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Green innovation disclosure, green investment, carbon emission disclosure, and firm value: The moderating role of firm size in ISSI-listed palm oil firms

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Abstract

This study examines the relationships between green innovation disclosure (GID), green investment (GI), and carbon emission disclosure (CED) and firm value. It tests the moderating role of firm size among palm oil companies listed on the Indonesia Sharia Stock Index (ISSI) during 2020–2024. Because empirical evidence on the valuation implications of corporate environmental practices is inconsistent, the study assesses whether these relationships vary by firm size. Guided by Legitimacy Theory, the analysis draws on panel data from 12 companies, comprising 60 firm-year observations. The data are analyzed using a fixed effects model and hierarchical regression. The results show that GID and GI are not statistically significant in the final model. CED has a positive and statistically significant coefficient. At the same time, its interaction with firm size is negative and statistically significant, indicating that the estimated association between CED and firm value varies with firm size. Firm size is positively associated with firm value, whereas its interactions with GID and GI are not statistically significant in the main model. Robustness tests using pooled ordinary least squares with year fixed effects and lagged firm value as the dependent variable yield consistent results for CED, firm size, and their interaction. However, the findings for GID and its interaction with firm size are sensitive to model specification. This study contributes to the environmental disclosure literature by highlighting firm size as a relevant condition in the association between carbon emission disclosure and firm value. The findings indicate statistical associations, not causal effects.

Keywords: carbon emission disclosure; firm size; firm value; green innovation disclosure; green investment.

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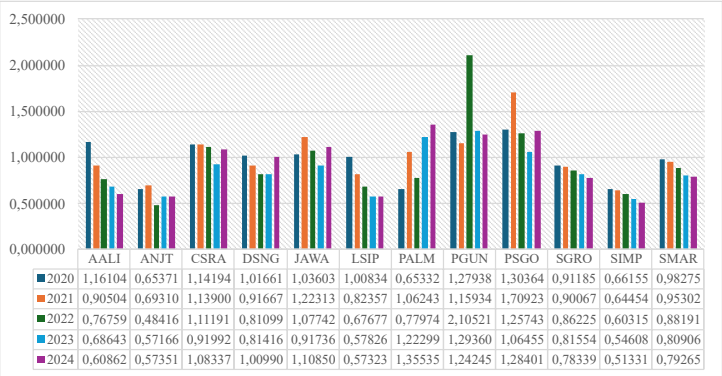
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Introduction

Indonesia's palm oil sector is the world's largest with around 59% of the world's palm oil production in 2025. This is enabled by the wide expansion of land used for palm tree cultivation, which covers more than 17.12 million hectares (Prasetya *et al.*, 2025). The palm oil sector greatly contributes to the economy of Indonesia through increasing exports, generating employment, and fostering growth in diverse regions (Duan *et al.*, 2023). However, the sector is still associated with several environmental problems, including deforestation, biodiversity loss, greenhouse gas emissions, and conflicts over land usage. These problems have attracted increasing scrutiny and contributed to growing demands for more stringent sustainability practices and regulations (Adwiyah *et al.*, 2023).

Growing concerns about climate change have increasingly influenced investor assessments, especially in industries that are highly exposed to environmental risks (Khiari *et al.*, 2025). Besides short-term financial performance, investors are now looking at how corporations are dealing with environmental risks and sustainability challenges (Pasupuleti, 2025). Environmental issues and international market pressures are important strategic concerns for palm oil companies. These pressures have compelled firms to integrate sustainability into their long-term business goals.

Firm value reflects market participants' assessments of a company's performance, risk, and prospects. One commonly used market-based measure is Tobin's Q, which compares a firm's market valuation with its asset base (Azzahra *et al.*, 2025). However, firm value in natural resource-dependent industries may be particularly sensitive to sustainability challenges because these industries have substantial environmental impacts and face considerable stakeholder scrutiny (Nani *et al.*, 2022). In addition, the higher stringency of sustainability regulations and initiatives, specifically OJK Regulation Number 51/POJK.03/2017 and sustainability-based stock indices developed by the Indonesia Stock Exchange, has increased the relevance of sustainability practices (e.g., CSR, sustainability, or green innovation disclosure) in corporate valuation (Pendyala & Nainggolan, 2024). Although sustainability has become increasingly relevant to corporate valuation, Tobin's Q values of several palm oil companies during 2020–2024 varied across firms and years. However, these variations do not establish whether environmental practices or disclosures are associated with firm value, as profitability, commodity prices, market conditions, and trade policies may also influence valuation.



	AALI	ANJT	CSRA	DSNG	JAWA	LSIP	PALM	PGUN	PSGO	SGRO	SIMP	SMAR
2020	1,16104	0,65371	1,14194	1,01661	1,03603	1,00834	0,65332	1,27938	1,30364	0,91185	0,66155	0,98275
2021	0,90504	0,69310	1,13900	0,91667	1,22313	0,82357	1,06243	1,15934	1,70923	0,90067	0,64454	0,95302
2022	0,76759	0,48416	1,11191	0,81099	1,07742	0,67677	0,77974	2,10521	1,25743	0,86225	0,60315	0,88191
2023	0,68643	0,57166	0,91992	0,81416	0,91736	0,57826	1,22299	1,29360	1,06455	0,81554	0,54608	0,80906
2024	0,60862	0,57351	1,08337	1,00990	1,10850	0,57323	1,35535	1,24245	1,28401	0,78339	0,51331	0,79265

Source: data processed by authors (2026)
Figure 1. Tobin's Q in ISSI-Listed Palm Oil Firms 2020-2024

Figure 1 illustrates variations in Tobin's Q among palm oil companies listed on the Indonesian Sharia Stock Index (ISSI) from 2020 to 2024. Several companies recorded Tobin's Q values below one, indicating that their market valuations were below the corresponding book-value benchmarks. However, these variations do not establish whether environmental sustainability practices are associated with firm value, as profitability, commodity prices, and broader market conditions may also influence valuation. Therefore, the observed pattern provides the empirical context for examining the relationship between green innovation disclosure, green investment, carbon emission disclosure, and firm value.

Previous studies have extensively examined the relationship between sustainability practices and corporate value. Corporate sustainability has been assessed using various measures, including corporate social responsibility, environmental transparency, sustainability reports, ESG reporting, green accounting, environmental performance, green innovation, green investments, and carbon emission reports (Alaika & Firmansyah, 2024; Fadipe *et al.*, 2025). These practices may be associated with firm value by enhancing information transparency, strengthening stakeholder trust, and reducing information asymmetry between firms and external stakeholders. However, empirical findings indicate that these relationships vary by sustainability dimension. Nguyen (2020) observed that sustainability reporting had a negative impact on the firm's value, but Priskila Sinaga et al. (2025) found that ESG disclosure was associated with higher firm value. In contrast, Alaika and Firmansyah (2024) found that sustainability disclosure did not significantly affect firm value in the Indonesian palm oil industry. These inconsistent findings suggest that different environmental practices may relate to firm value in different ways and therefore warrant separate empirical examination.

