Available online at www.ijournalse.org

Emerging Science Journal

(ISSN: 2610-9182)

Vol. 8, No. 6, December, 2024

Green Technology Innovation and Corporate Reputation: Key Drivers of ESG and Firm Performance

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Abstract

The purpose of this study is to investigate the impact of Environmental, Social, and Governance (ESG) performance and firm performance within China's manufacturing sector, with a novel focus on the mediating effect of green technology innovation and the moderating influence of corporate reputation. Using a 2011-2022 dataset from A-share listed manufacturing companies on the Shanghai and Shenzhen Stock Exchanges, the study employs multiple regression analysis with a two-way fixed-effects model to examine these relationships. Findings indicate that robust ESG practices significantly enhance company performance, mediated by green technological innovation. However, a negative moderating effect of corporate reputation suggests that higher corporate reputation weakens the ESG-financial performance relationship. Further analyses reveal that privately-owned firms, those in China's eastern region, and environmentally sustainable industries benefit most from strong ESG initiatives. This study addresses the challenge of disentangling key variables by analyzing their interconnected effects. The findings fill a gap in the existing literature by contributing to a deeper understanding of the relationship between ESG and corporate success, particularly through the mediating role of innovation and the moderating influence of reputation. Additionally, the study provides practical recommendations for managers and policymakers to enhance ESG strategies, promote growth, and support sustainable development.

Keywords:
ESG;
Firm Performance;
Green Technology Innovation;
Corporate Reputation.

Article History:

Received:	03	August	2024
Revised:	19	November	2024
Accepted:	25	November	2024
Published:	01	December	2024

1- Introduction

Amid a global push towards sustainability, governments and investors are increasingly focusing on companies' ESG (Environmental, Social, Governance) performance. This shift is driven by ESG's comprehensive approach to sustainable development— environmental protection, social responsibility, and governance excellence [1, 2]—and its capacity to tackle challenges like pandemics, climate change, and economic crises [3]. ESG aims to balance stakeholder interests and maximize social value [4]. ESG is recognized as a key indicator of sustainable development and responsible investing [5], ESG strategies are central to promoting low-carbon, green growth in the economy [6], offering robust support for the real economy's shift towards sustainability [7].

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DOI: http://dx.doi.org/10.28991/ESJ-2024-08-06-021

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Firms embracing ESG principles are at the forefront of societal wealth creation and the advancement of sustainable development, playing a crucial role in the modern economic landscape [6]. The integration of ESG practices is increasingly recognized as a moral imperative and a strategic business decision, with a growing body of evidence suggesting a direct correlation between robust ESG performance and improved financial outcomes for companies. This relationship indicates that a strong commitment to ESG standards can significantly attract investment, enhancing a company's capacity for sustainable growth [8] while simultaneously driving internal efficiencies, lowering risks that affect stock price returns [9], and fostering a culture of innovation within the firm [10]. However, translating ESG practices into economic benefits is complex, affected by factors like company size, industry characteristics, and regional differences [11]. This signals a clear necessity for more in-depth studies. These should investigate the direct effects of ESG initiatives on firm performance and examine how other variables may interact with ESG practices, further delineating the nuanced relationship between these factors.

Green technology innovation is increasingly recognized as a key driver of sustainable development, with significant contributions to resource conservation, environmental protection, and economic performance enhancement [12]. As a proactive strategy, it is indispensable in transforming market dynamics [13], leveraging internal and external resources to optimize processes and enhance production efficiency [14]. Integrating green technology into business models drives long-term value creation and marks a pathway towards sustainable economic success [15, 16]. By examining its mediating role, this research illuminates how green technological advancements operationalize ESG commitments into enhanced economic outputs, showcasing a novel perspective on the strategic integration of sustainability within corporate operations [17]. This approach provides insights into leveraging ESG principles to foster a competitive edge, contributing to a sustainable economic paradigm.

According to Fombrun [18], corporate reputation is a thorough assessment and comprehension of the company's past behaviour and future development potential by all societal sectors. It represents stakeholders' perceptions of the company's ability to meet expectations. A positive company reputation is a crucial strategic asset that can be converted into a long-term competitive advantage, changing the industry's competitive environment [19]. As a result, businesses can benefit from reputational returns [20], but if their reputation is tarnished, they will suffer large losses [21, 22]. The problem becomes more complex, especially when considering the reputation response's lagging effect and the dynamic relationship between CSR and performance [23]. With China's economy expanding quickly and market rivalry fiercer, a company's reputation is becoming more important to its survival and success. Therefore, it is particularly important and urgent to explore the moderating role of corporate reputation in the relationship between ESG practice and firm performance.

