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DOES BEING GREEN PAY OFF? THE ROLE OF ESG PERFORMANCE AND CARBON INTENSITY IN SHAPING GREEN BOND FINANCING AMONG ASIAN FIRMS

SER VERDE COMPENSA? O PAPEL DO DESEMPENHO ESG E DA INTENSIDADE DAS EMISSÕES DE CARBONO NA ESTRUTURAÇÃO DO FINANCIAMENTO POR TÍTULOS VERDES EM EMPRESAS ASIÁTICAS

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Abstract
Climate change has intensified the need for financial innovation to support sustainable transitions. Green bonds have emerged as key instruments to fund low carbon investments and promote environmental accountability. This study investigates how environmental, social, and governance (ESG) performance and carbon emission intensity affect the proportion of green bonds issued by Asian firms from 2019 to 2023. Results show that ESG score is negatively correlated with the proportion of green bonds, meaning that companies with higher sustainability credibility are less dependent on external green financing. Carbon emission intensity is positively associated with green bond proportion, indicating that firms with higher indirect emissions are more likely to use green bonds to demonstrate environmental commitment and enhance legitimacy. From sub-sample ASEAN and non-ASEAN firms highlight the role of institutional contexts in shaping sustainable finance adoption. These findings contribute by reinterpreting signaling theory and legitimacy theory within the Asian context, showing that firms with high ESG credibility refrain from costly green bond signaling due to established reputation, while firms with higher carbon emission intensity actively issue green bonds as legitimacy tools to maintain social and investor acceptance.

Keywords: Carbon Emission Intensity. ESG Score. Green Bond Proportion. SDG 9.

Resumo
As mudanças climáticas intensificaram a necessidade de inovação financeira para apoiar transições sustentáveis. Os títulos verdes emergiram como instrumentos-chave para financiar investimentos de baixo carbono e promover a responsabilidade ambiental. Este estudo investiga como o desempenho ambiental, social e de governança (ESG) e a intensidade das emissões de carbono afetam a proporção de títulos verdes emitidos por empresas asiáticas no período de 2019 a 2023. Os resultados indicam que a pontuação ESG está negativamente correlacionada com a proporção de títulos verdes, o que significa que empresas com maior credibilidade em sustentabilidade são menos dependentes de financiamento verde externo. A intensidade das emissões de carbono está positivamente associada à proporção de títulos verdes, indicando que empresas com maiores emissões indiretas tendem a utilizar títulos verdes para demonstrar compromisso ambiental e aumentar sua legitimidade. A análise de subamostras de empresas da ASEAN e não-ASEAN evidencia o papel dos contextos institucionais na adoção de práticas de finanças sustentáveis. Esses achados contribuem ao reinterpretar a teoria do signaling e a teoria da legitimidade no contexto asiático, demonstrando que empresas com alta credibilidade em ESG evitam o custoso sinal dos títulos verdes devido à reputação consolidada, enquanto empresas com maior intensidade de emissões de carbono emitem ativamente títulos verdes como

instrumentos de legitimidade para manter a aceitação social e dos investidores.

Palavras-chave: *Intensidade das Emissões de Carbono. Pontuação ESG. Proporção de Títulos Verdes. ODS 9.*

