Journal of Project Management 11 (2026) 1123–1132

Contents lists available at GrowingScience

Journal of Project Management

homepage: www.GrowingScience.com/jpm

Carbon emissions, ESG performance, and market reaction: Implications for sustainability project management in Thai listed companies

Jiratchaya Bunchuay[a], Nuttavong Poonpool[b*] and Utis Bhoungchirawattana[c*]

[a]*Ph.D. Candidate, Mahasarakham Business School, Mahasarakham University, Thailand*
[b]*Ph.D., Associate Professor, Mahasarakham Business School, Mahasarakham University, Thailand*
[c]*Ph.D., Assistance Professor, Mahasarakham Business School, Mahasarakham University, Thailand*

C H R O N I C L E

Article history:
Received April 12 2026
Received in Revised Format June 28 2026
Accepted July 31 2026
Available online July 31 2026

Keywords:
Carbon Emissions
ESG Performance
Market Reaction
Sustainability Project Management
Sustainability Disclosure
Thailand

A B S T R A C T

Climate change has increased the importance of carbon emissions and sustainability disclosure in corporate decision-making and capital markets. Despite growing interest in environmental, social, and governance (ESG) practices, limited evidence explains how ESG performance influences the relationship between carbon emissions and market reaction, particularly in emerging markets. This study examines the relationship between carbon emissions and market reaction and investigates the mediating role of ESG performance using panel data from 110 companies listed on the Stock Exchange of Thailand during 2021-2024, comprising 440 firm-year observations. Random-effects panel regression and mediation analysis are employed to test the proposed relationships. The results indicate that carbon emissions are negatively associated with market reaction, suggesting that investors perceive firms with higher carbon emissions as facing greater environmental and financial risks. ESG performance is positively associated with market reaction and partially mediates the relationship between carbon emissions and market reaction. These findings suggest that stronger ESG performance and sustainability disclosure can partially mitigate the adverse market effects of higher carbon emissions. This study contributes to the literature by providing empirical evidence from an emerging market where mandatory sustainability disclosure has recently been introduced. The findings also provide implications for sustainability project management by highlighting the importance of integrating carbon management and ESG practices into organizational planning, implementation, and performance evaluation to strengthen stakeholder confidence and support long-term organizational value.

© 2026 by the authors; licensee Growing Science, Canada

1. Introduction

Climate change has become one of the most pressing global challenges, creating substantial environmental and economic risks that increasingly influence corporate strategies and investment decisions (IPCC, 2021; Krueger et al., 2020). In response, governments and regulatory agencies have strengthened sustainability policies and environmental disclosure requirements to improve corporate transparency and accountability (Flammer, 2021; SEC Thailand, 2024). Consequently, carbon emissions have become an important indicator of firms' environmental performance and are increasingly incorporated into investors' assessments of climate-related risks and long-term corporate value (da Silva et al., 2016; Bolton & Kacperczyk, 2021; Pankratz et al., 2021; Trumpp et al., 2015). Alongside environmental performance, Environmental, Social, and Governance (ESG) performance has emerged as an important measure of corporate sustainability (Khan et al., 2016). ESG performance (Fatemi et al., 2018) reflects the extent to which firms integrate environmental responsibility, stakeholder engagement, and governance practices into their operations and is widely recognized as an indicator of corporate transparency and sustainability performance (Gillan et al., 2021; Friede et al., 2015; Zhou, D., & Zhou, 2021). Firms with stronger ESG performance are generally expected to reduce information asymmetry, strengthen investor confidence, and achieve more favorable market responses. From a theoretical perspective, this study draws on Signaling Theory and Legitimacy Theory. Signaling Theory suggests that sustainability disclosure provides credible information that reduces information asymmetry and improves investors' assessments of firm quality (Spence, 1973). Legitimacy Theory argues that organizations seek to align their environmental practices with stakeholder expectations and societal norms to maintain legitimacy and long-term support

* Corresponding author
E-mail Nuttavong.p@acc.msu.ac.th (N. Poonpool) utis24@acc.msu.ac.th (U. Bhoungchirawattana)
ISSN 2371-8374 (Online) - ISSN 2371-8366 (Print)
2026 Growing Science Ltd.
doi: 10.5267/j.jpm.2026.8.001

(Suchman, 1995; Dowling & Pfeffer, 1975). Together, these perspectives explain how carbon emissions and ESG performance may influence market reaction.

Thailand provides an appropriate context for this study following the introduction of mandatory greenhouse gas disclosure through the Form 56-1 One Report in 2021 (SEC Thailand, 2024; Oh, 2024). Although previous studies have examined the relationships among carbon emissions (Noh & Park, 2023), ESG performance, and firm value, empirical evidence on the mediating role of ESG performance in explaining market reaction remains limited, particularly in emerging markets.