This study examines three environmental dimensions, namely green innovation disclosure, green investment, and carbon emission disclosure. Green innovation disclosure refers to information firms

disclose about environmentally oriented innovations in their technologies, products, and production processes. Green investment refers to allocating financial resources to environmentally oriented activities, whereas carbon emission disclosure involves disclosing information on greenhouse gas emissions and related environmental management practices (Purwanti et al., 2022; Wang & Ahmad, 2024). These variables capture distinct aspects of corporate environmental engagement, including green innovation disclosure, resource allocation to environmental initiatives, and transparency in carbon-related information. Accordingly, green innovation disclosure and carbon emission disclosure are treated as disclosure-based constructs. In contrast, green investment represents actual resource allocation to environmental initiatives, provided that its operational measure captures environmental expenditure or investment rather than disclosure alone. Environmental disclosure does not necessarily indicate the extent of actual environmental investment or the effectiveness of environmental practices.

Previous studies have reported positive relationships between these environmental dimensions and firm value (Adwiyah et al., 2023; Putri & Paramita, 2025; Untari et al., 2023), whereas other studies have found insignificant or negative relationships (Akib et al., 2025; Nurjannah et al., 2025; Shafira, 2024). These mixed findings indicate that the valuation implications of corporate environmental engagement remain inconclusive, particularly in environmentally sensitive industries such as the palm oil sector. Examining these dimensions within a common empirical framework helps distinguish the valuation relevance of environmental resource allocation from that of environmental disclosure. Green investment represents the allocation of financial resources to environmental initiatives, whereas green innovation disclosure and carbon emission disclosure represent different forms of environmental transparency. Therefore, this study examines green innovation disclosure, green investment, and carbon emission disclosure in a single model to evaluate their individual associations with firm value. The study also examines firm size as a moderator to determine whether these associations vary across firms of different sizes. This approach provides a more integrated assessment of distinct environmental dimensions without assuming that including them in the same model necessarily implies synergy or complementarity.

Firm size has also been examined as a potential moderator of the relationship between environmental practices and firm value. Larger firms generally have greater financial resources and operational capacity and attract more public attention, which may increase scrutiny from investors and other stakeholders (Melawati & Nirwana, 2025). Previous studies report that firm size strengthens the relationship between sustainability practices and firm value (Anggraeni & Fitriyah, 2025; Sitorus, 2024), while others find no significant moderating effect (Dewi & Aryati, 2025; Rahmawati, 2025). These inconsistent findings leave uncertainty regarding whether firm size conditions the relationship between specific environmental dimensions and firm value. Accordingly, this study examines firm size as a potential moderator, given that differences in corporate resources and visibility may shape how environmental initiatives and disclosures relate to market valuation.

This study focuses on palm oil companies listed on the Indonesian Sharia Stock Index (ISSI) during 2020–2024. The palm oil industry provides a relevant research setting because of its economic significance and the environmental challenges associated with its operations (Murphy et al., 2021). ISSI membership defines the study's population and situates the analysis within the Indonesian sharia capital market. However, this sample selection does not imply that ISSI-listed companies exhibit investor responses or financing characteristics that differ from those of non-ISSI companies, as such differences would require an explicit empirical comparison. ISSI is therefore treated as the study's scope rather than as evidence of a distinctive market mechanism.

Legitimacy theory provides a conceptual basis for understanding why environmental practices and disclosures matter for companies facing environmental scrutiny. The theory suggests that firms depend partly on the perceived alignment between their activities and societal expectations (Dowling & Pfeffer, 1975). In the palm oil industry, green innovation disclosure and carbon emission disclosure may signal corporate responses to environmental concerns, while green investment reflects resource allocation toward environmental objectives. When stakeholders perceive these activities as credible and consistent with societal expectations, they may assess the firm more favorably and reduce concerns about

environmental controversies. Such perceptions may, in turn, be associated with lower perceived regulatory and operational risks, greater continuity of business operations, and more favorable expectations regarding future cash flows. These expectations may influence firm value through investors' assessment of the firm's prospects and risk profile. However, these mechanisms represent theoretical explanations rather than directly tested causal pathways in this study. The empirical analysis examines the relationships between green innovation disclosure, green investment, carbon emission disclosure, and firm value, as well as the moderating role of firm size. It does not directly measure organizational legitimacy, investor perceptions, financing access, or the mechanisms linking stakeholder acceptance to market valuation. Therefore, legitimacy theory serves as a conceptual framework for interpreting the potential valuation relevance of environmental practices and disclosures, rather than as a mechanism this study empirically verifies.

Building on these gaps, this study examines the relationships among green innovation disclosure, green investment, carbon emission disclosure, and firm value among palm oil companies listed on ISSI during 2020–2024. It further investigates whether firm size moderates these relationships using hierarchical regression. To assess the reliability of the empirical findings, the study also conducts robustness checks to examine whether the results remain consistent under alternative model specifications or measurement approaches where feasible. This study contributes to the sustainability and corporate finance literature by examining three distinct environmental dimensions within a common empirical framework, distinguishing the association of environmental investment from environmental disclosure with firm value, assessing whether firm size moderates these relationships, evaluating the sensitivity of the findings through robustness checks, and providing evidence from palm oil companies within the ISSI population. Rather than assuming that environmental practices and disclosures necessarily enhance firm value, the study empirically tests their associations with market valuation and whether these associations vary by firm size.

Literature Review

Legitimacy Theory

Legitimacy theory posits that firms seek to align their activities and disclosures with societal expectations to maintain social legitimacy and stakeholder support (Suchman, 1995). In the environmental context, green investment, green innovation disclosure, and carbon emission disclosure may signal corporate commitment to environmental responsibility and help reduce the perceived gap between business activities and societal expectations (Chariri & Ghazali, 2007; Deegan, 2002). When perceived as credible, these initiatives may support business continuity and reduce perceived environmental and operational risks, potentially shaping investors' expectations of future cash flows and firm value. Previous studies have reported positive associations between environmental practices, disclosures, and firm value (Y. Liu & Liu, 2025; Putri & Paramita, 2025; Takwa et al., 2025). However, this study does not directly measure legitimacy or the mechanisms linking stakeholder acceptance to market valuation. Legitimacy theory therefore serves as a conceptual framework for interpreting the relationships between the three environmental dimensions and firm value, including the potential moderating role of firm size.

The Effect of Green Innovation Disclosure and Firm Value

Green innovation disclosure refers to information firms communicate about environmentally oriented innovations in their technologies, products, and production processes (Arundel et al., 2007; Chen et al., 2006). Such disclosure may reduce information asymmetry and signal a firm's commitment to environmental responsibility, potentially strengthening investor confidence and corporate reputation (Li et al., 2022; Ruan et al., 2024). However, disclosure does not necessarily demonstrate the successful implementation or effectiveness of green innovation. More extensive disclosure may also reveal

implementation costs, technological uncertainties, or environmental challenges that investors perceive negatively. Therefore, the relationship between green innovation disclosure and firm value may depend on whether investors interpret the disclosed information as a credible signal of future benefits or as an indication of additional costs and risks. In this study, we expect a positive relationship because credible disclosure may improve investors' assessments of the firm's environmental commitment and long-term prospects. Based on the mechanism explained above, we propose the following hypothesis:

H1: Green innovation disclosure has a positive significant effect on firm value.