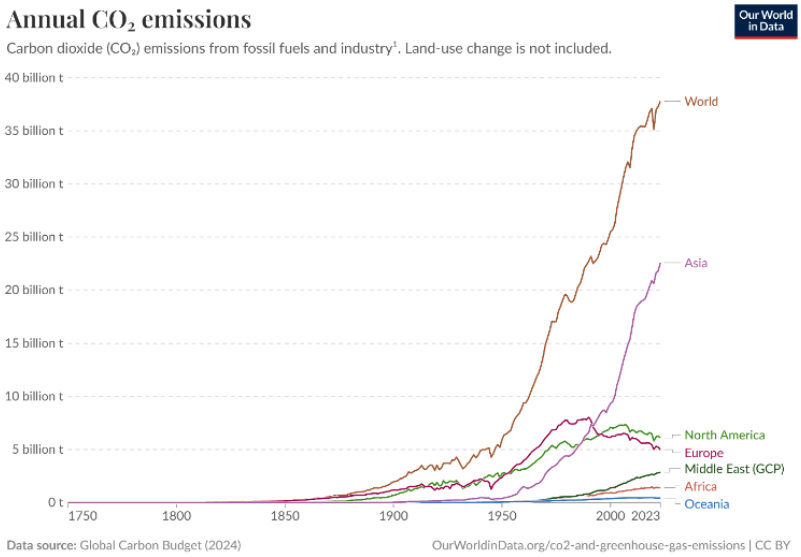
1 INTRODUCTION

According to the *State of the Global Climate 2023* report, 2023 was the hottest year on record, with global temperatures reaching 1.45°C above pre-industrial levels (World Meteorological Organization, 2024). In the same year, Antarctic sea ice declined to its lowest recorded extent, driven by the El Niño phenomenon and a major underwater volcanic eruption that increased sea surface temperatures and contributed to global warming (National Snow and Ice Data Center, 2023). Carbon emissions from fossil fuel combustion were also estimated to rise by approximately 0.8% in 2024 compared to 2023 (University of Exeter, 2024).

All firms generate carbon emissions through operational activities such as energy consumption, fuel use, and supply chain processes (Rexy, 2025). Carbon emission intensity is commonly used to assess emission levels relative to economic capacity, measured as CO_2-equivalent emissions per unit of revenue, value added, or total assets (European Union, 2022). The accumulation of greenhouse gases from human activities has resulted in tangible impacts, including extreme weather events, sea-level rise, droughts, and emerging health risks, posing significant global challenges (World Health Organization, 2023).

Figure 1

CO_2 Emission Growth in Asia



Source: Adapted from Our World in Data, 2024.

Figure 1. illustrates that in 2023, annual emissions in Asia reached nearly 25 billion tons of CO_2-e, making the region the largest contributor to global carbon emissions (Our World in Data, 2024). This high level of emissions is driven by intense energy consumption, rapid urbanization, population growth, and industrial production, which have not been sufficiently offset by the adoption of renewable energy sources. Accelerated industrialization in Asia has simultaneously heightened environmental awareness, prompting firms to adopt pollution-reduction strategies supported by government incentives and stricter environmental regulations (Bergquist, 2017). Companies demonstrating environmental responsibility also tend to gain positive public perception and reputational benefits, as environmentally friendly practices are increasingly viewed as both mitigating negative externalities and supporting long-term sustainability goals. To meet the Paris Agreement targets, the *World Economic Forum* (2024) estimates that the world requires between USD 3 – 6 trillion of investment annually through 2050. In this context, green bonds have emerged as vital financial instruments for mobilizing transition funding, and analyses based on scope 2 emission intensity provide a stronger foundation for understanding the environmental factors driving such issuances (Kadymov Mikhail, 2023).

In the early stages of green bond market development between 2015 and 2020, several challenges frequently emerged, including the lack of standardized assessment

frameworks and limited understanding of what constitutes a truly "green" project, which facilitated the risk of greenwashing practices. Differences in the interpretation of "green" across countries have also led to confusion among international investors, potentially undermining market confidence (Kimberley Long, 2021). One notable example occurred in China, where *clean coal* was included in the list of green projects in 2015, attracting international criticism (Business & Human Rights Resourch Center, 2020). Subsequently, new standards began to take shape during 2020 – 2021, including attempts to establish uniform definitions of green activities. In Southeast Asia, the ASEAN Green Bond Standards initially released in 2017 and revised in 2018 started to gain broader adoption during this period (State of Union, 2020). Furthermore, the issuance of green bonds remains regionally concentrated and uneven. The Asia-Pacific region recorded the largest cumulative issuance of green bonds, reaching USD 258.9 billion as of July 2025, with China contributing the largest share at USD 116.8 billion (Lim Fathimah Timmoria, 2025). Asian markets continue to exhibit structural imbalances in policy frameworks, investor participation, and disclosure practices, which affect the depth and credibility of the market (Satrianto et al., 2024). Policy heterogeneity across Asian economies remains a key barrier to harmonizing green finance growth across the region (Nguyen & Nguyen, 2024).

