

ESG, environmental innovation, and corporate profitability: Evidence of direct and lagged effects from Indonesia

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ABSTRACT

This study investigates whether environmental innovation serves as a mechanism through which ESG performance influences corporate profitability in an emerging market context. While prior studies showed a direct association between ESG and firm performance, evidence on the mediating role of environmental innovation remains limited, particularly in Indonesia. Using panel data from all non-financial firms listed on the Indonesia Stock Exchange during 2012-2023, this study employs fixed-effects regression, mediation analysis, and lagged-effect testing. ESG performance is measured by ESG scores, environmental innovation is proxied by environmental innovation scores, and profitability is assessed using return on assets (ROA) and return on equity (ROE). The results indicate that ESG performance positively affects both environmental innovation and profitability. Environmental innovation significantly improves ROE and shows a weaker contemporaneous effect on ROA, while lagged analyses show positive impacts on both profitability measures. The findings extend the ESG-performance literature by demonstrating that environmental innovation acts as a transmission mechanism through which ESG performance generates financial benefits over time in an emerging market setting. For managers and policymakers, the results underscore the importance of aligning ESG initiatives with environmental innovation strategies and supportive regulatory incentives to enhance long-term profitability and sustainable value creation.

Keywords: Corporate profitability, Emerging markets, Environmental innovation, ESG performance, Mediation analysis, Sustainability

JEL Classification: G32, M14, O31

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1. Introduction

Over the past two decades, global economic growth has increasingly been challenged by sustainability demands, including climate change, pollution, deforestation, biodiversity loss, and environmental degradation. These challenges have driven firms to move beyond profit maximization and adopt sustainable business practices to preserve ecosystem stability, support climate adaptation, and ensure long-term socio-economic welfare (Pörtner et al., 2023). In response, Environmental, Social, and Governance (ESG) has emerged as a widely used framework for evaluating corporate sustainability performance, enabling stakeholders to assess firms' environmental risk management, social responsibility, and governance quality. In Indonesia, ESG adoption has been reinforced by regulatory initiatives such as OJK Regulation No. 51/POJK.03/2017 and Surat Edaran No. 16/SEOJK.04/2021 mandating sustainability reporting, alongside the adoption of GRI, IFRS S1 and S2, and national sustainability standards (Ikatan Akuntan Indonesia, 2025).

However, ESG implementation remains uneven across sectors, suggesting that disclosure alone is insufficient without substantive sustainability actions. ESG performance is typically measured using ESG scores, which provide standardized and objective indicators of sustainability commitment and are increasingly used to attract sustainable investment (Li et al., 2021). Besides, Indonesia faces escalating environmental challenges, including high greenhouse gas emissions, deforestation, air pollution, plastic waste, and increasingly frequent extreme climate events. Indonesia is the world's sixth-largest emitter of greenhouse gases (Pristiandaru, 2024), consequently placing Indonesian companies under increasing scrutiny from international investors and global regulators, who are becoming more stringent in their expectations regarding carbon emissions. As a follow-up, Indonesia is committed to reduce emissions by 31.89-43.20 percent by 2030 and achieve net zero emissions by 2060 (Limanseto, 2022).

These conditions highlight the strategic importance of environmental innovation as a mechanism to integrate sustainability commitments into operational practices, such as cleaner technologies, energy efficiency, waste reduction, and sustainable business models. The various environmental data above indicate that environmental damage is a social issue and carries direct consequences for business sustainability. Thus, it creates pressure on companies to prove their sustainability commitment.

However, environmental innovation represents a strategic concept and effort to develop eco-friendly products, processes, or technologies that can transform costs into competitive advantages and improve efficiency over time, although it does not emerge spontaneously. Prior studies show that ESG practices can stimulate environmental innovation by strengthening corporate commitment, resource allocation, improving governance quality, and easing financial limitations (Wu et al., 2024). In contrast, other studies argue that ESG may hinder innovation due to high implementation costs and resource limitations, particularly in emerging markets where firms face institutional and financial constraints (Zhu et al., 2024). This divergence suggests that ESG driven environmental innovation may vary across contexts, depending on firms' capability and the institutional environment.

Profitability, commonly measured by Return on Assets (ROA) and Return on Equity (ROE), represents a critical indicator of whether sustainability investments translate into economic value (Aydoğmuş et al., 2022). However, prior empirical findings on the ESG-profitability relationship remain uncertain, some studies found that ESG practices may enhance profitability through reputational gains, risk reduction, and investor confidence (Ali et al., 2025). Also, particularly in emerging markets, ESG adoption is often limited by high costs, inadequate regulatory enforcement, delayed financial returns, and insufficient innovation capacity, consequently raising concerns that ESG may remain symbolic or devolve into greenwashing without substantive innovation.

Similarly, evidence on the profitability effects of environmental innovation is mixed. Some studies find that environmental innovation positively affects profitability (ROA) by reducing costs, improving operational efficiency, strengthening market position, and enhancing corporate reputation among investors (Akuma et al., 2025). However, its implementation often requires substantial upfront investment and may provide delayed financial returns (Batool et al., 2025). These findings indicate that the profitability effects of environmental innovation may depend on time horizons and firms' ability to absorb innovation-related costs. With these growing insights, several important research gaps remain.

The growing body of literature on ESG and firm performance shows an important gap remains in understanding the mechanisms through which ESG practices generate economic value. Existing studies have predominantly focused on the direct relationship between ESG performance and financial outcomes, providing limited insight into the processes that translate sustainability commitments into profitability. In essence, environmental innovation has received relatively little attention as a mediating mechanism linking ESG performance to corporate profitability. Addressing this mechanism gap constitutes the primary contribution of the present study.