The Effect of Green Investment and Firm Value

Green investment refers to allocating financial resources to environmentally oriented activities, such as energy efficiency, low-carbon technologies, renewable energy, and environmentally friendly infrastructure. Such investments may improve resource efficiency, reduce environmental liabilities, and strengthen firms' capacity to respond to environmental regulations (Eyraud et al., 2013; Zhang & Berhe, 2022). However, green investment also entails upfront costs, implementation expenses, and uncertainty about the timing and magnitude of future returns. Consequently, the relationship between green investment and firm value in the same year may be positive if investors anticipate future economic benefits and view the investment as credible. However, it may be negative if immediate costs outweigh expected benefits. Putri & Paramita (2025) reported a positive relationship between green investment and firm value in Indonesian energy companies. Building on this evidence, the present study expects a positive contemporaneous association if investors incorporate the anticipated long-term benefits of green investment into current market valuations. Nevertheless, this expectation does not imply that the investment's economic benefits are fully realized in the same year. Based on the mechanism explained above, we propose the following hypothesis:

H2: Green investment has a positive significant effect on firm value.

The Effect of Carbon Emission Disclosure and Firm Value

Carbon emission disclosure refers to information reported by firms regarding greenhouse gas emissions and related environmental management practices (Global Reporting Initiative, 2016). Such disclosure may reduce information asymmetry by enabling investors to assess environmental exposure, regulatory risks, and potential future liabilities more effectively (Luo et al., 2013; Matsumura et al., 2014). Greater transparency may also signal a firm's preparedness to manage climate-related risks, potentially supporting investor confidence and firm value. However, extensive disclosure does not necessarily indicate lower carbon emissions or superior environmental performance. It may instead reveal substantial emissions, regulatory exposure, or environmental liabilities that investors interpret negatively. Thus, the relationship between carbon emission disclosure and firm value may be positive or negative, depending on what is disclosed and how investors assess its implications. This study expects a positive association because transparent carbon reporting may reduce information uncertainty and improve investors' ability to evaluate the firm's environmental risk management. However, this expectation does not presume that disclosure itself reduces emissions. Based on the mechanism explained above, we propose the following hypothesis:

H3: Carbon emission disclosure has a positive significant effect on firm value.

The Effect of Firm Size on Firm Value

Firm size reflects the scale of a firm's assets and operations and may influence its market valuation through resource availability, operational capacity, and business diversification. Larger firms may benefit from economies of scale, broader access to financing, and greater capacity to withstand external

shocks, which can support expectations of business continuity and future cash flows (Cahyani & Gunawan, 2022; Efendi & Idayati, 2020). However, a larger asset base does not automatically indicate greater profitability or efficiency, as large firms may also face higher operating costs and organizational complexity. Nevertheless, larger firms are expected to have higher firm value because their resource capacity and operational scale may support business continuity and strengthen investor expectations regarding future performance. Based on the mechanism explained above, we propose the following hypothesis:

H4: Firm size has a positive significant effect on firm value.

The Moderating Effect of Firm Size on Green Innovation Disclosure and Firm Value

Firm size may condition the relationship between green innovation disclosure and firm value by influencing the visibility, credibility, and perceived economic significance of environmental information. Larger firms generally attract greater investor and stakeholder scrutiny, which may increase the relevance of their green innovation disclosures to market valuation. Their greater organizational capacity may also enable them to provide more comprehensive information about environmental initiatives and integrate disclosed innovations into broader business strategies (Ghofar *et al.*, 2025; Xu *et al.*, 2025). . Under these conditions, investors may better assess the potential long-term benefits of disclosed green innovations. However, greater visibility may also expose large firms to closer scrutiny when disclosures lack credible implementation or measurable outcomes. Therefore, firm size is expected to strengthen the positive association between green innovation disclosure and firm value by enhancing the credibility and valuation relevance of environmental information through greater visibility and organizational capacity. Based on the mechanism explained above, we propose the following hypothesis:

H5: Firm size positively moderates the relationship between green innovation disclosure and firm value.

The Moderating Effect of Firm Size on Green Investment and Firm Value

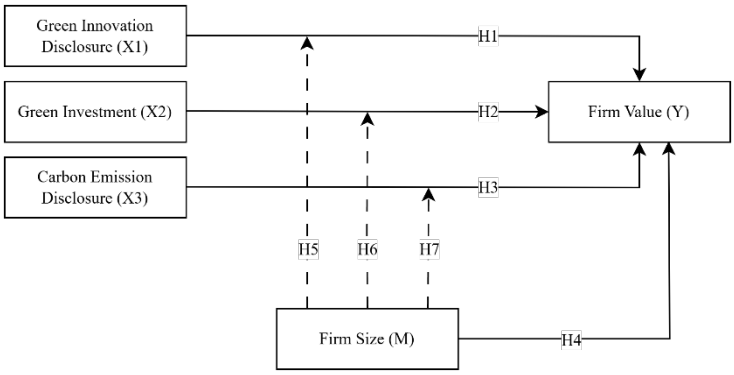
Firm size may moderate the relationship between green investment and firm value by influencing a firm's capacity to finance environmental projects, manage implementation costs, and realize the expected benefits of such investments. Larger firms generally have greater financial resources, more established operational processes, and better access to information, which may enable them to integrate green investments into their business activities more effectively. Moreover, their broader market reach and greater stakeholder visibility may allow them to capture reputational benefits and manage environmental risks more effectively. These advantages may strengthen investors' expectations that green investments will generate long-term economic benefits, thereby enhancing their contribution to firm value. However, green investments also involve initial costs, while their financial benefits may take time to materialize. Therefore, firm size is expected to strengthen the positive relationship between green investment and firm value, as larger firms are better positioned to manage investment costs and realize long-term benefits. Mubarok et al. (2025) provide relevant empirical support if their findings confirm that firm size strengthens the relationship between green investment and firm value. Based on the mechanism explained above, we propose the following hypothesis:

H6: Firm size positively moderates the relationship between green investment and firm value.

The Moderating Effect of Firm Size on Carbon Emission Disclosure and Firm Value

Firm size may influence the relationship between carbon emission disclosure and firm value by shaping the credibility, visibility, and valuation relevance of environmental information. Larger firms generally have greater organizational resources and more established reporting systems, which may enable them to communicate carbon-related information more systematically (Shi & Wang, 2024). Moreover, because larger firms tend to attract greater scrutiny from investors and other stakeholders, market assessments may pay more attention to their carbon emission disclosures. Credible disclosure may therefore help investors evaluate a firm's exposure to climate-related risks and potential regulatory liabilities. However, greater disclosure does not necessarily indicate lower carbon emissions or superior environmental performance, as it may also reveal substantial emissions and associated risks. Previous research suggests that firm size can influence how sustainability-related information relates to firm value, although the direction of this effect may vary across disclosure measures and research contexts (Chong & Loh, 2023). Therefore, this study expects firm size to strengthen the positive relationship between carbon emission disclosure and firm value, as larger firms' reporting capacity and stakeholder visibility may enhance the valuation relevance of credible carbon-related information. Based on the mechanism explained above, we propose the following hypothesis:

H7: Firm size positively moderates the relationship between carbon emission disclosure and firm value.



Source: data processed by authors (2026)
Figure 2. Research Model

Methodology

This study samples palm oil firms listed on the Indonesia Sharia Stock Index (ISSI) from 2020 to 2024. It was selected because it offers more extensive sustainability disclosures, reflecting the growing trend in environmental reporting standards among Indonesian listed firms. An initial screening identified 22 palm oil enterprises listed on ISSI. The research sample was selected using purposive sampling based on the following criteria: (1) companies that are continuously listed on the ISSI over the observation period, (2) companies that publish complete annual reports and sustainability reports, and (3) companies that are supplying complete data for all research variables. We removed 10 companies for incomplete reporting or data gaps, leaving a final sample of 12 companies with 60 firm-year observations. The secondary data were collected from the Indonesia Stock Exchange (IDX) and the official websites of the companies. The list of sample companies is provided in Appendix 1.

