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Do Firms Benefit More from Eco-Innovation than ESG Disclosure?

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Abstract

Research Originality: This study offers novelty by distinguishing the financial effects of substantive environmental actions (eco-innovation) from symbolic sustainability reporting (ESG disclosure) and examining the moderating role of firm size.

Research Objectives: This study investigates the direct effects of eco-innovation and ESG disclosure on firm performance and examines whether firm size moderates these relationships.

Research Method: The study used data on 236 high environmental-risk firms from 2018 to 2025, yielding 1,158 observations. We employed the High-Dimensional Fixed Effects (HDFE) estimator with industry and year fixed effects and firm-level clustered standard errors.

Empirical Results: Eco-innovation significantly enhances firm performance, whereas ESG disclosure exhibits no significant effect. Furthermore, firm size negatively moderates the relationship between eco-innovation and firm performance.

Implications: These findings imply that firms should prioritize eco-innovation over ESG disclosure alone, while policymakers should provide stronger financial incentives to support their sustainability transition, especially for smaller firms.

Keywords:

environmental economics; sustainability reporting; firm performance; resource-based view; emerging market.

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INTRODUCTION

As climate change intensifies and sustainability gains prominence, a transition to a green economy has become a key priority in global business strategies. Moreover, stakeholders, especially institutional investors and regulators, have demanded that firms be more accountable for the environmental and social consequences of their operational activities (Rau & Yu, 2024; Wang, 2025). The pressures are stronger for firms in the energy and basic materials sectors, where operations have a relatively direct impact on the environment. These sectors rely heavily on natural resource extraction and carbon-intensive production processes. Consequently, they are major sources of greenhouse gas emissions and the primary candidates for environmental policy instruments such as carbon taxes, regulations on total emissions, or restoration liabilities at the end of operations. These regulatory requirements further increase cost pressures, as Indonesia will implement a carbon tax under Law No. 7 of 2021 on the Harmonization of Tax Regulations (HPP Law), which encourages firms to shift to cleaner energy and less carbon-intensive production processes (Rokhmawati et al., 2024).

In response to these growing regulatory and stakeholder pressures, firms have increasingly incorporated ESG disclosure into their sustainability initiatives to communicate environmental responsibility, address stakeholder expectations, and comply with evolving regulatory requirements (Khamisu & Paluri, 2024). However, the financial implications of ESG disclosure remain subject to considerable academic debate. Some studies suggest that ESG disclosure reduces information asymmetry, enhances corporate transparency, improves stakeholder trust, and results in better firm performance (Alsayegh et al., 2020; Maji & Lohia, 2023), whereas other studies report a negative or insignificant impact (Firmansyah et al., 2023; Machmuddah et al., 2025). Based on the greenwashing hypothesis or the concept of '*cheap talk*', Treepongkaruna et al. (2024) argue that firms may formally communicate sustainability commitments while failing to implement corresponding operational changes, thereby resulting in symbolic compliance or greenwashing. Consequently, ESG disclosure alone may not accurately capture a firm's actual environmental commitment or its capacity to improve long-term firm performance (Biju et al., 2025). Therefore, this limitation highlights the need for firms to complement ESG disclosure with substantive environmental actions that translate sustainability commitments into tangible operational improvements, such as eco-innovation.

Eco-innovation is increasingly adopted as an adaptive strategy to enhance long-term firm performance and operational resilience (Mansour et al., 2024). However, whether implementing eco-innovation actually translates into improved firm performance remains widely debated in the academic literature. On the one hand, García-Sánchez et al. (2020, 2023) and López Pérez et al. (2024) emphasize that substantial investments in environmental innovation can constrain operating performance, particularly in the initial stages, by extending the return-on-investment period and raising shareholder concerns. On the other hand, from the perspective of the natural resource-based view (NRBV), the adoption of green technologies can reduce carbon emission intensity (Huang et al., 2026), alleviate the financial burden associated with environmental policies such as carbon taxation, and

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improve operational efficiency, particularly in developing countries (Rokhmawati et al., 2024). Accordingly, eco-innovation can strengthen competitive advantage and organizational legitimacy through substantive commitments to sustainability (Khan et al., 2021). These divergent perspectives suggest that eco-innovation does not automatically translate into improved firm performance, as its economic benefits depend on a firm's ability to convert environmental investments into operational efficiencies and performance improvements.