Flammer (Flammer, 2021) emphasized the critical role of environmental, social, and governance (ESG) performance in shaping investors' confidence and access to sustainable finance instruments such as green bonds. Firms with stronger ESG disclosure tend to attract environmentally conscious investors, supporting the view that sustainability transparency reduces information asymmetrical in capital markets (Broadstock et al., 2021). Meanwhile, Wang and Zhi (Wang & Zhi, 2016) argued that carbon emission intensity particularly under Scope 2, which reflects indirect energy related emissions has become a major indicator of a firm's environmental responsibility, yet its direct association with green bond issuance remains empirically underexplored in Asia. Despite the growing research on ESG and green finance, most empirical evidence originates from European and North American markets, leaving limited understanding of how sustainability performance and carbon intensity jointly influence corporate financing behavior in Asia (Broadstock et al., 2021; Chen et al., 2023). Furthermore, cross-country variations in environmental regulation, disclosure standards, and financial maturity across Asian economies may lead to heterogeneous responses to green finance initiatives

(OECD, 2023). This lack of integrated analysis across ESG performance and carbon emission dimensions creates an important research gap, motivating the present study to examine how ESG score and carbon emission intensity affect green bond proportion among Asian firms from 2019 to 2023, while accounting for market- and institutional-level differences through control variables such as ASEAN vs non-ASEAN classification, price to book ratio, and firm size.

Grounded in signaling, this study interprets the issuance of green bonds and the disclosure of ESG performance as credible signals through which firms communicate their commitment to sustainability and attract environmentally conscious investors (Spence, 1973). From the legitimacy perspective, firms seek to gain and maintain social acceptance by aligning their actions, such as reducing carbon emission intensity with societal norms and environmental expectations (Dowling & Pfeffer, 1975). These theoretical perspectives jointly explain how companies use sustainability performance and emission management to enhance investor trust and strengthen access to green finance.

Building on these theoretical foundations, the present study aims to examine how ESG score, and carbon emission intensity influence the proportion of green bonds issued by Asian firms from 2019 to 2023. The study also incorporates ASEAN versus non-ASEAN classification, market ratio (PBV), and firm size (total assets) as control variables to capture market and institutional heterogeneity across the region. Using firm-level panel data from Refinitiv Eikon, this research provides empirical insights into how sustainability performance and carbon management strategies shape firm's participation in green debt financing.

The contribution of this study is threefold. First, it reinterprets signaling theory by showing that the effectiveness of green signaling through green bond issuance is contextual. The finding that ESG score negatively influences green bond proportion implies that firms with strong ESG credibility tend to refrain from issuing additional costly signals, as their sustainability reputation is already well established. This study therefore extends signaling theory by identifying the condition of signal saturation, in which high ESG firms no longer need to incur further signaling costs through green bond issuance because their existing transparency and reputation already convey credibility to investors.

Second, it provides empirical support for legitimacy theory by demonstrating that firms with higher carbon emission intensity tend to issue more green bonds as a means of maintaining social and regulatory legitimacy. The positive relationship between carbon emission intensity and green bond proportion indicates that firms facing greater environmental pressure use green bonds as a legitimacy-reinforcing mechanism, signaling compliance with societal and investor expectations while mitigating reputational risks. This broadens the application of legitimacy theory within corporate green finance by framing green bond issuance as both a corrective and strategic response to environmental accountability.

Third, this study enriches the Asian green finance literature by offering comparative evidence across ASEAN and non-ASEAN economies, emphasizing how institutional maturity, regulatory development, and market structure shape the dynamics between ESG performance, emission management, and access to green capital in diverse regional contexts.

2 LITERATURE REVIEW

2.1 Green bonds

Bonds are debt instruments issued by governments or corporations to raise capital from investors, where the issuer agrees to pay periodic interest and repay the principal at maturity. More recently, green bonds have emerged as a debt instrument dedicated to financing environmentally sustainable projects.

The International Capital Market Association (ICMA) defines green bonds as fixed-income securities whose proceeds are exclusively applied to projects with clear environmental benefits such as renewable energy, energy efficiency, pollution prevention, or clean transportation under the Green Bond Principles (GBP) first published in 2014 and updated periodically (ICMA, 2021). Under the Green Bond Principles, green bonds are fixed-income securities whose proceeds are exclusively allocated to projects with clear environmental benefits, supporting climate-related and resource-efficient investments (OECD, 2017).

Green bonds have therefore become essential financial instruments supporting the global transition toward low-carbon and climate-resilient economies. They enable firms

to mobilize capital specifically for environmentally beneficial projects. Studies such as Flammer and García et al. (Flammer, 2021; García et al., 2023) emphasize that issuing green bonds can enhance a firm's reputation and environmental performance although development across Asian markets remains uneven.

