wang, T. (2025). Does ESG Information Disclosure Improve Green Innovation in Manufacturing Enterprises? *Sustainability*, *17*(6), 2413. https://doi.org/10.3390/su17062413

Wang, M., & Liu, Z. (2022). How do green innovation strategies contribute to firm performance under supply chain risk? Evidence from China's manufacturing sector. *Frontiers in Psychology*, *13*, 894766. https://doi.org/10.3389/fpsyg.2022.894766

Xie, X., Huo, J., & Zou, H. (2019). Green process innovation, green product innovation, and corporate financial performance: A content analysis method. *Journal of Business Research*, *101*, 697–706. https://doi.org/https://doi.org/10.1016/j.jbusres.2019.01.010

Yi, Y., Zeng, S., Chen, H., & Shi, J. J. (2021). When does it pay to be good? A meta-analysis of the relationship between green innovation and financial performance. *IEEE Transactions on Engineering Management*, *9*, 3260–3270.

Zhang, F., Qin, X., & Liu, L. (2020). The interaction effect between ESG and green innovation and its impact on firm value from the perspective of information disclosure. *Sustainability*, *12*(5), 1866. https://doi.org/10.3390/su12051866

Zhang, Z. (2022). China's carbon market: Development, evaluation, coordination of local and national carbon markets, and common prosperity. *Journal of Climate Finance*, *1*, 100001. https://doi.org/10.1016/j.jclimf.2022.100001

Zhou, Y., Lv, S., Wang, J., Tong, J., & Fang, Z. (2022). The impact of green taxes on the carbon emission efficiency of China's construction industry. *Sustainability*, *14*(9), 5402. https://doi.org/10.3390/su14095402