Firm size may explain variation in the effect of eco-innovation on firm performance, as resource capacity determines firms' ability to absorb the costs and risks associated with environmental innovation (López Pérez et al., 2024). Larger firms generally possess greater financial and human resources, stronger innovation capabilities, and higher visibility among stakeholders (Mansour et al., 2024). However, greater resource availability does not necessarily imply that larger firms achieve proportionally greater performance gains from eco-innovation than smaller firms. Lin et al. (2019) argue that smaller firms may derive greater financial benefits from green investments because they are more flexible and less constrained by organizational bureaucracy. In addition, smaller firms typically exhibit greater and faster growth potential than more mature firms (Garcia-Martinez et al., 2023), enabling innovation investments to translate into performance improvements more quickly. Thus, the evidence regarding the role of firm size remains inconclusive, requiring further investigation and offering an opportunity to extend the theoretical understanding of the conditions under which eco-innovation generates firm performance.

Although eco-innovation and ESG disclosure have been extensively examined, prior studies have generally examined them separately or as alternative proxies for sustainability performance (Firmansyah et al., 2023; Lin et al., 2019; Maji & Lohia, 2023; Mansour et al., 2024; Shuwaikh et al., 2023; Soesetio et al., 2024), implicitly representing them as the same measure of environmental commitment. Conceptually, however, these two dimensions are distinct. ESG disclosure primarily represents the external communication of sustainability information (Maji & Lohia, 2023), whereas eco-innovation reflects substantive investments and operational changes to improve environmental performance (Mansour et al., 2024). Comparative evidence on whether substantive environmental action through eco-innovation generates different firm performance from sustainability communication through ESG disclosure remains limited, particularly in high environmental risk sectors. Moreover, the moderating role of firm size in the relationship between eco-innovation and firm performance has received limited attention. These limitations constitute an important research gap, as it remains unclear whether firms operating in high environmental risk sectors derive greater benefits from substantive eco-innovation or from ESG disclosure. It is likewise unclear whether the effects of eco-innovation on firm performance vary across firms of different sizes.

To address these gaps, this study investigates the effects of eco-innovation and ESG disclosure on firm performance. It examines the moderating role of firm size in the relationship between eco-innovation and firm performance in high-environmental-risk sectors. The study contributes to the sustainability and corporate finance literature in two main respects. First, it provides novel empirical evidence from an emerging

market context by examining the effects of eco-innovation and ESG disclosure on firm performance within a unified empirical framework. This approach offers clearer, more robust evidence on whether firms in high-environmental-risk sectors derive greater benefits from eco-innovation or ESG disclosure. Second, it incorporates firm size as a moderating variable, thereby extending the understanding of how firm-level characteristics shape the financial consequences of eco-innovation. By integrating these dimensions, the study provides deeper insights into the conditions under which different sustainability strategies are associated with firm performance in high-environmental-risk sectors.

This study has two important practical implications. First, it offers important implications for firm managers and investors to engage beneficially with sustainability strategies, since eco-innovation and ESG disclosure have differential impacts on firm performance in the energy and basic materials sectors. Second, it provides useful implications for policymakers and regulatory authorities in designing and implementing environmental policies, such as carbon taxation, to mitigate environmental externalities and enforce firm accountability, thereby accelerating the transition toward a green economy in Indonesia.

METHODS

This study employs a quantitative, empirical research design based on panel data from 2018 to 2025. The population comprised all firms officially listed on the Indonesian stock market (IDX), including 107 in the energy sector and 143 in the basic materials sector. This study used purposive sampling with strict inclusion and exclusion criteria to form the panel dataset. The sample was selected based on the availability of annual reports and sustainability reports during the study period. Accordingly, 4 firms in the energy sector and 9 firms from the basic materials sector were excluded. This process yielded a final sample of 120 firms across the two strategic sectors, which is also highly representative. This yielded 1,158 firm-year observations, which were used in the econometric analysis.

Before conducting the regression analysis, the dataset underwent classical assumption tests to assess normality (Skewness-Kurtosis test), multicollinearity, heteroskedasticity (Breusch-Pagan-Godfrey test), and autocorrelation (Wooldridge test). Subsequently, the Chow, Hausman, and Lagrange Multiplier (LM) tests (Table 1) determined the appropriate panel-data specification, with results consistently supporting the Fixed Effects Model (FEM). Based on this model-selection procedure, the study employs the High-Dimensional Fixed Effects (HDFE) estimator to absorb industry and year fixed effects simultaneously. HDFE is preferred to conventional FE because it provides a fast, reliable approach to linear regression with support for multiple fixed effects (Correia et al., 2020), making it particularly well suited to this study's design. Industry fixed effects account for differences in operating characteristics and regulatory exposure across industries, while year fixed effects capture macroeconomic and regulatory shocks that may affect firm performance over time. By absorbing these fixed effects, HDFE efficiently implements the selected FE specification without explicitly estimating a large number of industry- and year-specific dummy variables.