However, the issuance and ongoing reporting requirements for green bonds remain onerous for many companies. Issuers frequently face complex verification and post-issuance reporting obligations, due to stringent verification and post-issuance reporting requirements (Hunt, 2024). These added regulatory and compliance costs, combined with the absence of universally accepted taxonomies and voluntary rather than mandatory frameworks, can deter smaller firms or those in emerging markets from using green bonds. As a result, some companies may prefer conventional debt instruments or sustainability-linked bonds, which typically entail lower compliance costs (Zhang & Zihan, 2024).

Empirical literature has also explored the role of environmental, social, and governance (ESG) performance in facilitating access to sustainable finance. A 7onsis ESG profile reduces information asymmetry and strengthens investor confidence, signaling a firm's long-term commitment to sustainability (Zheng et al., 2023). However, some studies argue that firms with high ESG credibility may not rely heavily on green bonds, as their environmental accountability is already established through non-financial disclosures. This inconsistency highlights the need to further examine whether ESG performance truly translates into higher participation in green bond markets.

Another emerging dimension in the literature is 7onsist emission intensity, particularly under indirect emission measures such as Scope 2 (or Scopes 1-2), which reflect firms' energy-related environmental burden. Recent studies such as Pang et al. And Torsten et al. (Pang et al., 2024) demonstrate that firms issuing green bonds tend to show reductions in emission intensity over time, while firm-level ratings research indicates that higher emission intensity (Scopes 1-2) may motivate green bond issuance. However, empirical evidence specifically linking Scope 2 emission intensity and green bond issuance in Asian firms remains relatively scarce.

From a theoretical standpoint, signaling theory and legitimacy theory (Spence, 1973) offer complementary explanations for firm's engagement in sustainable financing. Signaling theory suggests that ESG disclosure and green bond issuance serve as credible signals to investors, conveying information about a firm's sustainability quality.

Legitimacy theory, on the other hand, posits that firms particularly those with higher 8onsist emissions use green initiatives to maintain societal approval and align their activities with prevailing environmental norms.

To ensure the robustness of results, firm level characteristics such as 8onsis ratio (PBV), firm size (total assets), and regional classification (ASEAN vs non-ASEAN) are incorporated as control variables, 8onsistente with prior studies in green finance literature (Flammer, 2021; García et al., 2023). These control variables help account for firm-level and regional heterogeneity in green bond issuance across Asian markets.

2.2 Hypothesis development

2.2.1 Esg score and green bonds proportion

Green bonds have become essential financial instruments for funding environmentally responsible projects, while environmental, social, and governance (ESG) performance reflects a firm's overall commitment to sustainability. Firms with higher ESG scores typically demonstrate stronger environmental responsibility, transparency, and stakeholder engagement (Friede et al., 2015).

Previous studies report mixed findings on the relationship between ESG performance and green bond issuance. Some studies indicate a positive relationship, suggesting that firms with 8epend ESG profiles are more likely to issue green bonds as 8epende their sustainability strategies, leveraging their transparency to attract environmentally conscious investors and reduce information asymmetry (Garcia et al., 2017; Refinitiv, 2022). In this 8ependen, green bond issuance functions as na extension of corporate sustainability strategies in capital markets (Tang & Zhang, 2020).

However, other evidence highlights a negative relationship, indicating that firms with higher ESG credibility are less 8ependente on green bonds because they already possess reputational capital and easier access to traditional financing sources (Zheng et al., 2023). Firms with lower ESG performance, on the other hand, may strategically issue green bonds to strengthen their environmental reputation and demonstrate accountability to investors (Gao & Schmittmann, 2022; Garcia et al., 2017).

From a signaling theory perspective, green bonds serve as observable signals of firms' unobservable environmental quality (Spence, 1973), particularly for firms with

weaker ESG profiles, while firms with high ESG credibility face lower incentives to use green bonds for signaling purposes. Accordingly, in Asian markets where sustainability disclosure and regulatory enforcement remain uneven, firms with stronger ESG performance are expected to rely less on green bonds than firms with weaker ESG credibility.

H1: ESG score is negatively correlated to green bond proportion.

2.2.2 Carbon emission intensity and green bonds proportion

Carbon emission intensity represents the amount of greenhouse gases emitted relative to a firm's economic activity. Scope 2 emissions capture indirect emissions from purchased energy and are widely recognized as a key indicator of firms' energy-related environmental footprint (Torsten Ehlers et al., 2020). High Scope 2 emission intensity reflects greater reliance on fossil fuel–based energy, increasing firms' exposure to regulatory and reputational risks (ESMA Report on Trends, 2021).