Moreover, empirical evidence on the ESG-profitability relationship remains inconclusive in emerging economies, where institutional support, regulatory enforcement, and firms' innovation capabilities differ substantially from those in developed markets (Ruan & Liu, 2021). Indonesia provides a relevant setting to examine whether ESG-driven environmental innovation contributes to profitability under such conditions. Consequently, the financial benefits of sustainability investments may emerge only after a period of implementation, this study also explores potential lagged effects of ESG performance and environmental innovation on profitability. These context-specific and temporal analyses serve as complementary contributions that enrich understanding of the ESG-profitability relationship.

This study also differs from prior research in several important ways. First, the ESG-profitability literature has primarily examined whether ESG performance directly improves financial outcomes, producing mixed findings regarding the economic benefits of sustainability practices (Ali et al., 2025). Second, the ESG-innovation literature has largely focused on whether ESG initiatives stimulate innovation activities, with less attention given to whether such innovation ultimately translates into superior financial performance (Wu et al., 2024). Third, mediation approaches have increasingly been adopted in ESG research, yet prior studies have predominantly examined channels such as corporate reputation, governance quality, financing constraints, or stakeholder engagement, while environmental innovation remains relatively underexplored as a value-creation mechanism. By integrating these three streams of literature, this study investigates whether environmental innovation serves as the transmission mechanism through which ESG performance generates profitability and whether such effects materialize over time. Consequently, this study contributes not only by identifying a mediating pathway but also by connecting the ESG-profitability and ESG-innovation literatures within the context of an emerging economy.

Taken together, this study integrates Stakeholder Theory (Freeman, 1984) and Legitimacy Theory (Dowling & Pfeffer, 1975) to explain how ESG performance can be translated into corporate profitability through environmental innovation. These theories are complementary because they capture two interrelated sources of pressure that drive firms toward sustainability-oriented actions. Stakeholder Theory explains how firms respond to the expectations of investors, customers, employees, regulators, and communities by adopting ESG practices that strengthen trust, access to resources, and long-term competitiveness (Hörisch et al., 2014). However, stakeholders increasingly demand not only sustainability disclosure but also tangible environmental improvements.

Legitimacy Theory complements this perspective by explaining how firms seek to maintain alignment with broader societal norms, environmental regulations, and sustainability expectations to secure their social license to operate (Alsayegh et al., 2020). While Stakeholder Theory emphasizes pressures from specific stakeholder groups, Legitimacy Theory focuses on conformity with wider societal expectations. Together, these pressures encourage firms to move beyond symbolic ESG disclosure and implement substantive sustainability initiatives.

Environmental innovation represents the strategic mechanism through which stakeholder and legitimacy pressures are translated into operations. Firms seeking to fulfill stakeholder demands and maintain legitimacy are more likely to invest in cleaner technologies, energy-efficient processes, waste reduction initiatives, and environmentally friendly products. These innovations can improve resource efficiency, reduce operational costs, strengthen corporate reputation, and ultimately enhance profitability. Accordingly, environmental innovation is theorized not merely as an outcome of ESG performance but as the mechanism through which stakeholder and legitimacy pressures are transformed into financial value.

Overall, amid rising global pressure from investor demands, international sustainability standards, and intensifying market competition, Indonesian firms can no longer rely solely on disclosure but must demonstrate innovation-driven practices. Therefore, our study examines the role of environmental innovation as a mediating mechanism linking ESG performance and corporate profitability in Indonesian listed firms. The primary objective is to explain how ESG performance is translated into financial outcomes through environmental innovation. By examining Indonesian listed firms and incorporating lagged-effect analysis, this study further provides evidence from an emerging economy and captures the potential delayed realization of sustainability-related financial benefits. Thereby, the study contributes to the ESG literature by clarifying the mechanism through which ESG creates economic value while extending existing evidence on contextual and temporal dimensions of ESG outcomes.

2. Hypotheses Development

The Effect of ESG on Environmental Innovation

ESG performance serves as a signal of a firm's commitment to pressing environmental issues. High ESG scores are interpreted by the market as indicators of positive long-term prospects, driving internal incentives for innovations. Tan & Zhu (2022) explain that ESG positively influences environmental innovation because strong ESG performance enhances environmental awareness and signals favorable development prospects, increasing market interest and reflecting management commitment. In addition, strict environmental policies expose firms to governance and non-governance pressures—such as reputational scrutiny, monitoring, and litigation—encouraging greener governance practices. Moreover, ESG performance is not limited to passive reporting, but as an active driver of environmental innovation that strengthens long-term competitiveness.

H₁: ESG has a positive effect on environmental innovation.

The Effect of Environmental Innovation on Profitability

Environmental innovation is widely recognized as a key factor in achieving sustainability and competitive advantage, with growing literature examining its financial implications. Akuma et al. (2025) note that firms adopting sustainable practices benefit from cost savings, operational efficiency,

stronger market positioning, regulatory advantages, and improved risk management, all contributing to profitability. Prior studies also find environmental innovation positively affects both economic performance and cost performance (Tomeo & Mastrostefano, 2024). Therefore, environmental innovation represents not only an ethical commitment but also a strategic business decision that directly enhances profitability through improved reputation, customer loyalty, operational efficiency, product quality, investor attraction, and regulatory compliance.

H₂: Environmental innovation has a positive effect on return on assets (ROA).

H₃: Environmental innovation has a positive effect on return on equity (ROE).

The Effect of ESG on Profitability

ESG has gained increasing attention as sustainability and corporate social responsibility become central business concerns. Empirical studies consistently report a positive relationship between ESG and profitability (Ali et al., 2025; Aydoğmuş et al., 2022; Dalal & Thaker, 2019). Strong ESG performance reduces information asymmetry, enhances reputation, improves internal efficiency, and may attract regulatory incentives such as sustainability-related tax benefits. Thus, ESG engagement is not only ethically desirable but also financially beneficial.