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Moderated regression analysis (MRA) was specified to examine the effects of eco-innovation (ECOI), ESG disclosure (ESG), and the control variables (BS, AGE, and RISK) on firm performance, proxied by Return on Assets (ROA) and Net Profit Margin (NPM). We also incorporated firm size (SIZE) as a moderating variable in the relationship between eco-innovation and firm performance, proxied by ROA and NPM.

Table 1. Chow, Hausman, and Lagrange-Multiplier Test

Model	Chow	Hausman	Lagrange-Multiplier	Conclusion
(1)	0.0000	0.0037	0.0000	FE
(2)	0.0000	0.0007	0.0000	FE
(3)	0.0000	0.0000	0.0000	FE
(4)	0.0000	0.0234	0.0000	FE
(5)	0.0000	0.0234	0.0000	FE
(6)	0.0000	0.0151	0.0000	FE

Note: *** indicates significance at the 1% level.

Table 2 presents the measurements and data sources for all variables used in this study. We evaluate moderating interaction effects using moderated regression analysis (MRA).

$$Y_{i,t} = \alpha_{i,t} + \beta_1 ECOI_{i,t} + \beta_2 ESG_{i,t} + \sum \gamma\, Control_{i,t} + Industry_i + Year_t + \varepsilon_{i,t} \quad (1)$$

$$Y_{i,t} = \alpha_{i,t} + \beta_1 ECOI_{i,t} + \beta_2 ESG_{i,t} + \beta_3 SIZE_{i,t} + \sum \gamma\, Control_{i,t} + Industry_i + Year_t + \varepsilon_{i,t} \quad (2)$$

$$Y_{i,t} = \alpha_{i,t} + \beta_1 ECOI_{i,t} + \beta_2 ESG_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 ECOIxSIZE_{i,t} + \sum \gamma\, Control_{i,t} + Industry_i + Year_t + \varepsilon_{i,t} \quad (3)$$

Where Y represents firm performance, proxied by ROA and NPM. $Control_{it}$ includes firm age (AGE) and firm risk (RISK).

Table 2. Variable Operationalization

Variable	Role	Symbol	Measurement	Reference
Firm performance	Dependent	ROA	Earnings After Tax (EAT) / Total Assets	(Soesetio et al., 2024)
Firm performance	Dependent	NPM	Earnings After Tax (EAT) / Sales	(Soesetio et al., 2024)
Eco-innovation	Independent	ECOI	Dummy variable: valued at 1 if the firm has ISO 14001 certification, and 0 if it does not	(Mansour et al., 2024)
ESG Disclosure	Independent	ESG	Total score from all ESG disclosure indicators (112 items)	(Soesetio et al., 2024)
Firm Size	Moderator	SIZE	Natural Logarithm (Ln) of total firm assets	(Mansour et al., 2024)
Board Size	Control	BS	Total number of members on the board of directors	(Allodi et al., 2025)
Age	Control	AGE	Year of observation - the year of firm incorporation	(Mansour et al., 2024)
Risk	Control	RISK	Total Debt / Total Assets	(Mansour et al., 2024)

RESULTS AND DISCUSSION

The findings indicate that eco-innovation positively and significantly enhances firm performance, supporting the view that substantive environmental actions create economic value. In contrast, ESG disclosure shows no significant relationship with firm performance, suggesting that sustainability reporting alone may be insufficient to generate immediate financial benefits. Furthermore, firm size positively influences corporate performance. However, it weakens the positive effect of eco-innovation on firm performance, indicating that the financial returns from green innovation are more pronounced among smaller firms than larger firms. These findings provide preliminary evidence that substantive environmental actions and sustainability disclosure have different financial implications in high-environmental-risk industries.

Table 3. Descriptive Statistics

	Mean		Different test		Conclusion
	ISO 14001 certified	non-ISO 14001 certified	Mann Whitney U-test	Kruskal Wallis	
ROA	0.0744	0.0524	-2.726***	7.433***	Significant
NPM	0.0667	0.0187	-4.479***	20.057***	Significant
ESG	0.7224	0.6294	-9.736***	94.595***	Significant
BS	4.4978	3.5726	-10.009***	95.737***	Significant
RISK	0.4895	0.4695	-2.921***	8.531***	Significant
AGE	33.3423	29.1513	-4.505***	20.288***	Significant
SIZE	24.1057	25.4608	2.707***	7.327***	Significant

Note: *** indicates significance at the 1% level.