Accordingly, this study examines the relationship between carbon emissions and market reaction and investigates the mediating role of ESG performance using panel data from 110 companies listed on the Stock Exchange of Thailand during 2021-2024. The findings contribute to the sustainability and capital market literature by providing evidence from an emerging market and offer implications for sustainability project management by highlighting the importance of integrating environmental performance and ESG practices into organizational planning, implementation, and performance evaluation to strengthen stakeholder confidence and support long-term organizational value.

The remainder of this paper is organized as follows. Section 2 reviews the theoretical background and develops the hypotheses. Section 3 describes the research methodology. Section 4 presents the empirical results and discussion. Section 5 concludes the study and discusses its implications, limitations, and directions for future research.

2. Literature Review

2.1 Theoretical Background

2.1.1 Signaling Theory

Signaling Theory explains how firms reduce information asymmetry by voluntarily disclosing relevant information to external stakeholders, particularly investors (Spence, 1973). Because managers generally possess more information about a firm's operations and future prospects than outside investors, voluntary disclosure serves as an important mechanism for communicating firm quality and reducing uncertainty in capital markets.

In the context of sustainability management, disclosures related to carbon emissions and Environmental, Social, and Governance (ESG) performance provide important signals regarding a firm's environmental responsibility, governance quality, and long-term commitment to sustainable business practices (Asyari & Arieftiara, 2022). Transparent sustainability disclosure enables investors to better assess firms' exposure to climate-related risks and their capacity to create long-term value. Consequently, firms providing comprehensive and credible sustainability information are generally perceived as more transparent and accountable, thereby strengthening investor confidence and reducing information asymmetry (Hapsoro & Falih, 2020; El Ghoul et al., 2011).

Prior studies further suggest that investors increasingly incorporate environmental information into their investment decisions because sustainability disclosure improves the quality of firms' information environments and signals a commitment to responsible corporate management (Giansante et al., 2023). From the perspective of Signaling Theory, carbon emissions and ESG performance constitute important informational signals that influence investors' assessments of firm quality and ultimately affect market reaction. Accordingly, this theory provides the theoretical foundation for explaining the relationship among carbon emissions, ESG performance, and market reaction examined in this study.

2.1.2 Legitimacy Theory

Legitimacy Theory suggests that organizations seek to maintain legitimacy by aligning their operations and business practices with societal values, stakeholder expectations, and regulatory requirements (Dowling & Pfeffer, 1975; Suchman, 1995). The theory is based on the concept of a social contract, whereby organizations are expected to operate in ways that are considered appropriate and acceptable by society. Failure to meet these expectations may result in reputational damage, increased stakeholder pressure, and reduced organizational support.

In the context of sustainability management, organizations increasingly implement environmental initiatives, including carbon emission reduction and ESG disclosure, to demonstrate their commitment to sustainable development and responsible corporate behavior. Growing concerns over climate change, together with evolving regulatory requirements and stakeholder expectations, have encouraged firms to improve environmental performance and strengthen sustainability disclosure (Fernandes, 2023; Koseoglu et al., 2024). These sustainability practices reinforce organizational legitimacy by demonstrating compliance with societal expectations and enhancing corporate accountability.

Prior studies indicate that organizations with stronger sustainability performance are more likely to gain stakeholder trust, strengthen corporate reputation, and maintain positive relationships with investors, regulators, and other stakeholders (Oliveira et al., 2010). From the perspective of Legitimacy Theory, carbon emission reduction and ESG performance represent important mechanisms through which organizations maintain legitimacy and enhance stakeholder confidence. Accordingly, this theory provides the theoretical foundation for explaining how environmental performance and sustainability practices influence market reaction.

2.2 Carbon Emissions, ESG Performance, and Market Reaction

Carbon emissions have become an important indicator of firms' environmental performance and climate-related risk. As regulatory requirements and stakeholder expectations continue to increase, investors increasingly incorporate carbon-related information into their assessments of corporate sustainability and long-term value (Bolton & Kacperczyk, 2021; Krueger et al., 2020; Pástor et al., 2021; Deegan, 2002). Firms with higher carbon emissions are generally perceived as being exposed to greater environmental, regulatory, and reputational risks, which may result in less favorable market reactions. Previous studies consistently report that carbon emissions influence investor behavior and firm valuation. Firms with higher carbon emission intensity tend to receive less favorable market responses because investors associate carbon-intensive operations with higher future costs and sustainability-related risks (Giansante et al., 2023; Li et al., 2023). However, prior evidence remains inconclusive across different institutional settings, suggesting that the impact of carbon-related information may depend on corporate disclosure practices and governance quality (Asyari & Arieftiara, 2022; Lucia et al., 2022). In addition to environmental performance, ESG performance has become an important indicator of firms' sustainability management. ESG performance reflects how effectively organizations integrate environmental responsibility, governance quality, and stakeholder engagement into their business operations (Gillan et al., 2021). Strong ESG performance improves transparency, reduces information asymmetry, and enhances investor confidence, thereby contributing to more favorable market reactions (Velte, 2022; Wang et al., 2021; Wang & Xing, 2025). Moreover, ESG performance may represent an important organizational mechanism through which sustainability management influences investors' evaluations by demonstrating firms' commitment to responsible business practices (Eccles et al., 2014; Matsumura et al., 2014; Friede et al., 2015).