H₄: ESG has a positive effect on return on assets (ROA).

H₅: ESG has a positive effect on return on equity (ROE).

The Mediating Role of Environmental Innovation in the ESG-Profitability Relationship

The relationship between ESG and profitability often occurs indirectly through internal mechanisms that generate long-term economic value. Prior studies confirm environmental innovation as a mechanism linking ESG and financial performance (Chouaibi et al., 2022; De Lucia et al., 2020; Doni & Fiameni, 2024). Environmental innovation enhances cost efficiency, competitiveness, revenue opportunities, and long-term advantages, improving both ROA and ROE (Tomeo & Mastrostefano, 2024). Therefore, ESG contributes to profitability through disclosure and driving environmental innovation that generates financial outcomes.

H₆: Environmental innovation mediates the relationship between ESG and return on assets (ROA).

H₇: Environmental innovation mediates the relationship between ESG and return on equity (ROE).

3. Methodology

Table 1. Sample Construction

Sample Selection Criteria	Unique firms	Observation
All non-financial firms listed on the Indonesia Stock Exchange during 2012–2023 (a) and sectors industries represented (b)	a. 914 b. 9	13,710
Less: Firms without complete ESG data	(820)	(13,022)
Less: Firms with incomplete data for other study variables	(31)	(313)
Final	63	375

This study investigates the relationships between the independent variable (ESG), the mediating variable (environmental innovation), and the dependent variable (profitability), measured by Return on Assets (ROA) and Return on Equity (ROE). Moreover, the population for this study consists of all

non-financial firms listed on the Indonesia Stock Exchange (IDX) that disclosed ESG data during the period 2012 – 2023. Financial firms are excluded due to their distinct regulatory environment, capital structure, and financial characteristics. A multi-sector approach is employed to capture heterogeneity in ESG implementation and environmental innovation across industries, thereby enhancing external validity and generalizability.

Table 2. The operationalization of variables

Variable	Measurement
Dependent Variable	
Profitability	$\frac{\text{Net Income After Tax}}{\text{Total Assets}}$ $\frac{\text{Net Income After Tax}}{\text{Total Equity}}$ (Aydoğmuş et al., 2022; Cerciello et al., 2023)
Independent Variable	
ESG scores	ESG performance is measured using ESG scores as standardized indicators of sustainability commitment (Li et al., 2021). This study uses data from Refinitiv Eikon, which provides composite ESG scores from 0 to 100 across environmental, social, and governance pillars based on publicly disclosed information (Clément et al., 2022).
Mediating Variable	
Environmental Innovation	Proxied by the Environmental Innovation Score from Refinitiv Eikon, which ranges from 0 to 100 and is calculated based on transparency weights and industry quantitative median. The score reflects weighted environmental innovation indicators within the environmental (E) pillar, including environmental expenditures, eco-friendly products, renewable energy, and recyclable design (Albitar et al., 2023).
Control Variable	
Leverage	$\frac{\text{Total Liabilities}}{\text{Total Equity}}$
Board Size	$\text{Ln}(\text{Total Directors})$
Board Gender	$\frac{\text{Number of Female Directors}}{\text{Total Directors}}$
Financial Transparency	$\frac{(\Delta \text{Total Current Assets} + \Delta \text{Total Short-term Liabilities} + \Delta \text{Cash and equivalents} - \Delta \text{Long Term Liabilities} + \text{Depreciation and Amortization} + \Delta \text{Tax Payable})}{\text{Total Assets of the Previous Year}}$
Asset to Income Ratio	$\frac{\text{Total Assets}}{\text{Net Income Before Tax}}$ (Đặng et al., 2020; Sastroredjo et al., 2025)

An unbalanced panel data model is utilized to investigate differences in ESG score availability across firms and years. The criteria for the sample consist of (1) non-financial firms continuously listed on the IDX during the observation period; (2) Availability of ESG scores, audited financial statements, annual reports, and sustainability reports; and (3) Reporting periods ending in December. As a result, 375 firm-year observations were obtained.

The ESG data is collected from Refinitiv Eikon. The financial data, such as audited financial statements, annual reports, and sustainability reports, are obtained from the IDX and official company websites (Sekaran & Bougie, 2016). Panel data regression is conducted with a mediation framework. Further analysis is conducted using Python as a language programming, specifically the Panel OLS

function from the linear models library. To address potential econometric issues, robust standard errors is applied to correct heteroskedasticity. In addition, the mediation effect of environmental innovation is tested using the Sobel test, which evaluates the significance of indirect effects (Falk & Biesanz, 2016). Fixed-effects models are employed to control unobserved firm-specific heterogeneity. Moreover, lagged effect analysis is further conducted to capture the delayed financial impacts of environmental innovation. The regression equations are Eq. 1 and Eq. 2.

$$\text{PROF (ROA)} = \alpha + \beta_1\text{ESG} + \beta_2\text{ENV}_{\text{INNOV}} + \beta_3\text{LEV} + \beta_4\text{BOD}_{\text{SIZE}} + \beta_5\text{BOD}_{\text{GENDER}} + \beta_6\text{FFIN} + \beta_7\text{AIN} + \beta_8\text{Year} + \beta_9\text{Industry} + \varepsilon \quad (\text{Eq. 1})$$

$$\text{PROF (ROE)} = \alpha + \beta_1\text{ESG} + \beta_2\text{ENV}_{\text{INNOV}} + \beta_3\text{LEV} + \beta_4\text{BOD}_{\text{SIZE}} + \beta_5\text{BOD}_{\text{GENDER}} + \beta_6\text{FFIN} + \beta_7\text{AIN} + \beta_8\text{Year} + \beta_9\text{Industry} + \varepsilon \quad (\text{Eq. 2})$$

Where:

PROF (ROA) = Profitability (measured using Return on Assets); PROF (ROE) = Profitability (measured using Return on Equity); α = Constant; β = Regression Coefficient; ESG = Environmental, Social, and Governance Performance Score; $\text{ENV}_{\text{INNOV}}$ = Environmental Innovation Score; LEV = Leverage (measured using Debt to Equity Ratio); BOD_{SIZE} = Board Size; $\text{BOD}_{\text{GENDER}}$ = Board Gender; FFIN = Financial Transparency; AIN = Asset to Income Ratio; Year = a set of year dummies; Industry = for the industrial sector dummy; and ε = Error.