Table 3 presents summary statistics and non-parametric difference tests comparing ISO 14001-certified firms with non-certified firms for the variables included in this study. Tests on firm performance proxies suggest that ISO 14001-certified firms have significantly higher mean ROA and NPM, at 0.0744 and 0.0667, respectively. The Mann-Whitney U and Kruskal-Wallis tests strongly support the conclusion that ROA and NPM are significantly better at the $p < 0.01$ level. ESG disclosure is also significantly higher in ISO 14001-certified firms, with an average score of 0.7224. These findings empirically confirm that adherence to environmental certification standards is closely associated with higher firm performance and greater information availability in reporting.

Further analysis of governance and demographic variables confirms that the structural disparities between the two groups are statistically significant. We report that firms with environmental certification have more board structures, with a higher average number of directors (BS) of 4.4978 versus 3.5726 for their uncertified counterparts. From an organizational maturity perspective, ISO 14001-certified firms are, on average, more established, with a firm age (AGE) of 33.3423 years compared to 29.1513 years for non-certified firms. These differences in governance structure and operating history

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are significant at $p < 0.01$ based on non-parametric statistical tests. Although the average levels of financial risk exposure (RISK) differ only marginally in absolute terms (0.4895 vs. 0.4695), the non-parametric difference tests still identify this variation as significant at $p < 0.01$. The difference in firm size (SIZE) is also significant at $p < 0.01$, with ISO 14001-certified firms showing a lower mean value (24.1057) than non-certified firms (25.4608). Table 4 presents the pairwise correlations, none of which indicate evidence of multicollinearity among the variables.

Table 4. Correlation Matrix

	ECOI	ESG	BS	RISK	AGE	SIZE
ECOI	1.0000					
ESG	0.1720	1.0000				
BS	0.2468	0.1757	1.0000			
RISK	0.0240	-0.0353	-0.0423	1.0000		
AGE	0.1436	0.1806	0.2320	-0.0019	1.0000	
SIZE	-0.1598	0.1213	-0.0175	-0.0535	0.1702	1.0000

As reported in Table 5, eco-innovation exerted a positive and significant effect on firm performance across all baseline specifications. The positive effect of eco-innovation on firm performance indicates that environmental innovation contributes to firms' operational efficiency rather than merely fulfilling sustainability commitments. Investments in cleaner technologies, energy-efficient production processes, and resource optimization enable firms to reduce operating costs, improve resource utilization, and ease the financial burden of environmental regulations. These operational improvements are subsequently reflected in higher firm performance, as measured by ROA and NPM. Theoretically, this finding provides strong empirical support for the Natural Resource-Based View (NRBV), positioning eco-innovation as a valuable, rare, inimitable, and non-substitutable strategic asset that fosters long-term competitive advantage (Medina et al., 2022). Our results align closely with Benzidia et al. (2025), Helmina et al. (2022), and Mansour et al. (2024), who demonstrate that ISO 14001 adoption transforms internal operational routines into superior financial outcomes through waste elimination and structured risk management. By implementing eco-innovation activities, firms enhance overall performance and their green image while reducing production costs (Mansour et al., 2024). Accordingly, environmental innovations should not be viewed merely as cost burdens; rather, they can generate indirect economic benefits by reducing production costs and, consequently, improving economic performance (Yurdakul & Kazan, 2020). Additionally, eco-innovation helps firms address regulatory pressure associated with environmental compliance, create new market opportunities, and enhance the firm's green image, thereby strengthening its competitive advantage (Gu, 2023; Mansour et al., 2024).