Empirical evidence shows that firms with higher carbon emission intensity face stronger institutional pressure to demonstrate environmental accountability (Gianfrate & Peri, 2019). In response to these pressures, green bond issuance serves as a mechanism to finance cleaner technologies and signal environmental responsibility. Through the issuance of green bonds, firms can mitigate public criticism and regulatory scrutiny while aligning their financial practices with sustainability goals (Fatica & Panzica, 2021; Tang & Zhang, 2020).

From the perspective of legitimacy theory (Suchman, 1995), firms seek to gain and maintain social legitimacy by conforming to prevailing environmental norms and societal expectations. When carbon emission intensity is high, firms face stronger legitimacy pressure, encouraging the use of green bonds as a legitimizing action. In this context, green bond issuance becomes a strategic tool to manage legitimacy gaps and enhance stakeholders' perception of the firm's environmental responsibility. Accordingly, firms with higher Scope 2 carbon emission intensity are expected to issue a greater proportion of green bonds.

H2: *Carbon emission intensity is positively correlated to green bond proportion.*

3 METHODOLOGY

3.1 Hypothesis development

This study analyzes the factors influencing the proportion of green bonds issued by Asian firms from 2019 to 2023 across all industrial sectors. The initial population consists of 960 firms identified as green bond issuers in the Refinitiv Eikon database. Sample selection is based on the availability of complete data on green bond issuance, ESG scores, and Scope 2 carbon emission intensity over the observation period.

The final sample consists of 114 firm-year observations from seven Asian countries. The distribution of the sample by country and sector is reported in Tables 1 and 2.

Table 1

Distribution of sample firms by country

Country	Number of Firm
China	37
Japan	22
South Korea	22
Malaysia	10
Phillipines	4
Singapore	4
Thailand	15

Table 2

Distribution of sample firms by sector

Sector	Number of Firm
Bank	73
Coal	4
Construction and Engineering	2
Electric Utilities	5
Food Processing	2
Food Retail and Distribution	4
Highways and Rail Tracks	2
Investment Banking and Brokerage Services	3
Investment Holding Companies	1
Investment Management and Fund Operators	2
Life and Health Insurance	3
Medical Equipment, Supplies and Distribution	1
Oil and Gas Refining and Marketing	3
Pharmaceuticals	3
Real Estate Rental, Development and Operations	4
Wireless Telecommunications Services	2

As shown in Table 1, firms from ASEAN countries constitute a substantial share of green bond issuers in the sample, totaling 81 firms. Table 2 further shows that the banking sector dominates the sample, comprising 73 firms, reflecting its prominent participation in green bond issuance in Asia.

3.2 Variables

The study employs independent, dependent, and control variables, which are summarized in Table 3.

Table 3

Variable definitions and measures

Variable		**Definition and Measure**	**Predicted Direction**
Dependent Variable	Green Bond Proportion	Ratio of total green bond issuance to total assets (%) from Refinitiv Eikon.	
Independent Variable	ESG score	Composite environmental, social, and governance performance score from Refinitiv Eikon.	-
	CEI	Carbon emission intensity (Scope 2) measured as total Scope 2 CO_2-e emissions divided by total assets from Refinitiv Eikon.	+
	ASEAN	Dummy variable (1 = ASEAN firm; 0 = non-ASEAN firm).	-
Control Variable	MR	Market ratio measured as price-to-book value (PBV) from Refinitiv Eikon.	+
	Size	Firm size measured as total assets from Refinitiv Eikon.	-

(1) *Dependent variable: green bond proportion.* Green bond proportion is measured as the ratio of total green bond issuance to total assets. This measure captures the relative scale of green financing activities while ensuring comparability across firms of different sizes. Similar approaches have been applied in prior studies examining the determinants of corporate green financing in Asia (Alamgir & Cheng, 2023).

(2) *Independent variable: esg and carbon emission intensity (Scope 2).* The ESG score is obtained from Refinitiv Eikon, which assesses firms' environmental,

social, and governance performance using a standardized scale ranging from 0 to 100. Carbon emission intensity (CEI) is measured as total Scope 2 CO_2-e emissions divided by total assets. Scope 2 emissions are used as they reflect energy-related emissions from purchased electricity and heat, which are particularly relevant for non-industrial and service-oriented firms. (ESMA Report on Trends, 2021; OECD, 2022). Moreover, Scope 2 emissions are more consistently disclosed across Asian firms, enhancing cross-country comparability (Houten & Wedari, 2023; Torsten Ehlers et al., 2020).