4. Results

Table 3 displays the descriptive statistics. Overall, ESG adoption among Indonesian firms is moderate but uneven, indicating early-stage environmental innovation and wide disparities in operational and shareholder performance.

Table 3. Descriptive statistics

Variable	N	Mean	Deviation Std.	Min	Max
ESG	375	46.812	19.604	8.162	88.880
ENV_INNOV	375	19.169	28.573	0.000	94.643
ROA	375	8.562	11.603	-93.650	72.160
ROE	375	17.281	31.732	-133.954	221.103
LEV	375	0.238	0.183	0.000	0.811
BOD_SIZE	375	6.021	2.457	2.000	21.000
BOD_GENDER	375	10.110	13.458	0.000	75.000
FFIN	375	0.058	0.238	-0.824	1.578
AIN	375	1.336	137.293	-2157.670	239.053

Source: Data processed (2025)

Hypothesis Testing 1

Based on Table 4, the regression results reveal a consistent and robust relationship among ESG performance, environmental innovation, and firm profitability measured by ROA. In Model 1, ESG performance has a positive and highly significant effect on environmental innovation ($\beta = 0.56$, $p < 0.01$), indicating that higher ESG scores strongly encourage firms to engage in environmental innovation,

with the model explaining 17.7 percent of the variation in ENV_INNOV and being significant. Model 2 shows ENV_INNOV has a positive but relatively weak effect on ROA ($\beta = 0.039$, $p < 0.1$) suggesting that environmental innovation contributes to profitability. Model 3 further confirms that ESG has a strong and direct positive effect on ROA ($\beta = 0.175$, $p < 0.01$), highlighting the value relevance of ESG practices in improving firms' asset efficiency. However, Model 4 demonstrates that ENV_INNOV did not mediate the ESG-ROA relationship, as ENV_INNOV becomes insignificant ($\beta = 0.004$, $p > 0.1$), indicating that the impact of ESG on ROA is predominantly direct in the short run.

Particularly, Model 5 uncovers a dynamic mediation effect, where current environmental innovation negatively affects ROA ($\beta = -0.124$, $p < 0.1$), while its one-period lag (ENV_INNOV_LAG1) positively and significantly influences profitability ($\beta = 0.136$, $p < 0.05$), implying that the financial benefits of ESG-driven environmental innovation materialize over time rather than immediately. Overall, these findings emphasize that ESG enhances firm profitability both directly and indirectly through delayed environmental innovation, underscoring the importance of a long-term perspective in sustainability-driven value creation.

Table 4. Regression results 1

	Y = ENV_INNOV	Y = ROA	Y = ROA	Y = ROA	Y = ROA
	(1)	(2)	(3)	(4)	(5)
Variable	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)
ESG	0.560*** (0.086)		0.175*** (0.036)	0.172*** (0.039)	0.181*** (0.050)
ENV_INNOV		0.039* (0.024)		0.004 (0.025)	-0.124* (0.082)
ENV_INNOV_LAG1					0.136** (0.075)
LEV	16.713** (9.680)	-18.329*** (5.465)	-12.979** (5.665)	-13.054** (5.928)	-13.633** (6.887)
BOD_SIZE	0.224 (0.619)	-0.297 (0.267)	-0.705** (0.348)	-0.706** (0.347)	-0.467 (0.375)
BOD_GENDER	-0.031 (0.106)	0.094** (0.049)	0.096** (0.048)	0.096** (0.048)	0.109** (0.056)
FFIN	-0.910 (5.580)	9.606** (4.542)	9.884** (4.426)	9.888** (4.425)	5.523* (3.404)
AIN	-0.003 (0.008)	0.002 (0.003)	0.003 (0.004)	0.003 (0.004)	0.003 (0.004)
Time dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.177	0.216	0.295	0.293	0.304
Observations	375	375	375	375	312
F-statistic	7.475***	9.988***	13.591***	12.515***	9.547***

Notes: Hypotheses are tested using one-tailed tests. The values in parentheses represent the standard error. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Profitability using ROA. (1) = the effect of ESG on Environmental Innovation, (2) = the effect of Environmental Innovation on profitability (ROA), (3) = the effect of ESG on profitability (ROA), (4) = the full model that includes both ESG and Environmental Innovation simultaneously to assess whether Environmental Innovation mediates the relationship between ESG and profitability (ROA), (5) = the extended full model that incorporates lagged Environmental Innovation (one-period lag) to evaluate whether the mediating effect occurs with a delay (delayed mediation effect) on profitability (ROA).

Sobel Test 1

Moreover, in Table 5, the Sobel test indicates that environmental innovation weakly mediates the relationship between ESG performance and ROA at the 10 percent significance level.