In contrast to eco-innovation (ECOI), ESG disclosure exhibits a negative but mostly insignificant impact on firm performance in the short run, supporting Biju et al. (2025) and Firmansyah et al. (2023). As shown in Table 5 (column 2), the negative effect of

ESG disclosure is significant at $p < 0.1$ in only one ROA model and remains statistically insignificant across all NPM models. The insignificant relationship between ESG disclosure and firm performance suggests that sustainability reporting alone does not necessarily improve firm performance in the short term. ESG disclosure may enhance corporate transparency and demonstrate compliance with stakeholder expectations (Purwanti et al., 2026). However, ESG disclosure does not automatically improve operational efficiency or reduce production costs. Unlike ISO 14001 implementation, which primarily targets environmental efficiency and cost reduction, ESG disclosure merely becomes an administrative cost burden without providing real financial returns (Biju et al., 2025). Supporting activities such as corporate social responsibility (CSR) programs, governance enhancements, and sustainability audits and reporting significantly increase operational expenditures and compliance costs (Firmansyah et al., 2023). This creates a dilution effect, where efficiency gains from environmental initiatives are insufficient to offset the aggregate costs of ESG implementation and reporting. Particularly in emerging markets, limited internal capabilities often hinder firms from effectively integrating sustainability practices into their core operations. As a result, ESG disclosure often functions more as an instrument of external legitimacy than as a driver of internal efficiency (Li et al., 2024). ESG practices that are merely symbolic and not embedded in core operations (decoupled ESG) create administrative burdens and may undermine stakeholder relationships. This is because the effectiveness of sustainability initiatives depends critically on how deeply they are integrated into the firm's business strategy (Chen et al., 2025; Eliwa et al., 2026).

Table 5. Moderated Regression Analysis

	ROA			NPM		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ECOI	0.012***	0.016***	0.120***	0.016***	0.018***	0.089**
	(0.004)	(0.004)	(0.030)	(0.005)	(0.005)	(0.037)
ESG	-0.014	-0.018*	-0.014	-0.006	-0.005	-0.004
	(0.010)	(0.010)	(0.010)	(0.014)	(0.013)	(0.013)
BS	0.008***	0.008***	0.009***	0.015***	0.014***	0.015***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
AGE	-0.000***	-0.000***	-0.000***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RISK	-0.054***	-0.054***	-0.057***	-0.143***	-0.145***	-0.148***
	(0.007)	(0.007)	(0.007)	(0.010)	(0.010)	(0.009)
SIZE		0.003***	0.006***		0.001	0.003**
		(0.001)	(0.001)		(0.001)	(0.001)
ECOIxSIZE			-0.004***			-0.003**
			(0.001)			(0.001)
Constant	0.061***	-0.010	-0.090***	0.080***	0.064***	0.009
	(0.009)	(0.016)	(0.029)	(0.011)	(0.018)	(0.036)
R-square	0.160	0.185	0.198	0.388	0.392	0.399

Note: The symbols *, **, *** show significance at 10%, 5%, & 1%, respectively.

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For firm-specific determinants, SIZE positively affected firm performance. Larger firms are better positioned to benefit from economies of scale, which reduce unit production costs and improve operational efficiency (Ahmed et al., 2023; Fonseca et al., 2022). However, the moderation test results in Table 5 indicate a more complex dynamic: firm size weakens the positive influence of eco-innovation (ECOI) on firm performance. The negative moderating effect of firm size indicates that the performance gains from eco-innovation are more pronounced among smaller firms than among larger firms. Although large firms generally possess greater financial and technological resources to implement eco-innovation, they also tend to experience higher organizational complexity, longer decision-making processes, and greater coordination costs. This result contradicts Mansour et al. (2024), which found that firm size significantly strengthens the positive impact of eco-innovation on firm performance. Our empirical findings align with Lin et al. (2019) and Schrank & Kijkasiwat (2024), who demonstrate that corporate size functions as a contingency variable that moderates the green innovation-performance connection. Smaller firms are more motivated to differentiate themselves and enhance their visibility to attract external resources (Lin et al., 2019).

Table 6. Robustness Test using Lagged Eco-Innovation and ESG

VARIABLES	ROA	ROA	ROA	NPM	NPM	NPM
L.ECOI	0.010*	0.012**	0.020*	0.019***	0.017**	0.025**
	(0.006)	(0.006)	(0.011)	(0.007)	(0.007)	(0.011)
L.ESG	-0.030***	-0.033***	-0.032***	-0.011	-0.007	-0.007
	(0.011)	(0.011)	(0.011)	(0.016)	(0.016)	(0.016)
BS	0.006***	0.006***	0.006***	0.015***	0.015***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
AGE	-0.000	-0.000*	-0.000*	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
RISK	-0.050***	-0.049***	-0.050***	-0.144***	-0.145***	-0.145***
	(0.011)	(0.011)	(0.011)	(0.015)	(0.015)	(0.015)
SIZE		0.001	0.001		-0.002**	-0.001
		(0.001)	(0.001)		(0.001)	(0.001)
LECOIxSIZE			-0.000			-0.000
			(0.000)			(0.000)
Constant	0.073***	0.052***	0.046**	0.087***	0.122***	0.117***
	(0.012)	(0.020)	(0.021)	(0.015)	(0.021)	(0.023)
R-square	0.097	0.101	0.102	0.302	0.310	0.311

Note: The symbols *, **, *** show significant at 10%, 5%, & 1%, respectively.