Table 1. Sampling Procedures and Criteria

No.	Criteria	Total
1.	Palm oil sector companies listed in ISSI (2020–2024)	22
2.	Companies with incomplete reports/data	(10)
3.	Final sample companies	12
4.	Observation period	5
5.	Total observations	60

Source: data processed by authors (2026)

Firm value (FV) is measured using Tobin's Q, calculated as the sum of the market value of equity and the book value of total liabilities divided by the book value of total assets. The market value of equity is calculated by multiplying the year-end share price by the number of outstanding shares. Green innovation disclosure (GID) is measured using a disclosure index comprising eight indicators related to resource optimization, recycling and green technology adoption, environmental campaigns, energy-efficient technologies and equipment, eco-safe product design, eco-friendly packaging, energy-efficient product design, and hazardous material reduction. Each indicator is assigned a score of 1 if disclosed and 0 otherwise (Rahelliamelinda & Handoko, 2024; Setyawan & Wijayanti, 2023). The GID index is calculated by dividing the number of disclosed indicators by the number of applicable indicators.

Green investment (GI) is measured as environmental investment expenditure divided by total assets (Hua & Gao, 2026; Khalid et al., 2023; Zhang & Berhe, 2022). Environmental investment expenditure includes reported spending related to pollution prevention, renewable energy, resource efficiency, and emission reduction. We identify eligible expenditures based on information disclosed in companies' annual and sustainability reports. Undisclosed expenditure amounts are not automatically assigned a value of zero unless the available disclosures indicate that no relevant expenditure was incurred.

Carbon emission disclosure (CED) is measured using five indicators under the Global Reporting Initiative (GRI) 305 standard, covering direct greenhouse gas emissions (GRI 305-1), energy indirect greenhouse gas emissions (GRI 305-2), other indirect greenhouse gas emissions (GRI 305-3), greenhouse gas emissions intensity (GRI 305-4), and greenhouse gas emissions reduction (GRI 305-5). Each indicator is scored 1 if disclosed and 0 otherwise. The CED index is calculated as the number of disclosed indicators divided by the total number of applicable indicators (Global Reporting Initiative, 2016).

Firm size (FS) is measured as the natural logarithm of total assets (Rahmayani et al., 2025; Salsabila & Purwaningsih, 2025). It serves as the moderating variable to examine whether firm size influences the relationships between GID, GI, CED, and firm value. The study also includes four control variables: leverage, profitability, liquidity, and firm age. Leverage (DER) is measured as total debt divided by total equity (Kusuma & Sari, 2025). Profitability (ROA) is measured as net income divided by total assets (Husna & Satria, 2019; Zahwa et al., 2025). Liquidity (CR) is measured as current assets divided by current liabilities (Zahwa et al., 2025). Firm age (AGE) is measured as the natural logarithm of the number of years between the observation year and the company's establishment year (Widuri, 2020). Appendix 2 presents the operational definitions and measurement formulas.

To test the research hypotheses, this study employs panel data regression using a balanced dataset. We conduct the Chow, Hausman, and Lagrange Multiplier (LM) tests to determine the appropriate panel estimation method, with the specification test results presented in Appendix 3. Based on the estimation results, we select the fixed effects model (FEM) for the main analysis. We run hierarchical regressions by sequentially adding environmental variables, firm size, and interaction terms to examine the moderating effects of firm size. The interaction terms are constructed by multiplying each environmental variable by firm size. To assess the robustness of the findings, we also use lagged firm value ($lnFV_{it-1}$) as the dependent variable, while the independent and control variables are measured in year (t). The main regression model is specified as follows:

$$lnFV_{it} = a + \beta_1 CV_{it} + \varepsilon_{it} \quad (1)$$

$$lnFV_{it} = a + \beta_1 CV_{it} + \beta_2 GID_{it} + \varepsilon_{it} \quad (2)$$

$$lnFV_{it} = a + \beta_1 CV_{it} + \beta_2 GID_{it} + \beta_3 GI_{it} + \varepsilon_{it} \quad (3)$$

$$lnFV_{it} = a + \beta_1 CV_{it} + \beta_2 GID_{it} + \beta_3 GI_{it} + \beta_4 CED_{it} + \varepsilon_{it} \quad (4)$$

$$lnFV_{it} = a + \beta_1 CV_{it} + \beta_2 GID_{it} + \beta_3 GI_{it} + \beta_4 CED_{it} + \beta_5 FS_{it} + \varepsilon_{it} \quad (5)$$

$$lnFV_{it} = a + \beta_1 CV_{it} + \beta_2 GID_{it} + \beta_3 GI_{it} + \beta_4 CED_{it} + \beta_5 FS_{it} + \beta_6 GID\ x\ FS_{it} + \varepsilon_{it} \quad (6)$$

$$lnFV_{it} = a + \beta_1 CV_{it} + \beta_2 GID_{it} + \beta_3 GI_{it} + \beta_4 CED_{it} + \beta_5 FS_{it} + \beta_6 GID\ x\ FS_{it} + \beta_7 GI\ x\ FS_{it} + \varepsilon_{it} \quad (7)$$

$$lnFV_{it} = a + \beta_1 CV_{it} + \beta_2 GID_{it} + \beta_3 GI_{it} + \beta_4 CED_{it} + \beta_5 FS_{it} + \beta_6 GID\ x\ FS_{it} + \beta_7 GI\ x\ FS_{it} + \beta_8 CED\ x\ FS_{it} + \varepsilon_{it} \quad (8)$$

where *i* denotes the firm and *t* denotes the observation year. *FV* represents firm value, *GID* denotes green innovation disclosure, *GI* represents green investment, *CED* denotes carbon emission disclosure, *FS* denotes firm size, *CV* represents the control variables, α is the intercept, β represents the estimated coefficients, and ε is the error term.

Result

Table 2 presents descriptive statistics and the correlation matrix for 60 firm-year observations of palm oil companies listed on the Indonesia Sharia Stock Index (ISSI) from 2020–2024. Firm Value has a mean of −0.107 and a standard deviation of 0.308, with values ranging from −0.725 to 0.744. Green Innovation Disclosure (GID) has a mean of 0.885 and a standard deviation of 0.135, while Green Investment (GI) has a mean of 0.043 and a standard deviation of 0.040. Carbon Emission Disclosure (CED) has a mean of 0.653 and a standard deviation of 0.294. Firm Size (FS), measured as the natural logarithm of total assets, has a mean of 29.826 and a standard deviation of 1.015. Leverage, Profitability, Liquidity, and Firm Age have mean values of 1.774, 0.044, 1.975, and 3.546, respectively.

The correlation matrix shows that Firm Value is negatively correlated with GID (−0.357), CED (−0.624), and FS (−0.587), and positively correlated with GI (0.223). The strongest pairwise correlation among the explanatory variables is between CED and FS (0.559). These correlations describe the preliminary associations among the study variables. Appendix 4 presents the results of the classical assumption tests, comprising normality, multicollinearity, heteroskedasticity, and autocorrelation tests, all of which meet the criteria established in this study.