2.3 Research Gap and Hypothesis Development

Although previous studies have examined the relationships among carbon emissions, ESG performance, and market outcomes, several research gaps remain.

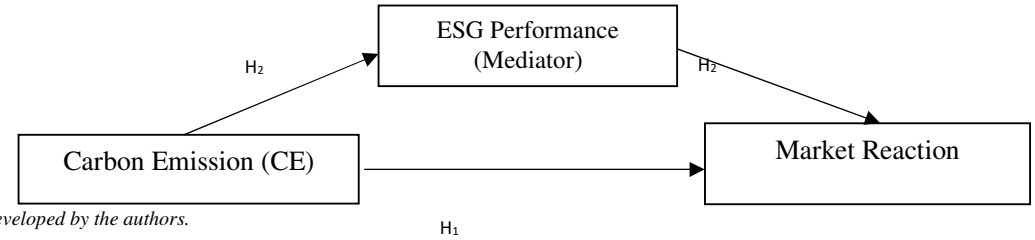
First, most prior studies focus on the direct effects of carbon emissions or ESG performance separately, while limited attention has been given to the mechanism through which ESG performance links carbon emissions with market reaction. Consequently, the role of ESG performance as an intermediary between environmental performance and investor responses remains insufficiently understood. Second, existing evidence has been generated primarily from developed economies. Empirical evidence from emerging markets remains limited, particularly in Thailand, where mandatory sustainability disclosure through the Form 56-1 One Report has only recently been introduced. This regulatory change provides an appropriate setting for examining how investors respond to carbon emissions and sustainability information. Drawing upon Signaling Theory and Legitimacy Theory, this study argues that firms with lower carbon emissions are expected to receive more favorable market reactions because they signal stronger environmental responsibility and lower sustainability-related risk. Furthermore, ESG performance serves as an important mechanism through which firms communicate their sustainability commitment, improve transparency, and strengthen investor confidence. Accordingly, ESG performance is expected to mediate the relationship between carbon emissions and market reaction. Therefore, based on Signaling Theory, Legitimacy Theory, and the identified research gaps, this study proposes the following hypotheses:

H_1: *Carbon emissions are negatively associated with market reaction.*

H_2: *ESG performance mediates the relationship between carbon emissions and market reaction.*

2.4 Conceptual Framework

Based on Signaling Theory and Legitimacy Theory, this study proposes a conceptual framework explaining the relationship between carbon emissions, ESG performance, and market reaction. Carbon emissions represent firms' environmental performance, whereas ESG performance reflects the effectiveness of sustainability management and corporate disclosure practices. From the perspective of Signaling Theory, ESG performance provides credible information regarding firms' environmental responsibility and governance quality, thereby reducing information asymmetry between firms and investors. Legitimacy Theory further suggests that organizations strengthen stakeholder confidence by aligning their environmental practices with societal expectations and regulatory requirements. Accordingly, this study proposes that carbon emissions directly influence market reaction, while ESG performance serves as a mediating mechanism through which firms' sustainability management practices affect investor responses. The proposed conceptual framework is presented in Fig. 1.



Source: Developed by the authors.

Fig. 1. Conceptual Framework

3. Research design and methodology

3.1 Data and Sample Selection

This study employs a quantitative research design using balanced panel data to examine the relationship between carbon emissions, ESG performance, and market reaction among companies listed on the Stock Exchange of Thailand (SET). Panel data analysis enables the examination of both cross-sectional and time-series variations, thereby improving estimation efficiency and controlling for unobservable firm-specific effects.

The sample consists of 110 companies listed on the SET over the period 2021–2024, resulting in 440 firm-year observations. The study period begins in 2021 following the introduction of mandatory sustainability disclosure through the Form 56-1 One Report, which requires listed companies to report greenhouse gas emissions and other sustainability-related information. This provides an appropriate setting for examining investors' responses to carbon emissions and ESG performance during the early stage of mandatory sustainability reporting in Thailand. Financial and sustainability data were obtained primarily from the Bloomberg Professional Database, including carbon emissions, ESG performance, stock prices, total assets, and financial leverage. Annual reports and information published by the Stock Exchange of Thailand (SET) were used to verify corporate disclosure data. Companies with incomplete information on the variables used in this study were excluded from the sample to ensure data consistency and reliability.

3.2 Variable Measurement

This study examines the relationship between carbon emissions, ESG performance, and market reaction. The dependent, independent, mediating, and control variables are defined as follows.

3.2.1 Market Reaction (MR)

Market reaction (MR) is the dependent variable and is measured as the average stock price change within five trading days following the disclosure of the annual report through the Stock Exchange of Thailand (SET), following Treepongkaruna and Suttipun (2024). This measure captures investors' short-term responses to newly disclosed corporate information.