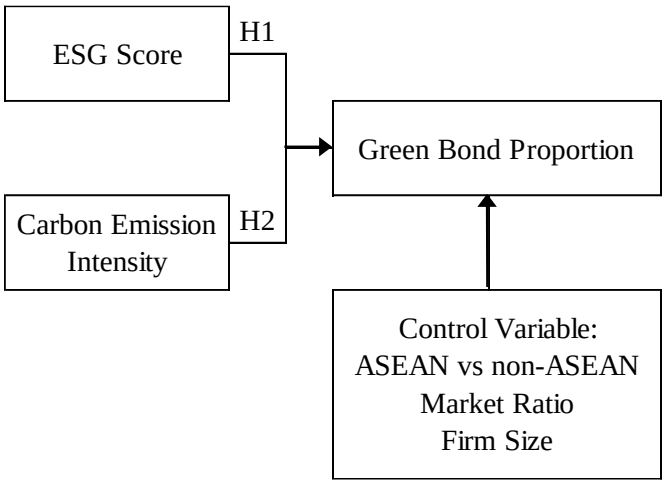
(3) *Control variable: ASEAN vs non-ASEAN (ASEAN), market ratio (PBV), size (total assets).* Three control variables are included to capture institutional and firm-level heterogeneity. The ASEAN dummy variable (1 = ASEAN firm, 0 = non-ASEAN firm) captures differences in regulatory environments and green finance adoption across regions (Securities Commission Malaysia, 2025). The market ratio (PBV) reflects firms' market valuation and growth potential, which may influence their capacity to issue green bonds (Bolton & Kacperczyk, 2021). The firm size variable, measured as the natural logarithm of total assets, controls for differences in organizational scale, as larger firms generally have greater access to sustainable financing instruments (Flammer, 2021).

3.3 Model design

The study employs independent, dependent, and control variables, which are summarized in Table 3.

Figure 2

Framework



This study employs a regression model to examine the effect of ESG performance and 13arbono emission intensity on the proportion of green bond issuance among Asian firms.

$$GreenBondProportionit = \beta 0 + \beta 1ESGScoreit + \beta 2CEIit + \beta 3ASEANit + \beta 4MRit + \beta 5Sizeit + \mu i + \mathcal{E}it$$

Information:

- ESG_{it} = Environmental, Social, Governance
- CEI_{it} = Carbon Emission Intensity
- $ASEAN_{it}$ = ASEAN vs non-ASEAN
- MR_{it} = Market Ratio
- $Size_{it}$ = Firm Size
- β_0 = Constant
- $\beta_{1,}\beta_{2,} \ldots \beta_5$ = Regression Coefficient
- I = Company
- t = Year
- μ = Unobserved Firm Specific Effect
- $\mathcal{E}$ = Error

This study applies a panel data regression model with a random effects specification to examine the impact of ESG performance and carbon emission intensity on the proportion of green bond issuance among Asian firms during the 2019–2023

period. To address potential issues of heteroskedasticity and autocorrelation across firms, clustered standard errors are employed at the firm level.

4 RESULTS

4.1 Descriptive statistical result

Table 4 presents the descriptive statistics. The proportion of green bonds varies considerably across firms. The differences in green bond proportions appear to be influenced by industry characteristics, where the banking sector tends to adopt a more cautious and conservative approach in allocating sustainable financial instruments, while the retail sector being closer to consumers shows a more proactive attitude in integrating green financing as part of its marketing and sustainability strategies. Firms with ESG scores below 50 (22 firms) have an average green bond proportion of 0.0110, whereas firms with ESG scores above 50 (92 firms) show a lower average proportion of 0.0096. This finding suggests that companies with weaker ESG performance tend to rely more on green bonds as a means of demonstrating their environmental commitment and attracting sustainability-oriented investors. The carbon emission intensity shows a wide variation between the lowest and highest values, reflecting substantial differences across industries. This variation is largely driven by sectoral characteristics, where firms in the banking sector exhibit relatively low emission intensity, while companies in the coal industry record the highest levels due to their energy-intensive operations.