Table 3 presents the hierarchical regression results across eight model specifications. All models are statistically significant overall, with F-statistics ranging from 11.364 to 15.722 and reported Prob(F-statistic) values of 0.000 ($p < 0.001$). The R^2 increases from 0.815 in Model 1 to 0.903 in Model 8, while the adjusted R^2 ranges from 0.752 to 0.846. Model 8 has the highest explanatory power among the eight specifications.

Table 2. Descriptive Statistics and Correlation Matrix

Variable	Obs	Mean	Std. Dev.	Min	Max	(1)	(2)	(3)
Firm Value	60	-0.106552	0.307722	-0.725321	0.744418	1.000000		
Green Innovation Disclosure	60	0.885417	0.134770	0.500000	1.000000	-0.356833	1.000000	
Green Investment	60	0.043423	0.039635	0.0000488	0.136584	0.223038	-0.057348	1.000000
Carbon Emission Disclosure	60	0.653333	0.294277	0.200000	1.000000	-0.623697	0.316962	-0.215448
Firm Size	60	29.82623	1.014533	27.96647	31.44506	-0.587254	0.411374	-0.274544
Leverage	60	1.773515	4.384923	0.000418	29.31664	0.196066	-0.239296	-0.065256
Profitability	60	0.043818	0.109670	-0.375230	0.493031	-0.168867	0.260203	0.236424
Liquidity	60	1.975224	1.968139	0.146930	10.49789	-0.248598	0.273937	-0.119543
Firm Age	60	3.546498	0.537816	2.484907	4.634729	-0.160439	0.227335	0.046930

Variable	Obs	(4)	(5)	(6)	(7)	(8)	(9)
Firm Value	60	-0.623697	-0.587254	0.196066	-0.168867	-0.248598	-0.160439
Green Innovation Disclosure	60	0.316962	0.411374	-0.239296	0.260203	0.273937	0.227335
Green Investment	60	-0.215448	-0.274544	-0.065256	0.236424	-0.119543	0.046930
Carbon Emission Disclosure	60	1.000000	0.559477	-0.086628	0.053319	0.214163	0.266835
Firm Size	60	0.559477	1.000000	-0.209923	-0.032290	0.141522	0.174622
Leverage	60	-0.086628	-0.209923	1.000000	-0.295157	-0.227229	0.434954
Profitability	60	0.053319	-0.032290	-0.295157	1.000000	0.135719	-0.176966
Liquidity	60	0.214163	0.141522	-0.227229	0.135719	1.000000	0.150278
Firm Age	60	0.266835	0.174622	0.434954	-0.176966	0.150278	1.000000

Source: data processed by authors (2026)

The coefficient of GID is positive but statistically insignificant in Models 2–8. Its coefficient ranges from 0.349 to 4.512, and the interaction term GID × FS is statistically insignificant in Models 6–8. Therefore, H1 is not supported, as the results do not establish a statistically significant positive relationship between green innovation disclosure and firm value. H5 is also not supported, because the interaction between green innovation disclosure and firm size is not statistically significant.

GI has a negative and statistically significant coefficient at the 10% level in Models 3–6, with estimates ranging from −1.317 to −1.452. However, the coefficient becomes statistically insignificant in Models 7 and 8. Since the estimated coefficient is negative in the intermediate models and insignificant in the final specification, H2 is not supported. The interaction term GI × FS is statistically insignificant in Models 7 and 8, with coefficients of 0.708 and 0.329, respectively. Accordingly, H6 is not supported, as the results do not establish a statistically significant positive moderating effect of firm size on the relationship between green investment and firm value.

CED is statistically insignificant in Models 4–7. In Model 8, its coefficient is positive and statistically significant at the 1% level, with an estimate of 11.215. However, because CED is included alongside its interaction with FS, this coefficient represents the estimated association when FS equals zero rather than the general association across the observed sample. Consequently, the coefficient alone cannot conclusively establish the positive direct effect hypothesized in H3. To determine whether H3 is supported, evaluate the conditional association through marginal-effect analysis at relevant values of firm size.

FS has a positive and statistically significant coefficient in Models 5–8, with estimates ranging from 0.592 to 0.879. These results indicate a positive association between firm size and firm value in the specifications that include FS. Therefore, H4 is supported by the positive and statistically significant coefficient on firm size in these models.

The interaction term CED × FS is negative and statistically significant at the 1% level in Model 8, with a coefficient of −0.381. This indicates that firm size significantly moderates the relationship between carbon emission disclosure and firm value, but the direction of moderation is negative. Therefore, H7 is not supported, because the hypothesis predicts a positive moderating effect.

Among the control variables, Leverage is statistically insignificant across all eight models. Profitability has a negative and statistically significant coefficient in Models 1–4 but becomes insignificant in Models 5–8. Liquidity has a negative and statistically significant coefficient throughout all eight models, with estimates ranging from −0.077 to −0.062. Firm Age is statistically insignificant in most specifications, although its coefficient is negative and significant at the 10% level in Models 2 and 3 and at the 5% level in Model 8.

Table 3. Results of Fixed-Effect Panel Regression

Variables	Model 1	Model 2	Model 3	Model 4
Leverage	0.001	0.004	0.003	0.003
	(0.007)	(0.007)	(0.007)	(0.007)
Profitability	-0.704***	-0.818***	-0.754***	-0.609**
	(0.213)	(0.215)	(0.214)	(0.271)
Liquidity	-0.070**	-0.062**	-0.062**	-0.062**
	(0.028)	(0.027)	(0.027)	(0.027)
Firm Age	-0.608	-0.835*	-0.833*	-0.451
	(0.422)	(0.426)	(0.418)	(0.605)
Green Innovation Disclosure		0.453	0.407	0.372
		(0.235)	(0.232)	(0.236)
Green Investment			-1.317*	-1.327*
			(0.782)	(0.785)
Carbon Emission Disclosure				-0.162
				(0.185)
Firm Size				
GID x FS				
GI x FS				
CED x FS				
Observations	60	60	60	60
R^2	0.815	0.830	0.841	0.844
Adj. R^2	0.752	0.767	0.776	0.775
F-statistic	12.937	13.107	13.028	12.279
Prob(F-statistic)	0.000	0.000	0.000	0.000
Variables	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Leverage	0.003	0.003	0.003	0.003
	(0.006)	(0.006)	(0.007)	(0.006)
Profitability	-0.347	-0.334	-0.324	-0.399
	(0.285)	(0.291)	(0.293)	(0.250)
Liquidity	-0.077***	-0.076***	-0.076***	-0.075***
	(0.027)	(0.027)	(0.027)	(0.023)
Firm Age	-1.080	-1.029	-1.100	-1.314**
	(0.646)	(0.670)	(0.681)	(0.582)
Green Innovation Disclosure	0.349	2.628	2.686	4.512
	(0.226)	(6.618)	(6.661)	(5.681)
Green Investment	-1.452*	-1.391*	-21.975	-11.194
	(0.753)	(0.781)	(28.968)	(24.774)
Carbon Emission Disclosure	-0.158	-0.179	-0.172	11.215***
	(0.177)	(0.188)	(0.190)	(2.888)
Firm Size	0.592**	0.645**	0.682**	0.879***
	(0.269)	(0.313)	(0.320)	(0.276)
GID x FS		-0.078	-0.081	-0.148
		(0.226)	(0.227)	(0.194)
GI x FS			0.708	0.329
			(0.996)	(0.852)
CED x FS				-0.381***
				(0.096)
Observations	60	60	60	60
R^2	0.860	0.861	0.863	0.903
Adj. R^2	0.794	0.789	0.787	0.846
F-statistic	12.974	12.060	11.364	15.722
Prob(F-statistic)	0.000	0.000	0.000	0.000

**** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$. Standard error is shown in parentheses.*

Source: data processed by authors (2026)

The main regression results indicate that the relationships between environmental practices and firm value differ across the dimensions examined. Green innovation disclosure (GID) has a positive but statistically insignificant coefficient. In contrast, green investment (GI) exhibits a negative and weakly significant coefficient in intermediate specifications before becoming insignificant in the final model. Carbon emission disclosure (CED) and firm size (FS), by contrast, have positive, statistically significant coefficients in the final specification. Meanwhile, the CED × FS interaction is negative and statistically significant. The interactions between GID and FS and between GI and FS are statistically insignificant, providing no support for the hypothesized positive moderating effects. We then evaluate these findings against the robustness test to determine whether the principal relationships remain consistent under an alternative specification.

GID has a positive but statistically insignificant coefficient in the main regression; therefore, H1 is not supported. This result is consistent with Arniati et al. (2025) and Anggraini & Gunawan (2024), who report insignificant relationships between environmental disclosure or green innovation and firm value, but differ from Indrawan et al. (2025) and Zaikin et al. (2024)who identify positive associations. From the perspective of legitimacy theory, environmental innovation disclosure may communicate a firm's commitment to environmental responsibility; however, disclosure alone does not establish the substantive implementation or economic effectiveness of the reported practices (Deegan, 2002; Suchman, 1995). The robustness test yields a positive GID coefficient that is weakly significant at the 10% level in Model 8. This difference indicates that the relationship is sensitive to model specification and does not provide conclusive evidence of a consistent positive association between GID and firm value.

GI exhibits a negative and weakly significant coefficient in the intermediate main-regression specifications but becomes statistically insignificant in the final model. Accordingly, H2 is not supported because the final specification does not establish a significant relationship between green investment and firm value. This result is consistent with Handayani (2025), Dearani et al. (2025), and Juanda & Yumna (2025), who report insignificant relationships, but contrasts with Putri and Paramita (2025) and Nurjannah et al. (2025), who identify positive associations. Although environmental investment may support resource efficiency and environmental improvements, the associated expenditures may precede the realization of financial benefits, making the short-term valuation implications uncertain (Eyraud et al., 2013; Zhang & Berhe, 2022). The robustness test also produces an insignificant GI coefficient in Model 8, reinforcing the conclusion that the final specifications do not establish a statistically significant relationship between green investment and firm value.

CED has a positive and statistically significant coefficient in the final main-regression model, providing initial support for H3 at the coefficient level. This finding is consistent with Pratiwi et al. (2024), Maharani et al. (2024) and Harnida et al. (2025) who identify carbon-related disclosure as relevant to firm value, although previous research also reports insignificant or negative relationships in other settings (Shafira, 2024; Stefani & Gunawan, 2024). Carbon transparency may reduce information asymmetry and help investors assess firms' exposure to climate-related risks and environmental liabilities (Luo et al., 2013; Matsumura et al., 2014). The robustness test similarly produces a positive and statistically significant CED coefficient in Model 8, indicating consistency in the coefficient's direction and statistical significance across the two specifications.

FS has a positive and statistically significant coefficient in the main-regression specifications that include this variable, supporting H4. This finding is consistent with Sitepu et al. (2024), who examine plantation companies, and Mauren & Syarif (2025), who report a positive association between firm size and firm value. Larger firms may have greater access to financial and organizational resources and may benefit from economies of scale and broader investor visibility, although size alone does not guarantee operational efficiency or superior environmental performance. The robustness test also identifies a positive and statistically significant FS coefficient in Model 8, reinforcing the consistency of this association across specifications. Because the final model includes interaction terms involving firm

size, however, the coefficient should be interpreted conditionally rather than as an unconditional relationship between firm size and firm value.

The interaction between GID and FS is negative but statistically insignificant in the main regression, providing no support for H5, which predicts positive moderation. This finding is consistent with Rahmawati (2025) reports no significant moderating effect of firm size on the relationship between green innovation and firm value, although other research identifies a moderating role for firm size in selected environmental relationships (Anggraini & Gunawan, 2024). In the robustness test, the interaction remains negative and becomes weakly significant at the 10% level in Model 8. This difference suggests that the estimated moderating relationship is sensitive to model specification rather than providing consistent evidence of negative moderation. Accordingly, the hypothesized positive moderating effect of firm size on the GID × firm value relationship is not supported.

The interaction between GI and FS is statistically insignificant in the main regression, indicating that firm size does not significantly moderate the relationship between green investment and firm value; consequently, H6 is not supported. This result is consistent with Rahmawati (2025) reports no significant moderating effect of firm size on the GI × firm value relationship. Although larger firms may possess greater financial and organizational resources to undertake environmental investments, these resources do not necessarily ensure that investment benefits are realized within the observation period. The robustness test also produces a statistically insignificant GI × FS coefficient in Model 8, reinforcing the consistency of this finding across the final specifications. The analysis provides insufficient evidence that firm size significantly changes the relationship between green investment and firm value.

The interaction between CED and FS is negative and statistically significant in the main regression, indicating that the estimated relationship between CED and firm value becomes less positive as firm size increases, subject to the model specification. H7 is not supported. This finding is comparable to Chong & Loh (2023) who report that firm size strengthens the negative relationship between ESG transparency and firm valuation in the palm oil sector. The robustness test also produces a negative and statistically significant CED × FS coefficient in Model 8, indicating that the direction and statistical significance of this interaction are consistent across specifications. Although greater stakeholder scrutiny of larger firms may provide a plausible explanation, this mechanism is not directly examined in the present study; marginal-effects analysis is needed to establish how the conditional relationship varies across the observed range of firm size.

The control-variable results also vary across model specifications. In the main regression, leverage is statistically insignificant throughout the reported models, whereas profitability and liquidity are negative and statistically significant in several specifications; firm age is statistically significant only in selected models. In contrast, leverage, profitability, liquidity, and firm age are statistically insignificant in Model 8 of the robustness test. These differences suggest that the estimated relationships of the control variables are less consistent across specifications than those of CED, firm size, and their interaction. Although the robustness model reports an R^2 of 0.712, an adjusted R^2 of 0.540, and an F-test p-value below 0.001, these statistics reflect explanatory power and overall model significance rather than the robustness of each individual coefficient.

The findings indicate that the valuation implications of environmental practices vary across firms. The main regression and robustness tests consistently identify positive and statistically significant coefficients for CED and firm size, alongside a negative and statistically significant interaction between CED and firm size in the final specifications. By comparison, the relationship between GID and firm value and the interaction between GID and firm size are sensitive to model specification, while GI and its interaction with firm size remain statistically insignificant in the final models. These findings extend the legitimacy theory discussion by suggesting that environmental disclosure should not automatically be interpreted as evidence of increased firm value, because its valuation relevance may depend on how stakeholders assess the information and the firm's environmental commitments (Deegan, 2002; Suchman, 1995). The results should be interpreted as conditional associations rather than causal effects,

particularly because investor perceptions, disclosure credibility, and the timing of returns from environmental investments are not directly measured.