3.2.2 Carbon Emissions (CE)

Carbon emissions (CE) are the primary independent variable representing firms' environmental performance. Following previous studies, carbon emission intensity is measured as total carbon emissions divided by sales (CE/SALE), expressed as metric tons per unit of sales (Khatib et al., 2023; Kim et al., 2023; Ratmono et al., 2021; Palea & Drogo, 2020; Yuliana & Wedari, 2023). Lower values indicate better environmental performance and more effective carbon emission management.

3.2.3 ESG Performance (ESG)

ESG performance (ESG) is the mediating variable and is measured using the Bloomberg ESG Disclosure Score, ranging from 0.1 to 100. Following previous studies, the natural logarithm of the ESG score is used to improve data normality and reduce heteroscedasticity.

3.2.4 Control Variables

Two firm-specific control variables are included in the analysis. Firm size (SIZE) is measured as the natural logarithm of total assets, while leverage (LEV) is measured as the ratio of total debt to total assets. These variables are included to control for firm characteristics that may influence market reaction.

The definitions, measurements, and data sources of all variables are summarized in Table 1.

Table 1
Variable Definitions and Measurements

Variable	Definition	Measurement	Source
MR	Market Reaction	$MR = \frac{\sum_{n=1}^{5} R_t}{5}, where\ R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$	Bloomberg Professional Database; Annual Reports
CE	Carbon Emissions	$CE = \frac{Total\ Carbon\ Emissions\ (tCO_2e)}{Sale}$	Bloomberg Professional Database
ESG	ESG Performance	ESG=ln (Bloomberg ESG Disclosure Score)	Bloomberg Professional Database
SIZE	Firm Size	SIZE=ln (Total Assets)	Bloomberg Professional Database
LEV	Leverage	$LEV = \frac{\text{Total Debt}}{\text{Total Assets}}$	Bloomberg Professional Database

Note: MR = Market Reaction; CE = Carbon Emissions; ESG = Environmental, Social, and Governance Performance; SIZE = Firm Size; LEV = Leverage. Carbon emissions (CE) are measured as total greenhouse gas emissions (tCO_2e) divided by annual sales revenue, representing carbon emission intensity. ESG performance is measured using the natural logarithm of the Bloomberg ESG Disclosure Score.

3.3 Data Analysis and Econometric Specification

Panel data regression analysis was employed to examine the proposed hypotheses regarding the relationship between carbon emissions, ESG performance, and market reaction. The analysis was conducted using random-effects panel regression models, as the Hausman specification test indicated that the random-effects estimator was more appropriate than the fixed-effects

estimator (p-values > 0.05). Year fixed effects were included in all models to control for time-specific factors, while firm size (SIZE) and leverage (LEV) were incorporated as control variables.

To test Hypothesis 1, which proposes that carbon emissions are negatively associated with market reaction, the following baseline model was estimated:

Model (1): Direct effect model (H1)

$$MR_{it} = \beta_0 + \beta_1 CE_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \varepsilon_{it}$$

To test **Hypothesis 2**, which proposes that ESG performance mediates the relationship between carbon emissions and market reaction, three additional regression models were estimated following the mediation procedure proposed by Baron and Kenny (1986).

Model (2): Mediator model

$$ESG_{it} = \beta_0 + \beta_1 CE_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \varepsilon_{it}$$

Model (3): Outcome model

$$MR_{it} = \beta_0 + \beta_1 ESG_{it} + \beta_2 SIZE_{it} + \beta_3 LEV_{it} + \varepsilon_{it}$$

Model (4): Full mediation model

$$MR_{it} = \beta_0 + \beta_1 CE_{it} + \beta_2 ESG_{it} + \beta_3 SIZE_{it} + \beta_4 LEV_{it} + \varepsilon_{it}$$

where:

- **MR** = Market reaction
- **CE** = Carbon emissions
- **ESG** = ESG performance
- **SIZE** = Firm size
- **LEV** = Leverage
- **i** = Firm
- **t** = Year
- **ε** = Error term

Hypothesis 1 is supported if the coefficient of carbon emissions (β_1) in Model (1) is negative and statistically significant. Following Baron and Kenny (1986), mediation is supported when: (1) carbon emissions significantly affect market reaction (Model 1), (2) carbon emissions significantly affect ESG performance (Model 2), (3) ESG performance significantly affects market reaction (Model 3), and (4) ESG performance remains significant while the coefficient of carbon emissions is reduced after ESG performance is included in Model (4), indicating a partial mediating effect.

To ensure the robustness of the findings, additional analyses were conducted using firm-clustered robust standard errors, additional firm-level control variables, and an alternative measure of carbon emissions. Multicollinearity was assessed using the Variance Inflation Factor (VIF), and no evidence of serious multicollinearity was detected. The robustness analyses confirmed that the empirical results remained stable across alternative model specifications.