Furthermore, smaller firms typically have stronger growth potential than mature firms (Garcia-Martinez et al., 2023), allowing innovation investments to translate more quickly into improved firm performance. In contrast, larger firms often face organizational inertia, bureaucratic complexity, and diminishing marginal returns to innovation investments,

reducing the incremental financial gains from additional eco-innovation initiatives. Consequently, while firm size contributes positively to firm performance in general, it also weakens the marginal financial benefits of eco-innovation.

The analysis of the control variable indicates that board size positively and significantly influences firm performance. This indicates that larger boards improve firm performance (Hyarat et al., 2024). Resource dependence theory posits that larger boards improve firm performance by providing extensive management know-how, organizational effectiveness, and other necessary resources (Alodat et al., 2022). Larger boards are associated with higher levels of board diversity in skills and experience, leading to improved oversight quality and effectiveness of strategic decisions (Danso et al., 2024). Financial risk (RISK), proxied by leverage, showed a negative and significant effect on firm performance. Higher debt levels are consistently associated with lower firm performance, as reflected in lower ROA and NPM (Maji & Lohia, 2023; Shuwaikh et al., 2023). Higher leverage increases fixed interest expenses and financial risk, thereby reducing a firm's ability to generate net income. According to trade-off theory, excessive leverage negates the benefits of the tax shield and increases the likelihood of financial distress and bankruptcy (Ahmed et al., 2023). Similarly, firm age (AGE) negatively affects firm performance. Profits tend to fall over time as firms age (Ahmed et al., 2023). Organizational complexities and reduced strategic flexibility lead to declining operational efficiency for long-established firms. Mature firms are especially prone to innovation stagnation and slower growth dynamics. Grounded in structural inertia theory, older organizations tend to become entrenched in structural rigidity, complex bureaucratic layers, and a heightened resistance to environmental change. This accumulation of structural inertia ultimately erodes the competitive agility of older firms relative to younger and more innovative firms, leading to a systematic decline in ROA as the firm progresses through its life cycle.

To address endogeneity, especially reverse causality bias, we conducted further testing using a lagged model specification, reported in Table 6. The findings indicate that eco-innovations in the prior period (L.ECOI) consistently positively affect firm performance. This carry-over effect indicates that measures to improve environmental efficiency implemented in earlier periods directly lead to better firm performance in later periods. Green innovation investments are inherently time-lagged, as significant financial returns emerge only after a certain period has passed (Oliveira et al., 2025). In addition, lagged ESG (L.ESG) demonstrates a negative and significant effect on ROA. Further interaction testing shows that corporate size (SIZE) did not moderate the relationship between eco-innovation (ECOI) and firm performance.

CONCLUSION

The findings indicate that eco-innovation significantly enhances firm performance compared with ESG disclosure. This result is consistent with the Natural Resource-Based View (NRBV), which suggests that substantive sustainability practices can improve operational efficiency and reduce costs. Furthermore, firm size negatively moderates the positive relationship between eco-innovation and firm performance. In larger firms,

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organizational complexity, lower procedural flexibility, and higher coordination costs may constrain the effectiveness of environmental innovation compared with smaller firms. Smaller firms tend to exhibit lower organizational inertia, enabling them to translate green investments into improvements in firm performance more effectively.

From a policy perspective, these findings emphasize the need for a more stringent and progressive paradigm shift in sustainability-oriented economic policies, particularly in industries with high environmental risks. As ESG disclosure requirements alone may encourage symbolic reporting (decoupling) without generating substantial financial benefits, capital market regulators should move beyond disclosure-based requirements by mandating greater transparency regarding the substantive implementation of sustainable practices and imposing appropriate penalties for non-compliance. Governments should also provide stronger financial incentives to support firms' sustainability transitions, including subsidies for green technology investment, tax deductions, and preferential access to green financing, particularly for smaller firms. Finally, governments and independent institutions should establish periodic sustainability assessment and ranking systems, complemented by recognition and award programs for firms demonstrating outstanding commitment to green economy initiatives.

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