Robustness Test

The robustness analysis uses pooled ordinary least squares (OLS) with year fixed effects to examine the consistency of the main findings. The robustness test presented in Appendix 5 confirms the positive and significant associations of carbon emission disclosure and firm size with firm value, as well as the negative and significant interaction between carbon emission disclosure and firm size. The positive association between green innovation disclosure and firm value, along with its negative interaction with firm size, is significant only in the robustness model, indicating sensitivity to model specification. In contrast, green investment and its interaction with firm size remain statistically insignificant in the final model. Overall, the robustness results reinforce the findings on carbon emission disclosure and firm size while highlighting the specification sensitivity of other relationships.

Conclusion, Limitations, and Further Research

This study examines the relationships between green innovation disclosure, green investment, carbon emission disclosure, and firm value, with firm size as a moderating variable, among palm oil companies listed on the Indonesia Sharia Stock Index (ISSI) during 2020–2024. The findings indicate that firm size is positively associated with firm value, while carbon emission disclosure exhibits a positive and statistically significant association with firm value in the final regression model. However, the interaction between carbon emission disclosure and firm size is negative and statistically significant, indicating that the relationship between carbon emission disclosure and firm value varies with firm size. Green innovation disclosure and green investment do not show consistent statistically significant relationships with firm value, while their interactions with firm size are generally insignificant in the main regression. The robustness analysis supports the findings for carbon emission disclosure and firm size, although the results for green innovation disclosure and its interaction with firm size vary across specifications. These findings represent statistical associations rather than causal effects. This study has several limitations, including the small sample of 12 ISSI-listed palm oil companies and 60 firm-year observations, potential sample selection bias due to the availability and completeness of corporate reports, and possible subjectivity in coding environmental disclosures. Furthermore, zero values may reflect either the absence of an activity or disclosure or unavailable information, while the observational design and limited study period constrain causal inference and the assessment of delayed effects. Future research should broaden the sample and observation period, strengthen disclosure measurement through standardized coding criteria and independent verification, distinguish zero values from missing data, differentiate green investment from routine environmental costs, and account for the timing of environmental information and potential delayed effects on firm value.

Conflict of Interest Statement

The authors declare no conflicts of interest regarding this study. The entire research process and the writing of this article were conducted independently, without any personal, commercial, or institutional interests that could influence the results or interpretation of this study

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Appendix

Appendix 1. List of Selected Sample Companies

No.	Stock Code	Company Name
1.	AALI	Astra Agro Lestari Tbk
2.	ANJT	Austindo Nusantara Jaya Tbk
3.	CSRA	Cisadane Sawit Raya Tbk
4.	DSNG	Dharma Satya Nusantara Tbk
5.	JAWA	Jaya Agra Wattie Tbk
6.	LSIP	PP London Sumatra Indonesia Tbk
7.	PALM	Provident Investasi Bersama Tbk
8.	PGUN	Pradiksi Gunatama Tbk
9.	PSGO	Palma Serasih Tbk
10.	SGRO	Sampoerna Agro Tbk
11.	SIMP	Salim Ivomas Pratama Tbk
12.	SMAR	Sinar Mas Agro Resources and Technology Tbk

Source: data processed from the idx (2026)

Appendix 2. Operational Definitions of Variables

No.	Operational Definition	Measurement
1.	Firm Value is measured using Tobin's Q, which reflects market valuation by considering the market value of equity and the book value of debt relative to the book value of total assets (Azzahra et al., 2025).	$\text{Tobin's Q} = \frac{\text{MVE} + \text{BVTD}}{\text{BVA}}$
2.	Green Innovation Disclosure refers to the extent to which a company discloses environmentally friendly innovations in its products, production processes, and management systems. The eight indicators comprise: 1) resource optimization; 2) recycling and green technology adoption; 3) environmental campaigns; 4) energy-efficient technologies and equipment; 5) eco-safe product design; 6) eco-friendly packaging; 7) energy-efficient product design; and 8) hazardous material reduction (Rahelliamelinda & Handoko, 2024; Setyawan & Wijayanti, 2023).	$\text{GID} = \frac{\text{Number of items disclosed}}{\text{Number of disclosure items}}$
3.	Green Investment refers to the allocation of company funds to environmental investments, including pollution prevention, renewable energy, resource efficiency, and emission reduction initiatives (Khalid et al., 2023; Zhang & Berhe, 2022).	$\text{GI} = \frac{\text{Green Investment Expenditures}}{\text{Total Assets}}$
4.	Carbon Emission Disclosure refers to the extent to which a company discloses information on greenhouse gas emissions based on seven GRI 305 indicators: 1) direct GHG emissions (GRI 305-1); 2) energy indirect GHG emissions (GRI 305-2); 3) other indirect GHG emissions (GRI 305-3); 4) GHG emissions intensity (GRI 305-4); and 5) GHG emissions reduction (GRI 305-5) (Global Reporting Initiative, 2016).	$\text{CED} = \frac{\text{Number of items disclosed}}{\text{Number of disclosure items}}$
5.	Firm Size represents the scale of a company's resources and serves as a moderating variable to examine whether company size changes the relationship between environmental practices and firm value (Indrawan et al., 2025; R. Liu et al., 2025).	$\text{FS} = \text{Ln (Total Assets)}$
6.	Leverage measures the extent to which a company uses debt relative to its equity to finance its operations (Kusuma & Sari, 2025).	$\text{DER} = \frac{\text{Total Debt}}{\text{Total Equity}}$
7.	Profitability measures a company's ability to generate earnings from its assets (Husna & Satria, 2019; Zahwa et al., 2025).	$\text{ROA} = \frac{\text{Net Income}}{\text{Total Assets}}\ x\ 100\%$

No.	Operational Definition	Measurement
8.	Liquidity measures a company's ability to meet its short-term obligations using its current assets (Zahwa et al., 2025).	$\text{CR} = \frac{\text{Current Assets}}{\text{Current Liabilities}}$
9.	Firm Age represents the length of time a company has operated since its establishment until the observation year (Widuri, 2020).	$\text{FA} = \text{Ln (Observation Year} - \text{Establishment Year)}$

Source: data processed by author (2026)