4. Results and Discussion

4.1 Descriptive Statistics

Table 1
Variable Definitions and Measurements

Variable	Mean	Std. Dev.	Min	Max
MR	-0.01	0.43	-2.90	3.66
CE	2.39	0.92	-0.34	5.17
ESG	64.84	21.66	14.10	100.00
SIZE	1.12	1.12	0.08	6.89
LEV	19.76	6.58	8.64	27.56

Note: N = 440 firm-year observations.

Table 2 presents the descriptive statistics for the variables based on 440 firm-year observations. The results indicate sufficient variation across firms in market reaction, carbon emissions, ESG performance, and firm characteristics, supporting the suitability of the dataset for panel data analysis. The mean value of market reaction (MR) is -0.01, with values ranging from -2.90 to 3.66, indicating substantial variation in investors' responses following annual report disclosure. Carbon emissions (CE) have a mean value of 2.39 (Min = -0.34, Max = 5.17), suggesting considerable differences in carbon emission intensity

across firms. ESG performance (ESG) has an average score of 64.84, ranging from 14.10 to 100.00, reflecting variation in sustainability performance and disclosure practices among Thai listed companies. The control variables also exhibit adequate variation. The mean values of firm size (SIZE) and leverage (LEV) are 1.12 and 19.76, respectively, indicating differences in firm characteristics across the sample. Overall, the observed variability supports the subsequent regression analysis.

4.2 Correlation Analysis

Table 3
Pearson Correlation Matrix

Variable	MR	CE	ESG	SIZE	LEV
MR	1				
CE	-0.141**	1			
ESG	0.126**	0.136**	1		
SIZE	0.051	-0.015	-0.073	1	
LEV	-0.089	-0.012	0.059	-0.770**	1

*Note: * There is a significant correlation at the 0.05 level (2-tailed); ** There is a significant correlation at the 0.01 level (2-tailed).*

Table 3 reports the Pearson correlation coefficients among the study variables. The correlation matrix provides preliminary evidence of the relationships among the variables prior to the panel regression analysis. Market reaction (MR) is negatively correlated with carbon emissions (CE) ($r = -0.141$, $p < 0.01$), suggesting that firms with higher carbon emission intensity tend to experience less favorable market reactions. In contrast, ESG performance (ESG) is positively correlated with market reaction ($r = 0.126$, $p < 0.01$), indicating that firms with stronger sustainability performance generally receive more favorable investor responses. Carbon emissions are positively correlated with ESG performance ($r = 0.136$, $p < 0.01$). This correlation represents only a bivariate association, and the relationship is further examined using multivariate panel regression analysis after controlling for firm characteristics. Among the control variables, neither firm size (SIZE) nor leverage (LEV) is significantly correlated with market reaction. Although SIZE and LEV exhibit a relatively high negative correlation ($r = -0.770$, $p < 0.01$), the correlation coefficient remains below the commonly accepted threshold of 0.80, suggesting that multicollinearity is unlikely to be a serious concern (Gujarati & Porter, 2009; Hair et al., 2019).

4.3 Regression Results

Table 4 reports the random-effects regression results for testing the proposed hypotheses. The Hausman specification test indicates that the random-effects model is appropriate for all estimated models ($p > 0.05$). Year fixed effects and the control variables (SIZE and LEV) are included in all estimations.

Table 4
Panel Regression Results: The Effects of Carbon Emissions and ESG Performance on Market Reaction

Variables	(1) Market Reaction	(2) ESG Performance	(3) Market Reaction	(4) Market Reaction
	Direct Effect (H1)	Mediator Model	Outcome Model	Mediation Model (H2)
Carbon Emissions (CE)	-0.063***	0.020*	-	-0.075***
	(0.024)	(0.011)		(0.027)
ESG Performance (ESG)	-	-	0.322**	0.377***
			(0.140)	(0.143)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	440	440	440	440
R^2	0.029	0.019	0.026	0.052
Hausman test (p-value)	0.220	0.435	0.493	0.432

*Notes: Standard errors are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. All models are estimated using random-effects panel regression with year fixed effects and control variables (SIZE and LEV).*

Model (1): Direct Effect of Carbon Emissions on Market Reaction

Model (1) examines the direct relationship between carbon emissions and market reaction. Carbon emissions exhibit a negative and statistically significant coefficient ($\beta = -0.063$, $p < 0.01$), indicating that firms with higher carbon emission intensity experience less favorable market reactions. Therefore, H1 is supported.

Model (2): Mediator Model

Model (2) estimates the effect of carbon emissions on ESG performance. The coefficient of carbon emissions is positive and weakly significant ($\beta = 0.020$, $p < 0.10$), indicating that firms with higher carbon emissions tend to report higher ESG performance.

Model (3): Outcome Model

Model (3) examines the relationship between ESG performance and market reaction. ESG performance has a positive and statistically significant effect on market reaction ($\beta = 0.322$, $p < 0.05$), indicating that firms with stronger ESG performance receive more favorable market reactions.

Model (4): Mediation Model

Model (4) includes both carbon emissions and ESG performance. ESG performance remains positively associated with market reaction ($\beta = 0.377$, $p < 0.01$), while carbon emissions remain negatively associated with market reaction ($\beta = -0.075$, $p < 0.01$). The significance of both coefficients indicates that ESG performance partially mediates the relationship between carbon emissions and market reaction. Accordingly, H2 is supported.