Table 5. Sobel test 1

Coefficient a (ESG to ENV_INNOV)	0.560
Standard Error a	0.086
Coefficient b (ENV_INNOV to PROF (ROA))	0.039
Standard Error b	0.024
Sobel Z-Value	1.577
P-Value (one-tailed)	0.057
Conclusion	Sig. (* p < 0,1)

Hypothesis Testing 2

The regression results, as shown in Table 6, indicate a consistent and robust relationship among ESG performance, environmental innovation, and firm profitability measured by ROE. Model 1 shows that ESG performance has a positive and highly significant effect on environmental innovation ($\beta = 0.56$, $p < 0.01$) indicating that higher ESG scores substantially encourage firms to engage in environmental innovation. Model 2 demonstrates that environmental innovation positively and significantly improves ROE ($\beta = 0.243$, $p < 0.01$) suggesting that environmentally innovative firms generate higher returns for shareholders. Model 3 further confirms that ESG directly enhances ROE ($\beta = 0.636$, $p < 0.01$), supporting the value-relevance of ESG practices. Model 4 reveals that environmental innovation partially mediates the ESG-ROE relationship, as both ESG ($\beta = 0.564$, $p < 0.01$) and ENV_INNOV ($\beta = 0.128$, $p < 0.05$) remain significant. Model 5 highlights a dynamic effect, where lagged environmental innovation (ENV_INNOV_LAG1) positively mediates the ESG-ROE relationship ($\beta = 0.251$, $p < 0.05$) while environmental innovation is insignificant, implying that the financial benefits of ESG-driven environmental innovation materialize over time.

Related to the economic benefit, following the prior studies of [Saastroedjo & Suganda \(2026\)](#) and [Suganda & Kim \(2023\)](#), this study found that while holding everything else constant, a one standard deviation increase in ESG performance generates a 10.978-unit improvement in firm performance (profitability) through environmental innovation (indirect effect, from the mediation path). It is derived from 0.560 (ESG coefficient to ENV_INNOV) $\times$ 0.243 (ENV_INNOV coefficient to ROE) $\times$ 19.604 (ESG standard deviation) / 17.281 (Mean ROE) = 0.154 , equivalent to a 15.44 percent increase relative to average ROE. This indicates that although environmental innovation shows a statistically significant but relatively weak mediating role in the ESG–ROA relationship, suggesting that ESG-driven innovation has started to influence operational performance but with limited short-term accounting impact, the indirect pathway becomes much more economically meaningful when performance is viewed through ROE, which better captures investor expectations. The 15.44 percent indirect economic benefit indicates that a measurable share of ESG’s contribution to shareholder returns occurs specifically through environmental innovation as a transmission channel. This 15.44 percent reflects the financial return generated when firms translate ESG commitments into cleaner technology, efficiency improvements, and tangible environmental solutions.

Therefore, ESG does not create value only through reputation, disclosure quality, or governance improvements, but also through real operational and technological transformation. From a capital market perspective, this suggests that investors are able to recognize and price not just ESG signals,

but also the long-term competitive advantage embedded in innovation activities. While smaller than the direct ESG effect, this portion represents value that would not exist without innovation investment, meaning environmental innovation acts as a strategic amplifier that strengthens the pathway from sustainability performance to equity profitability. Further confirms that ESG becomes economically more powerful when it is operationalized rather than merely disclosed.

Table 6. Regression results 2

	Y = ENV_INNOV	Y = ROE	Y = ROE	Y = ROE	Y = ROE
	(1)	(2)	(3)	(4)	(5)
Variable	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)
ESG	0.560*** (0.086)		0.636*** (0.129)	0.564*** (0.119)	0.610*** (0.140)
ENV_INNOV		0.243*** (0.078)		0.128** (0.065)	-0.110 (0.127)
ENV_INNOV_LAG1					0.251** (0.139)
LEV	16.713** (9.680)	-9.101 (15.615)	10.342 (16.182)	8.196 (16.657)	8.811 (20.377)
BOD_SIZE	0.224 (0.619)	-0.850 (0.818)	-2.162** (1.093)	-2.191** (1.113)	-1.323 (1.184)
BOD_GENDER	-0.031 (0.106)	0.208** (0.121)	0.210** (0.114)	0.214** (0.113)	0.262** (0.135)
FFIN	-0.910 (5.580)	13.108* (9.796)	13.916* (9.546)	14.032* (9.344)	6.077 (8.254)
AIN	-0.003 (0.008)	0.021*** (0.004)	0.021*** (0.004)	0.022*** (0.004)	0.024*** (0.004)
Time dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared	0.177	0.130	0.195	0.205	0.227
Observations	375	375	375	375	312
F-statistic	7.475***	8.682***	8.313***	8.145***	7.194***

Notes: Hypotheses are tested using one-tailed tests. The values in parentheses represent the standard error. *** p < 0.01, ** p < 0.05, * p < 0.1. Profitability using ROE. (1) = the effect of ESG on Environmental Innovation, (2) = the effect of Environmental Innovation on profitability (ROE), (3) = the effect of ESG on profitability (ROE), (4) = the full model that includes both ESG and Environmental Innovation simultaneously to assess whether Environmental Innovation mediates the relationship between ESG and profitability (ROE), (5) = the extended full model that incorporates lagged Environmental Innovation (one-period lag) to evaluate whether the mediating effect occurs with a delay (delayed mediation effect) on profitability (ROE).

Sobel Test 2

As presented in Table 7, Sobel Test 2 provides substantially stronger evidence than Sobel Test 1, indicating that ENV_INNOV serves as a strong and statistically significant mediator in the relationship between ESG and ROE, as reflected by a high Sobel Z-value of 2.810 with a one-tailed p-value of 0.002 (p < 0.01). This evidence is primarily driven by the sizable path coefficient from environmental innovation to ROE ($\beta = 0.243$), which is markedly larger than its effect on ROA, suggesting that environmental innovation not only results from ESG commitments but also contributes meaningfully

to shareholder returns. Unlike ROA, which is more sensitive to short-term asset efficiency, ROE better captures investor perceptions, managerial performance, and firms' ability to manage transition risks. Accordingly, environmental innovations such as clean technology adoption, emission reductions, and energy efficiency improvements are interpreted by capital markets as credible signals of effective risk management and long-term strategic orientation.