Table 4

Descriptive statistic

Variable	Mean	Std.Dev	Min	Max
Green Bond Proportion	0.0099	0.0193	0.0001	0.1441
ESG	66.78	16.09	27.10	91.91
CEI	0.0000	0.0000	0.0000	0.0006
ASEAN	0.6754	0.4703	0	1
MR	1.2262	2.4584	0.18	18.78
Size (USD million)	918,685	1,3900	543	5,617,654

4.2 Hausman test

The null hypothesis (H_0) of the Hausman test states that the Random Effects model is appropriate, while the alternative hypothesis (H_1) supports the Fixed Effects model. The test produced a chi-square value of 2.48 with 3 degrees of freedom and a p-value of 0.4794, which exceeds the 0.05 significance level. Therefore, H_0 cannot be rejected, indicating that the Random Effects model is more appropriate and efficient for this analysis.

4.3 Analysis based on random effect model-clustered standrd error

Table 5 presents the regression results of the random effects model with clustered standard errors, examining the influence of ESG performance and carbon emission intensity on the proportion of green bond issuance among Asian firms.

Table 5

REM with clustered standard error result

Green Bond Proportion	Coefficient	P>|z|
Green Bond Proportion		
ESG	-0.0007	0.001
CEI	5.9600	0.000
ASEAN	-0.0091	0.421
MR	0.0043	0.000
Size	-0.0156	0.003

Table 5 reports the random effects regression results with clustered standard errors to address heteroskedasticity and autocorrelation. ESG performance has a negative and significant effect on green bond proportion (coefficient = −0.0007, p = 0.001), indicating that firms with higher ESG credibility tend to issue fewer green bonds, likely due to lower financing constraints and reduced reliance on green bonds as signaling instruments. This finding is consistent with prior studies showing that firms with stronger ESG performance have better access to conventional financing (Bolton & Kacperczyk, 2021; Zheng et al., 2023) and aligns with signaling theory (Spence, 1973).

In contrast, carbon emission intensity (CEI) exhibits a positive and highly significant relationship with green bond proportion (coefficient = 5.9600, p = 0.000),

suggesting that firms with higher Scope 2 emissions are more inclined to issue green bonds to finance emission reduction and signal environmental commitment.

Among the control variables, the ASEAN dummy is negative but insignificant, indicating no systematic difference between ASEAN and non-ASEAN firms. Market ratio (MR) is positive and significant, reflecting stronger investor demand for sustainability-oriented firms, while firm size shows a negative and significant effect, implying that smaller firms allocate a higher share of debt financing to green bonds.

Overall, the results support signaling and legitimacy theories, suggesting that firms with lower ESG performance or higher emission intensity strategically use green bonds to communicate environmental commitment in Asian markets.

4.4 Robustness test

To ensure the reliability of the main regression results, a robustness test was conducted by dividing the sample into ASEAN and non-ASEAN firms. This analysis examines whether regional institutional differences affect the relationship between ESG performance, carbon emission intensity, and green bond proportion. The sample was split because the main regression showed no significant ASEAN effect, indicating that regional heterogeneity may moderate these relationships.

Table 6

Robust regression result for ASEAN and non-ASEAN firms

	ASEAN		**Non-ASEAN**	
	Coefficient	**P>|z|**	**Coefficient**	**P>|z|**
Green Bond Proportion				
ESG	0.0003	0.341	-0.0010	0.000
CEI	1.110	0.000	2.140	0.429
MR	0.0022	0.099	0.0127	0.049
Size	-0.0377	0.000	-0.1723	0.014

Table 6 presents the robustness test results separating the sample into ASEAN and non-ASEAN firms. The results provide deeper insights into regional dynamics in sustainable financing behavior. ESG performance exhibits a negative relationship with green bond proportion (coefficient = -0.0010, p = 0.000) in non-ASEAN countries such as China, Japan, and South Korea, where ESG regulations and disclosure practices are more mature. This suggests that firms with strong ESG reputations in these markets no

longer rely on green bonds as additional signaling mechanisms to demonstrate their sustainability commitment.

In contrast, among ASEAN countries including Malaysia, the Philippines, Singapore, and Thailand the effect of ESG is insignificant (coefficient = 1.110; p = 0.000), while carbon emission intensity shows a significant positive relationship with green bond issuance. This indicates that firms with higher emissions in ASEAN economies tend to use green bonds as legitimacy tools to respond to external environmental pressure. ESG disclosure remains uneven and often voluntary. Investors rely more heavily on quantifiable and verifiable environmental indicators, such as Scope 2 emission intensity, to assess firms' environmental commitment. The limited standardization of ESG reporting frameworks across ASEAN countries has contributed to inconsistent ESG data quality in the region (PSE, 2025; Securities Commission Malaysia, 2025). Consequently, firms with higher carbon intensity are more likely to issue green bonds as legitimacy instruments.