Overall, the results indicate that carbon emissions are negatively associated with market reaction, whereas ESG performance is positively associated with market reaction and partially mediates the relationship between carbon emissions and market reaction.

4.4 Robustness Tests

To assess the robustness of the empirical findings, several alternative model specifications were estimated. Table 5 reports the results obtained using different estimation methods, additional control variables, and an alternative measure of carbon emissions.

Table 5
The robustness tests using alternative model specifications.

Variables	(1) Baseline RE	(2) Clustered RE	(3) RE + Additional Controls	(4) Alternative Carbon Measure
Carbon Emissions (CE)	-0.073***	-0.072***	-0.077***	-0.028***
	(0.026)	(0.027)	(0.026)	(0.010)
ESG Performance (ESG)	0.379***	0.353**	0.371**	0.460***
	(0.141)	(0.142)	(0.143)	(0.016)
Firm Size (SIZE)	-0.002	-0.008	-0.002	-0.100
	(0.005)	(0.007)	(0.005)	(0.010)
Leverage (LEV)	-0.050	-0.044	-0.045	-0.043
	(0.033)	(0.033)	(0.031)	(0.033)
Additional Controls	No	No	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	440	440	440	440
R^2	0.052	0.059	0.056	0.050
Hausman test (p-value)	0.103	0.418	0.110	0.945

*Notes: Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All models are estimated using random-effects panel regression with year fixed effects. Column (2) reports firm-clustered robust standard errors. Column (3) includes additional firm-level control variables. Column (4) replaces carbon emission intensity (CE/SALE) with total carbon emissions as an alternative measure.*

Column (1) presents the baseline random-effects model with year fixed effects. The results show that carbon emissions remain negatively associated with market reaction ($\beta = -0.073$, $p < 0.01$), whereas ESG performance has a positive and statistically significant effect on market reaction ($\beta = 0.379$, $p < 0.01$).

Column (2) re-estimates the baseline model using firm-clustered robust standard errors to account for potential heteroskedasticity and within-firm serial correlation. The estimated coefficients remain similar in magnitude and significance, indicating that the main findings are robust to alternative standard error estimation.

Column (3) includes additional firm-level control variables to address potential omitted-variable bias. The coefficients of carbon emissions ($\beta = -0.077$, $p < 0.01$) and ESG performance ($\beta = 0.371$, $p < 0.05$) remain statistically significant and retain the expected signs, confirming the stability of the baseline results.

Column (4) employs total carbon emissions as an alternative proxy for environmental performance instead of carbon emission intensity. The results remain qualitatively unchanged. Carbon emissions continue to exhibit a significant negative association with market reaction ($\beta = -0.028$, $p < 0.01$), while ESG performance maintains a positive and significant effect ($\beta = 0.460$, $p < 0.01$).

Overall, the robustness analyses confirm that the principal findings are stable across alternative model specifications, estimation methods, and measurements of carbon emissions. The consistent evidence supports the conclusion that higher carbon emissions are associated with less favorable market reactions, whereas stronger ESG performance is associated with more favorable market responses.

5. Discussion

The results indicate that carbon emissions are negatively associated with market reaction, suggesting that investors perceive firms with higher carbon emission intensity as facing greater environmental and financial risks. This finding is consistent with previous studies (Bolton & Kacperczyk, 2021; Krueger et al., 2020) and supports Legitimacy Theory, which argues that firms enhance stakeholder acceptance by aligning their environmental practices with societal expectations and regulatory requirements (Suchman, 1995).

The findings also show that ESG performance is positively associated with market reaction and partially mediates the relationship between carbon emissions and market reaction. This result supports Signaling Theory (Spence, 1973), indicating that stronger ESG performance provides credible information regarding firms' sustainability practices, reduces information asymmetry, and enhances investor confidence. Although higher carbon emissions negatively influence market reaction, improved ESG performance can partially mitigate these adverse effects through greater transparency and stronger sustainability governance.

From a project management perspective, the findings suggest that carbon emission management should be implemented as a strategic sustainability initiative supported by effective planning, governance, implementation, and performance monitoring. Organizations that successfully integrate carbon management into sustainability projects are more likely to strengthen ESG performance and improve stakeholder confidence, thereby enhancing market perception and long-term organizational value.

Finally, the robustness analyses confirm that the results remain consistent across alternative model specifications and measurements of carbon emissions, supporting the reliability of the empirical findings. Overall, this study contributes to the project management literature by demonstrating that effective sustainability management, reflected in carbon emission management and ESG implementation, plays an important role in improving market outcomes in an emerging economy.

5. Conclusions

This study examines the relationship between carbon emissions and market reaction and investigates the mediating role of ESG performance using panel data from Thai listed companies during 2021–2024. The findings indicate that carbon emissions are negatively associated with market reaction, while ESG performance is positively associated with market reaction and partially mediates this relationship. These results suggest that stronger ESG performance can partially mitigate the adverse market effects associated with higher carbon emissions.