Table 7. Sobel test 2

Coefficient a (ESG to ENV_INNOV)	0.560
Standard Error a	0.086
Coefficient b (ENV_INNOV to PROF (ROE))	0.243
Standard Error b	0.078
Sobel Z-Value	2.810
P-Value (one-tailed)	0.002
Conclusion	Sig. (***) $p < 0,01$

Table 8. Bootstrap mediation analysis

Relationship	Indirect Effect	90% Confidence Interval	Conclusion
ESG → Environmental Innovation → ROA	0.0144	[-0.0129; 0.0614]	Not Significant
ESG → Environmental Innovation → ROE	0.1020	[-0.0180; 0.3298]	Not Significant

The bootstrap mediation analysis (Table 8) shows that the indirect effect of ESG on ROA through environmental innovation was 0.0144. However, the 90 percent confidence interval ranged from -0.0129 to 0.0614, which included zero. Similarly, the indirect effect of ESG on ROE through environmental innovation was 0.1020, with a 90 percent confidence interval ranging from -0.0180 to 0.3298. Since both confidence intervals included zero, the indirect effects were not statistically significant. Therefore, environmental innovation does not significantly mediate the relationship between ESG performance and firm profitability.

5. Discussion

This paper confirms that ESG performance has a positive and significant effect on environmental innovation, indicating that firms with higher ESG scores are more actively engaged in developing environmentally oriented innovations. The patterns found are consistent with evidence that stronger ESG performance significantly promotes the quantity and quality of green innovation in A share Chinese firms, partly via easing financing constraints and agency costs (Liang et al., 2025; Tan & Zhu, 2022). This is also consistent with evidence from ASEAN and other emerging economies showing that stronger ESG disclosure and governance are associated with higher levels of green innovation and environmental R&D (Tripopsakul, 2025).

The finding suggests that ESG operates as a capability building mechanism, which improved governance, transparency, and stakeholder engagement channel resources and managerial attention into cleaner technologies and environmental projects (Wu et al., 2024). This pattern aligns with stakeholder theory, which posits that firms respond to salient stakeholder demands by reconfiguring strategies

and investments to preserve access to critical resources and support. The positive association between ESG and environmental innovation in the Indonesian sample suggests that firms respond to growing stakeholder expectations from regulators, investors, and global supply chain partners by investing in environmentally oriented innovations.

Prior studies show that stronger ESG engagement can strengthen stakeholder trust, reduce greenwashing risk (Lee & Raschke, 2023) and to enhanced competitive performance through green technology innovation (Cao et al., 2025). Consequently, firms may pursue environmental innovation as a strategic response to stakeholder pressures, even when short term financial payoffs remain uncertain (Tripopsakul, 2025). At the same time, this mechanism is compatible with legitimacy theory, as ESG and green innovation in emerging markets are often used to align with evolving societal expectations and institutional pressures, also to avoid sanctions or reputational losses (Lee & Raschke, 2023).

In the Indonesian context, however, ESG induced environmental innovation appears uneven and partly symbolic. In contrast to ASEAN wide evidence where environmental and governance disclosures significantly raise green innovation and partially translate into higher market valuation (Tripopsakul, 2025), Indonesian studies frequently document weak or even negative short run ESG–value relationships, particularly when ESG is treated primarily as a disclosure obligation (Ramadhana & Effendi, 2025). This supports the argument that ESG currently functions as a legitimacy seeking mechanism, whereby firms prioritize visible reporting and basic compliance to satisfy regulators and foreign investors, while deeper, process embedded innovations remain concentrated in a subset of large or resource rich firms.

This pattern aligns with legitimacy theory, which posits that organizations may adopt symbolic conformity, such as sustainability reports or selective innovations to maintain legitimacy without fully transforming underlying practices. The Indonesian evidence therefore suggests that ESG often acts as an initial trigger rather than a fully substantive driver of innovation. It urges firms toward environmental projects, but the width and depth of innovation are limited by domestic demand, regulatory enforcement, and internal capabilities (Ramadhana & Effendi, 2025). Overall, the evidence suggests that Indonesian firms are in a transitional phase of sustainability integration

ESG has evolved beyond compliance, yet it remains largely practiced as reputation-driven in its short-term financial impact. Environmental innovation, while positively linked to ESG engagement, has not fully matured into a dominant short-run value driver. Its contribution to profitability is more gradual and time dependent. This dynamic underscore the importance of adopting a long-term perspective when evaluating sustainability-driven value creation in emerging markets.

However, the direct financial payoff of environmental innovation on asset based profitability appears limited. Environmental innovation has only a positive but weak effect on ROA, indicating that the innovation slightly improves asset based profitability but does not yet fundamentally transform short term operating efficiency. Several studies find that green innovation or environmental innovation improves financial performance only modestly or with lags, due to high upfront R&D and implementation costs (Cabaleiro-Cerviño & Mendi, 2024). This supports the argument that environmental innovation initially operates as a cost intensive adjustment mechanism, with firms incurring R&D outlays, learning costs and process disruptions before substantial productivity gains and revenue growth appear (Khalil et al., 2022). From a stakeholder theory perspective, this reflects a transition phase in which firms comply with stakeholder pressure for greener practices while short term ROA effects remain small or uncertain (Wu et al., 2024).

The findings suggest that although ESG performance may encourage firms to engage in environmental innovation, such innovation does not appear to translate directly into improved profitability, as measured by ROA and ROE. One possible explanation is that environmental innovation

often requires substantial investment and implementation costs in the short term, while the economic benefits tend to materialize over a longer period. Consequently, the profitability gains generated by environmental innovation may not be immediately reflected in accounting-based performance indicators.