Overall, this pattern highlights the uneven stages of ESG adoption and green finance framework development across Asian regions, reflecting the influence of institutional maturity and regulatory enforcement on firms' sustainability strategies.

Carbon emission intensity in non-ASEAN shows a positive but insignificant effect on green bond proportion (coefficient = 2.140, p = 0.429). This suggests that emission levels are not a primary determinant of green bond issuance in more advanced regulatory environments. These countries have adopted more mature sustainability disclosure and environmental governance frameworks, reducing the need to rely on green bonds as emission-related legitimacy tools. In such contexts, firms' environmental credibility is established through formal ESG transparency and regulatory compliance, reducing the need to use green bonds as a response to emission-related reputational risks. As a result, carbon emission intensity does not function as a legitimacy seeking driver of green bond issuance in non-ASEAN markets.

In contrast, the ASEAN subsample shows a strong and significant positive relationship between carbon emission intensity and green bond proportion (coefficient = 1.110, p = 0.000). This indicates that firms with higher indirect emissions in ASEAN economies are more likely to issue green bonds as part of their environmental response strategy. Given that ESG disclosure frameworks in the region remain uneven and in many cases voluntary, stakeholders often rely on measurable indicators, such as Scope 2

emission intensity, to assess environmental accountability. Therefore, firms with higher carbon intensity tend to use green bonds as legitimacy instruments to signal commitment to environmental improvement, reduce negative public perception, and align with rising sustainability expectations. This is consistent with legitimacy theory, which states that organizations undertake visible symbolic or strategic actions to maintain social acceptance when their activities negatively affect environmental or societal stakeholders.

The robustness analysis confirms that the baseline relationships remain consistent and statistically valid when accounting for regional heterogeneity. The contrasting results between ASEAN and non-ASEAN firms underscore the importance of regulatory maturity and market readiness in shaping how ESG performance and carbon emission intensity influence green bond issuance decisions across Asia.

5 CONCLUTION AND LIMITATION

This study examines the effects of environmental, social, and governance (ESG) performance and carbon emission intensity on the proportion of green bonds issued by Asian firms from 2019 to 2023. The results indicate that ESG performance has a significant negative effect on green bond proportion, suggesting that firms with strong sustainability reputations rely less on green bonds as signaling tools. In contrast, carbon emission intensity (Scope 2) shows a significant positive effect, indicating that firms with higher indirect emissions are more likely to issue green bonds. Robustness tests reveal regional heterogeneity: carbon emission intensity is the main driver of green bond issuance among ASEAN firms, while ESG performance plays a more influential role in non-ASEAN markets.

These findings have important implications for policy and corporate strategy. For policymakers, the results highlight the need to harmonize ESG reporting standards and green bond classification frameworks across Asia. Differences in the maturity of sustainability disclosure systems lead to contrasting roles of green bonds, functioning as supplementary instruments in more developed markets and as legitimacy tools in ASEAN economies. Strengthening the ASEAN Green Bond Standards and advancing the ASEAN Taxonomy for Sustainable Finance may enhance the credibility of green bonds as sustainability signals (ACMF, 2018; Sica et al., 2023).

From a corporate perspective, ASEAN firms should view green bonds not only as reputation-enhancing tools but also as strategic instruments to build long-term ESG credibility. Greater transparency in the allocation and reporting of green bond proceeds can improve investor confidence. Meanwhile, firms in non-ASEAN markets should integrate ESG considerations into broader financing strategies, focusing on measurable environmental outcomes rather than symbolic instruments.

This study has several limitations. Carbon emission intensity is measured only using Scope 2 emissions, excluding Scope 1 and Scope 3 emissions, which may result in an incomplete assessment of firms' total carbon footprints. In addition, the observation period (2019–2023) represents a transitional phase before the full implementation of mandatory ESG reporting in several Asian countries, potentially affecting cross-country comparability.

Future research should incorporate all three emission scopes to provide a more comprehensive assessment of corporate carbon accountability and its influence on green bond issuance.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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