This study contributes to the sustainability and project management literature by showing that effective carbon emission management, supported by ESG implementation and transparent sustainability practices, enhances investor confidence and organizational value. The findings also provide empirical evidence from an emerging market where sustainability disclosure has recently become mandatory.

From a practical perspective, organizations should integrate carbon emission management and ESG practices into sustainability planning and implementation to strengthen environmental performance and stakeholder confidence. The findings also provide useful insights for investors and policymakers seeking to improve corporate sustainability and disclosure quality.

This study is limited to Thai listed companies during 2021–2024. Future research may examine other institutional settings, longer study periods, or alternative environmental performance measures to further validate and extend the findings.

Funding

This research was financially supported by Mahasarakham Business School, Mahasarakham University.

References

Asyari, S., & Arieftiara, D. (2022). Investors React to Disclosure of Carbon Emissions and Environmental Performance. *International Journal of Contemporary Accounting, 4*(1), 59-76. http://dx.doi.org/10.25105/ijca.v4i1.13911

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of personality and social psychology, 51*(6), 1173. https://doi.org/10.1037/0022-3514.51.6.1173

Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk?. *Journal of financial economics, 142*(2), 517-549. https://doi.org/10.1016/j.jfineco.2021.05.008

Deegan, C. (2002). Introduction: The legitimising effect of social and environmental disclosures–a theoretical foundation. *Accounting, auditing & accountability journal, 15*(3), 282-311. https://doi.org/10.1108/09513570210435852

da Silva, P. P., Moreno, B., & Figueiredo, N. C. (2016). Firm-specific impacts of CO2 prices on the stock market value of the Spanish power industry. *Energy Policy, 94*, 492-501.https://doi.org/10.1016/j.enpol.2016.01.005

Dowling, J., & Pfeffer, J. (1975). Organizational legitimacy: Social values and organizational behavior. *Pacific sociological review, 18*(1), 122-136. https://doi.org/10.2307/1388226

Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The impact of corporate sustainability on organizational processes and performance. *Management science, 60*(11), 2835-2857. https://doi.org/10.1287/mnsc.2014.1984

El Ghoul, S., Guedhami, O., Kwok, C. C., & Mishra, D. R. (2011). Does corporate social responsibility affect the cost of capital?. *Journal of banking & finance, 35*(9), 2388-2406. https://doi.org/10.1016/j.jbankfin.2011.02.007

Fatemi, A., Glaum, M., & Kaiser, S. (2018). ESG performance and firm value: The moderating role of disclosure. *Global finance journal, 38*, 45-64. https://doi.org/10.1016/j.gfj.2017.03.001

Flammer, C. (2021). Corporate green bonds. *Journal of financial economics, 142*(2), 499-516. https://doi.org/10.1016/j.jfineco.2021.01.010

Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: Aggregated evidence from more than 2000 empirical studies. Journal of Sustainable *Finance & Investment, 5*(4), 210–233. https://doi.org/10.1080/20430795.2015.1118917

Giansante, S., Fatouh, M., & Dove, N. (2023). Carbon emissions announcements and market returns. *Sustainability, 15*(13), 10385. https://doi.org/10.3390/su151310385

Gillan, S. L., Koch, A., & Starks, L. T. (2021). Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of corporate finance, 66*, 101889. https://doi.org/10.1016/j.jcorpfin.2020.101889

Gujarati, D. N., & Porter, D. C. (2009**).** *Basic Econometrics* (**5**th ed.). McGraw-Hill.

Hapsoro, D., & Falih, Z. N. (2020). The effect of firm size, profitability, and corporate governance on sustainability reporting. *International Journal of Energy Economics and Policy, 10*(3), 305–312. https://doi.org/10.32479/ijeep.8976

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage.

IPCC. (2021). Climate change 2021: The physical science basis. Cambridge University Press. https://doi.org/10.1017/9781009157896

Khan, M., Serafeim, G., & Yoon, A. (2016). Corporate sustainability: First evidence on materiality. *The accounting review, 91*(6), 1697-1724. https://doi.org/10.2308/accr-51383

Khatib, S. F., Ismail, I. H., Salameh, N., Abbas, A. F., Bazhair, A. H., & Sulimany, H. G. H. (2023). Carbon emission and firm performance: the moderating role of management environmental training. *Sustainability, 15*(13), 10485. https://doi.org/10.3390/su151310485

Kim, S. J., Kim, H., & Atukeren, E. (2023). Effects of board Independence on greenhouse gas emissions and financial consequences: Evidence from South Korea. *Environments, 10*(3), 56. https://doi.org/10.3390/environments10030056

Koseoglu, M. A., Arici, H. E., Saydam, M. B., & Olorunsola, V. O. (2024). Environmental, social and governance assets and diversity scores: exploring their relationship to carbon emissions in global companies. *Management Decision, 62*(10), 3181-3207. https://doi.org/10.1108/MD-05-2023-0818

Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *The Review of Financial Studies, 33*(3), 1067–1111. https://doi.org/10.1093/rfs/hhz137

Li, W., Liu, T., & Wei, M. (2023). Heterogeneous response of the stock market to CO2 emissions in China. *Frontiers in Energy Research, 10,* 1074262. https://doi.org/10.3389/fenrg.2022.1074262

Lucia, A., Battiston, S., & Kvedaras, V. (2022). Over with carbon? Investors' reaction to the Paris Agreement and the US withdrawal. Investors' Reaction to the Paris Agreement and the US Withdrawal (August 31, 2022). https://doi.org/10.2139/ssrn.4205537

Matsumura, E. M., Prakash, R., & Vera-Muñoz, S. C. (2014). Firm-value effects of carbon emissions and carbon disclosures. *The Accounting Review, 89*(2), 695–724. https://doi.org/10.2308/accr-50629

Noh, J. H., & Park, H. (2023). Greenhouse gas emissions and stock market volatility: an empirical analysis of OECD countries. *International Journal of Climate Change Strategies and Management, 15*(1), 58-80. https://doi.org/10.1108/IJCCSM-10-2021-0124

Oh, H. (2024). The moderating role of ESG administration on the relationship between tourism activities and carbon emissions: a case study of basic local governments in South Korea. *Sustainability, 16*(12), 5215. https://doi.org/10.3390/su16125215

Oliveira, L., Lima Rodrigues, L., & Craig, R. (2010). Intellectual capital reporting in sustainability reports. *Journal of Intellectual Capital, 11*(4), 575-594. https://doi.org/10.1108/14691931011085696

Palea, V., & Drogo, F. (2020). Carbon emissions and the cost of debt: Evidence from European firms. *Journal of Cleaner Production, 264*, 121662.https://doi.org/10.1016/j.jclepro.2020.121662

Pástor, Ľ., Stambaugh, R. F., & Taylor, L. A. (2021). Sustainable investing in equilibrium. *Journal of financial economics, 142*(2), 550-571. https://doi.org/10.1016/j.jfineco.2020.12.011

Pankratz, N., Bauer, R., & Derwall, J. (2023). Climate change, firm performance, and investor surprises. *Management science, 69*(12), 7352-7398 . https://doi.org/10.1016/j.jcorpfin.2021.101969

Ratmono, D., Darsono, D., & Selviana, S. (2021). Effect of carbon performance and company characteristics on carbon disclosure. *International Journal of Energy Eco-nomics and Policy, 11*(1), 101-109. https://doi.org/10.1257/jep.9.4.97

Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics, 87*(3), 355–374. https://doi.org/10.2307/1882010

Suchman, M. C. (1995). Managing legitimacy: Strategic and institutional approaches. *Academy of management review, 20*(3), 571-610. https://doi.org/10.5465/amr.1995.9508080331

SEC Thailand. (2024). Sustainability and greenhouse gas disclosure in Form 56-1 One Report. Securities and Exchange Commission, Thailand.

Treepongkaruna, S., & Suttipun, M. (2026). The impact of environmental, social and governance (ESG) reporting on corporate profitability: evidence from Thailand. *Journal of Financial Reporting and Accounting, 24*(2), 815-841. https://doi.org/10.1108/JFRA-09-2023-0555

Trumpp, C., Endrikat, J., Zopf, C., & Guenther, E. (2015). Definition, conceptualization, and measurement of corporate environmental performance: A critical examination of a multidimensional construct. *Journal of Business Ethics, 126*, 185–204. https://doi.org/10.1007/s10551-013-1931-8

Velte, P. (2022). Meta-analyses on corporate social responsibility (CSR): a literature review. *Management Review Quarterly, 72*(3), 627-675. https://doi.org/10.1007/s11301-021-00211-2

Wang, J., Li, J., & Zhang, Q. (2021). Does carbon efficiency improve financial performance? Evidence from Chinese firms. *Energy Economics, 104*, 105658. https://doi.org/10.1016/j.eneco.2021.105658

Wang, Z., & Xing, T. (2025). ESG information disclosure, stock price informativeness and corporate digital transformation. *Applied Economics, 57*(6), 600-616. https://doi.org/10.1080/00036846.2024

Yuliana, Y., & Wedari, L. K. (2023). Carbon Performance, Green Strategy, Financial Performance Effect on Carbon Emissions Disclosure: Evidence from High Polluting Industry in Indonesia. *International Journal of Sustainable Development & Planning, 18*(5).https://doi.org/10.18280/ijsdp.180529

Zhou, D., & Zhou, R. (2021). ESG performance and stock price volatility in public health crisis: Evidence from COVID-19 pandemic. *International Journal of Environmental Research and Public Health, 19*(1), 202. https://doi.org/10.3390/ijerph19010202

© 2026 by the authors; licensee Growing Science, Canada. This is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (http://creativecommons.org/licenses/by/4.0/).