Turning to equity based performance, the results indicate that investors do value both ESG and innovation. Environmental innovation has a positive and statistically significant effect on ROE, implying that environmental innovation increases shareholder returns and that capital markets reward sustainability driven strategies. ESG has an even stronger positive and highly significant effect on ROE, confirming that ESG is a key driver of shareholder value rather than merely a non financial reporting tool. Global and regional studies report that equity based metrics such as ROE and Tobin's Q are more sensitive to ESG and green innovation signals than short term accounting ratios, as markets price expectations about future cash flows and risk (Aydoğmuş et al., 2022). The results imply that capital markets interpret ESG driven environmental innovation as a credible signal of long term value creation and preparedness for regulatory and market transitions (Cao et al., 2025). It aligns with stakeholder theory, which views investors as a critical stakeholder group that rewards proactive environmental and social risk management, and legitimacy theory, which highlights markets grant performance legitimacy to firms whose ESG practices and innovation efforts appear substantive rather than symbolic.

Furthermore, ESG demonstrates a more direct and economically meaningful impact on profitability. ESG has a positive and statistically significant effect on ROA and ROE, showing that better ESG performance improves asset utilization efficiency and shareholder capital efficiency. Cross country evidence indicates that higher ESG scores tend to raise ROA and other accounting measures, for example net profit margin, by lowering risk, improving stakeholder relations, and easing access to finance (Khalil et al., 2022). This is in line with the argument that ESG functions as a direct value creation mechanism, where enhanced reputation, stakeholder trust, and more efficient resource use are already visible in ROA. The positive ESG–ROA and ESG–ROE relationships in this study are consistent with broader emerging market research showing that ESG can enhance profitability and firm value when integrated into strategy (Aydoğmuş et al., 2022). However, they contrast with Indonesian findings that ESG scores have a negative or insignificant impact on firm value or ROA, especially when ESG is treated as a cost or when domestic investors under prioritize environmental issues (Oktadewi & Diantini, 2025). This study further extends previous work by demonstrating a more favorable ESG–performance profile among Indonesian firms that combine ESG with environmental innovation and are more visible to global investors, suggesting that stakeholder driven and legitimacy driven mechanisms operate more strongly in this subset than in the broader market.

Moreover, when ESG and environmental innovation are simultaneously included into the ROA model, ESG remains statistically positive and significant, while environmental innovation becomes non significant, although the Sobel test still indicates a weak mediating effect. Similar patterns appear in Indonesian and ASEAN studies where sustainability or environmental innovation entails significant upfront costs, limited short term revenue gains, and therefore weak or negative associations with ROA, even as these activities improve longer term efficiency and market value (Aydoğmuş et al., 2022; Cao et al., 2025). This finding challenges the narrow interpretation of stakeholder theory that views innovation as the primary transmission channel through which ESG translates into short-term accounting performance. Instead, it echoes legitimacy-based evidence suggesting that ESG and governance mechanisms can improve financial outcomes even when innovation effects are delayed or muted (Lee & Raschke, 2023). Nevertheless, the pattern remains broadly consistent with stakeholder theory, which recognizes that responding to stakeholder pressure may involve short-term financial sacrifices in order to secure long-term relational and reputational benefits. Accordingly, the positive but relatively weak

coefficient of environmental innovation on ROA likely reflects a transitional phase in which innovation initiatives have not yet fully translated into asset-based profitability.

When both ESG and environmental innovation are included in the ROE model, both coefficients remain positive and significant, indicating partial mediation. Conceptually, this is consistent with other's research showing that ESG can influence performance through innovation (mediation) and that innovation in turn strengthens the ESG–performance relationship (moderation) (Tan & Zhu, 2022). The mediation analysis shows that 15.4 percent of ROE improvement arises through ESG driven environmental innovation. It is in line with findings that ESG's financial impact is amplified when firms translate ESG commitments into concrete green technology innovation and process changes, rather than relying solely on disclosure (Wu et al., 2024). This supports the argument that environmental innovation acts as a strategic amplifier of ESG's financial impact, and is consistent with evidence that markets reward ESG aligned innovation strategies with higher competitive performance, productivity, and survival prospects (Cabaleiro-Cerviño & Mendi, 2024).

ESG practices in Indonesia primarily function as legitimacy and stakeholder-response mechanisms, while their economic benefits increasingly materialize through environmental innovation, especially in terms of equity-based returns. This implies that ESG adoption without substantive innovation integration may yield limited short-term asset efficiency, highlighting the importance of stronger regulatory alignment, innovation incentives, and institutional support to transform ESG from symbolic compliance into a value-creating sustainability strategy, also the importance of long-term sustainability-oriented innovation policies.

The dynamic analysis refines this finding further. ESG continues to have a positive and significant effect on ROA over time, whereas environmental innovation has a negative effect on ROA and positive effect on ROE in the current period, but a positive and significant effect for both measures in the following period. Prior studies in emerging and developed markets on ESG and green innovation report that ESG–performance links often involve time lags, and that green innovation can depress profitability initially but improve it later as capabilities and efficiencies accumulate. This supports the argument that environmental innovation is a dynamic, path dependent process whose financial benefits emerge only after learning and diffusion. From a stakeholder theory perspective, this matches findings that investors and other long horizon stakeholders respond to ESG and green innovation signals in anticipation of future gains and reward firms earlier through higher ROE or valuation, while accounting measures like ROA reflect the slower adjustment of operations and cost structures. From a legitimacy theory perspective, it is consistent with evidence that firms may initially overinvest in visible environmental projects or ESG disclosure to secure legitimacy, with substantive efficiency gains materializing later (Wu et al., 2024).