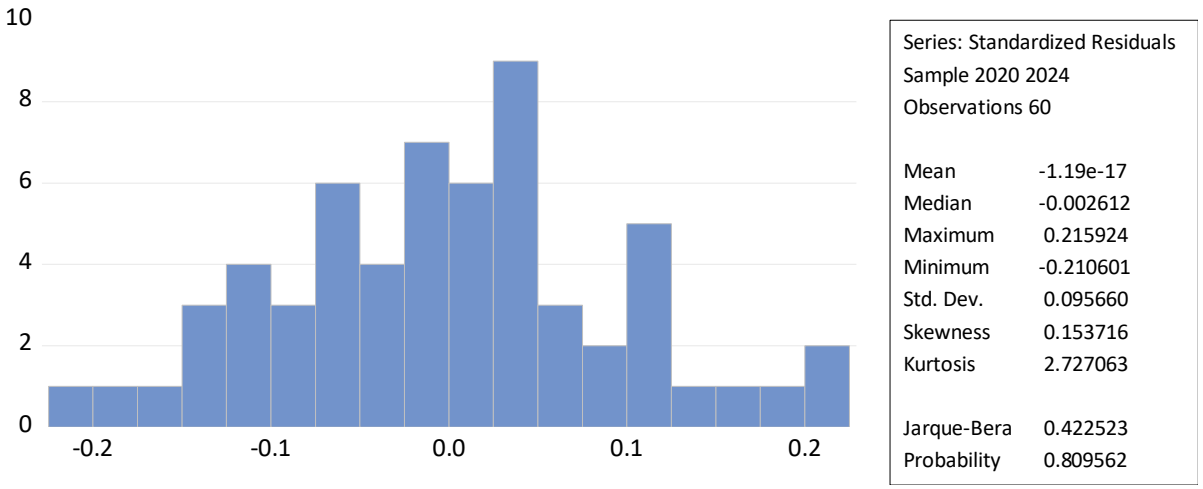
Appendix 3. Model Estimation Result

Test	Prob.	Sig	Decision
Chow Test (OLS vs FEM)	0.0000	0.05	FEM
Hausman Test (FEM vs REM)	0.0000	0.05	FEM
Lagrange Multiplier (OLS vs REM)	0.0002	0.05	REM

Source: data processed by author (2026)

Appendix 4. Classical Assumption Tests

Normality Test



Source: data processed using EViews 12 (2026)

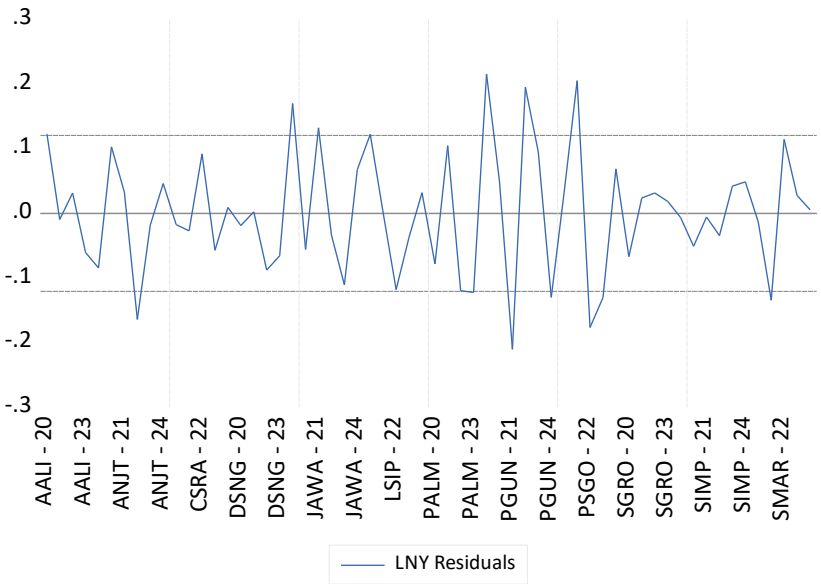
Multicollinearity Test

Covariance Analysis: Ordinary
Date: 10/25/26 Time: 10:55
Sample: 2020 2024
Included observations: 60

Correlation	FV	GID	GI	CED	FS	DER	ROA	CR	FA
FV	1.000000								
GID	-0.356833	1.000000							
GI	0.223038	-0.057348	1.000000						
CED	-0.623697	0.316962	-0.215448	1.000000					
FS	-0.587254	0.411374	-0.274544	0.559477	1.000000				
DER	0.196066	-0.239296	-0.065256	-0.086628	-0.209923	1.000000			
ROA	-0.168867	0.260203	0.236424	0.053319	-0.032290	-0.295157	1.000000		
CR	-0.248598	0.273937	-0.119543	0.214163	0.141522	-0.227229	0.135719	1.000000	
FA	-0.160439	0.227335	0.046930	0.266835	0.174622	0.434954	-0.176966	0.150278	1.000000

Source: data processed using EViews 12 (2026)

Heteroskedasticity Test



Source: data processed using EViews 12 (2026)

Autocorrelation Test

Residual Cross-Section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals
Equation: M_FEM
Periods included: 5
Cross-sections included: 12
Total panel observations: 60
Cross-section effects were removed during estimation

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	84.59735	66	0.0612

Source: data processed using EViews 12 (2026)

Appendix 5. Robustness Test

Variables	Model 1	Model 2	Model 3	Model 4
Leverage	-0.120877	0.160759	0.171173	-2.332397
	(2.152626)	(2.176927)	(2.203777)	(3.066643)
Profitability	0.005858	0.007417	0.007343	0.006370
	(0.009979)	(0.010133)	(0.010267)	(0.010256)
Liquidity	-0.271724	-0.354188	-0.346662	-0.049820
	(0.308837)	(0.321707)	(0.330756)	(0.415905)
Firm Age	0.013211	-0.151109	-0.150866	0.631919
	(0.611756)	(0.637538)	(0.644961)	(0.927936)
Green Innovation Disclosure		0.327768	0.322353	0.250281
		(0.351701)	(0.358318)	(0.362059)
Green Investment			-0.154126	-0.173736
			(1.208292)	(1.203183)
Carbon Emission Disclosure				-0.330853
				(0.283114)
Firm Size				
GID x FS				
GI x FS				
CED x FS				
Observations	60	60	60	60
R^2	0.549552	0.558470	0.558641	0.572868
Adj. R^2	0.395990	0.394179	0.379995	0.385347
F-statistic	3.578697	3.399286	3.127093	3.054950
Prob(F-statistic)	0.000488	0.000700	0.001348	0.001537
Variables	**Model 5**	**Model 6**	**Model 7**	**Model 8**
Leverage	-16.540740	-26.968960	-26.134740	-33.297260
	(11.547310)	(13.849690)	(14.105510)	(12.448480)
Profitability	0.006929	0.007748	0.007878	0.008142
	(0.010188)	(0.010109)	(0.010216)	(0.008901)
Liquidity	0.192275	0.265724	0.254950	0.145113
	(0.454306)	(0.453282)	(0.458492)	(0.400624)
Firm Age	0.050956	0.360549	0.433594	0.119466
	(1.027395)	(1.043597)	(1.065881)	(0.932727)
Green Innovation Disclosure	0.229560	13.989530	13.930640	16.609670*
	(0.359689)	(10.314250)	(10.420240)	(9.109037)
Green Investment	-0.289724	0.080349	21.146990	36.967250
	(1.197545)	(1.217981)	(45.317300)	(39.725460)
Carbon Emission Disclosure	-0.327343	-0.452544	-0.459584	16.250130***
	(0.280987)	(0.293662)	(0.297044)	(4.631233)
Firm Size	0.546650	0.869559*	0.832603	1.121736**
	(0.428562)	(0.488529)	(0.499870)	(0.442809)
GID x FS		-0.469763	-0.466637	-0.565826*
		(0.351917)	(0.355570)	(0.311011)
GI x FS			-0.724517	-1.280747
			(1.557964)	(1.366103)
CED x FS				-0.558858***
				(0.154650)
Observations	60	60	60	60
R^2	0.589563	0.607496	0.609717	0.711530
Adj. R^2	0.394605	0.406212	0.394035	0.540007
F-statistic	3.024056	3.018103	2.826919	4.148313
Prob(F-statistic)	0.001585	0.001545	0.002607	0.000070

**** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$. Standard error is shown in parentheses.*

Source: data processed by authors (2026)