Overall, the findings point to a two-stage ESG value-creation process in emerging markets. In the first stage, stronger ESG engagement primarily functions as a legitimacy and stakeholder-alignment mechanism that directly enhances profitability and market value through improved risk management, financing conditions, and reputational capital (Lee & Raschke, 2023). In the second stage, ESG gradually evolves into a capability-building platform that expands firms' innovation resources and alleviates financial and agency constraints, thereby supporting higher volumes and quality of environmental innovation. Within this process, environmental innovation plays a slower but strategic role. The financial benefits tend to materialize with a lag as firms accumulate technological and organizational learning, strengthen green reputations, and operate in institutional environments that allow eco-innovations to translate into higher value (Khalil et al., 2022). Taken together, these findings suggest that ESG in emerging markets should not be viewed merely as a short-term legitimacy tool, but as a long-term

innovation engine that gradually converts sustainability commitments into durable competitive and financial gains.

From a theoretical perspective, this study offers several contributions. First, it extends Stakeholder Theory and Legitimacy Theory by identifying environmental innovation as a transmission mechanism through which ESG performance generates financial value. Rather than viewing ESG solely as a direct driver of profitability, the findings demonstrate that stakeholder and legitimacy pressures are translated into economic outcomes through innovation-oriented responses. Second, the study refines these theories by showing that ESG and environmental innovation influence profitability through different temporal pathways. While ESG can generate relatively immediate financial benefits through enhanced reputation, stakeholder trust, and access to resources, the benefits of environmental innovation tend to emerge more gradually as firms accumulate technological capabilities and operational efficiencies. Third, the findings establish important boundary conditions for ESG value creation. In emerging economies characterized by uneven innovation capabilities and evolving sustainability institutions, ESG may initially function as a legitimacy and stakeholder-alignment mechanism, whereas innovation-driven financial gains are more likely to materialize over time. These insights contribute to a more dynamic understanding of how ESG creates value under different institutional and temporal conditions.

From an accounting perspective, this study contributes to the growing literature on ESG measurement and sustainability reporting. The findings suggest that ESG scores contain economically relevant information beyond symbolic disclosure, as they are associated with both environmental innovation and corporate profitability. This evidence supports the decision-usefulness perspective of sustainability reporting by indicating that ESG-related disclosures can serve as informative signals for investors, regulators, and other stakeholders when assessing firms' long-term value creation potential. Furthermore, the mediating role of environmental innovation suggests that the quality and substance of ESG reporting matter, as financial benefits appear more likely when disclosed sustainability commitments are accompanied by actual innovation activities rather than mere compliance-oriented reporting. The results therefore reinforce the importance of high-quality ESG score and standardized sustainability reporting frameworks in enhancing the credibility and usefulness of non-financial information within corporate reporting systems.

6. Conclusion

This study demonstrates that ESG performance contributes positively to corporate profitability, highlighting the economic relevance of sustainability practices among Indonesian listed firms. However, environmental innovation was not found to significantly mediate the relationship between ESG performance and profitability, as the bootstrap confidence intervals for both ROA and ROE included zero. These findings suggest that while ESG performance may encourage environmental innovation and enhance profitability, environmental innovation does not function as a statistically significant transmission mechanism between the two. Moreover, the lagged-effect analysis indicates that the benefits of environmental innovation may emerge gradually over time, highlighting the long-term nature of sustainability investments and the need to evaluate ESG outcomes beyond short-term financial performance.

From a theoretical perspective, this study extends Stakeholder Theory and Legitimacy Theory by demonstrating that ESG performance can simultaneously promote environmental innovation and corporate profitability. While environmental innovation was not found to be a statistically significant mediating mechanism, the findings suggest that stakeholder and legitimacy pressures may influence innovation and financial performance through multiple pathways. The study also refines existing ESG

literature by highlighting that the economic effects of sustainability initiatives may follow different temporal trajectories, with innovation-related benefits potentially emerging over a longer time horizon. Furthermore, the findings provide evidence from an emerging economy context, where uneven innovation capabilities and evolving sustainability institutions shape the effectiveness of ESG practices.

From a practical perspective, the results imply that firms should move beyond compliance-oriented ESG disclosure and integrate environmental innovation into their core business strategies. ESG initiatives are more likely to generate long-term value when supported by investments in cleaner technologies, resource efficiency, and sustainable operational practices. For regulators and policymakers, the findings highlight the importance of strengthening sustainability reporting frameworks, promoting high-quality ESG disclosure, and providing incentives that encourage innovation-oriented sustainability practices. Such efforts can improve the credibility of ESG information and support the realization of long-term economic and environmental benefits.

Notable limitations have been identified in this study. First, although fixed-effects estimation and lagged analysis were employed, the possibility of endogeneity arising from reverse causality, omitted variables, or unobserved time-varying factors cannot be entirely ruled out. Second, the analysis relies on ESG scores derived from publicly available disclosures, which may be subject to ESG disclosure availability bias, as firms with more extensive sustainability reporting are more likely to receive ESG assessments. Third, the sample only includes firms with complete ESG and financial data during the study period. As a result, firms with limited ESG disclosures or incomplete reporting may not be represented in the analysis. Taken together, the use of aggregate ESG scores may obscure the distinct effects of environmental, social, and governance dimensions, while environmental innovation proxies may not fully capture the quality and substance of innovation activities.

Future research may address these limitations by employing more advanced approaches to mitigate endogeneity concerns, examining the individual dimensions of ESG performance, and incorporating broader measures of environmental innovation. In addition, further studies could explore the role of ESG disclosure quality, sustainability assurance, accounting measurement models for sustainability-related performance, and integrated reporting practices in strengthening the relationship between ESG initiatives, innovation outcomes, and corporate profitability.

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