The importance of Environmental, Social, and Governance (ESG) research is growing, particularly in economies experiencing rapid industrial growth like China. The country's swift expansion, especially in the manufacturing sector, which accounts for more than half of its total energy consumption [24], has resulted in significant environmental issues such as resource depletion and pollution [25]. These challenges highlight the urgent need to investigate ESG practices within China's manufacturing sector, crucial for the nation's economy and its environmental impact [26]. Despite this urgency, a significant gap exists in the literature; no prior studies have comprehensively addressed the challenge of analyzing the interconnected effects of ESG performance, corporate performance, green technology innovation, and corporate reputation, particularly within the manufacturing sector. This study aims to bridge this gap by providing a clear framework to examine the complex interactions between ESG performance and corporate success. By exploring the mediating role of innovation and the moderating influence of reputation, our findings contribute to a deeper understanding of this relationship, advancing the discourse on the financial benefits of sustainable practices.

This study sets out three primary objectives: 1) To examine the direct impact of ESG performance on the financial performance of manufacturing enterprises in China, assessing how effectively ESG practices contribute to these firms' economic success. 2) To investigate the mediating role of green technology innovation, analyzing how it bridges the gap between ESG practices and enhanced firm performance, thereby highlighting its importance in realizing the benefits of ESG initiatives. 3) To assess the moderating influence of corporate reputation on the relationship between ESG performance and firm performance, determining whether reputation amplifies or diminishes the effects of ESG practices on economic outcomes. The original achievement of this study lies in its development of a comprehensive framework that systematically analyzes these interconnected effects, thus filling a significant gap in the literature. The study overcomes these challenges by utilizing a robust dataset and sophisticated analytical models, offering empirical evidence that deepens the understanding of how ESG engagement translates into corporate success. The findings highlight the critical roles of green technological innovation and corporate reputation, providing actionable insights for enhancing ESG strategies. This research supports the recent push by Chinese policymakers towards responsible business practices, offering evidence to inform the refinement of regulations and the promotion of transparency and sustainability in business operations.

2- Literature Review, Hypotheses, and Research Model

2-1- ESG Performance in China's Manufacturing Industry

The ESG performance of Chinese manufacturing companies varies, with some making significant strides while others face challenges in implementation and resource allocation [27]. Issues such as a lack of specialized ESG talent and insufficient policy support are prevalent, impacting the adoption and effectiveness of ESG practices [28]. Despite these challenges, the recognition of the economic benefits of ESG performance has grown, evidenced by its positive impact on operational efficiency and investment attractiveness [4, 29]. The importance of ESG is further underscored by the increasing flow of capital into green enterprises, with a notable rise in ESG-themed funds reaching approximately 257.84 billion yuan by 2021 [30]. This surge in investment is forcing companies to enhance their ESG strategies amidst a critical period of regulatory and system development in China's ESG landscape [31]. This backdrop sets the stage for a deeper exploration of how green technology innovation and corporate reputation can drive the ESG agenda forward, offering pathways for sustainable growth and competitive advantage in the global market.

2-2- Underpinning Theories

Stakeholder Theory: Stakeholder theory highlights the critical role of stakeholder interactions in the sustained development of enterprises. According to Freeman & McVea [32], businesses must engage with diverse stakeholders, each with distinct expectations and preferences regarding corporate behavior and outcomes. This theory posits that by aligning corporate actions with stakeholder expectations through effective ESG practices, firms can enhance stakeholder satisfaction and support, ultimately fostering a conducive environment for long-term success. Freeman [33] further argues that active engagement with stakeholders is crucial for maintaining a positive corporate image and trust, which are vital for the operational longevity of any business.

Signaling Theory: Signaling theory provides a framework for understanding how corporations communicate their qualities and values to the market, especially in environments characterized by information asymmetry. Rynes et al. [34] and Grigoriou et al. [35] discuss how firms with information advantages can strategically signal their ESG commitments to positively influence stakeholder perceptions and market positions. Ortega Carrasco & Ferrón Vílchez [36] emphasize that revealing ESG performance is a significant signal to external stakeholders, indicating the company's internal qualities and commitment to governance standards. Such signaling enhances transparency, simplifies external oversight and boosts investor and consumer confidence, thereby improving market valuation and corporate governance [37].

Reputation Theory: Reputation theory explores the impact of a company's reputation on its interactions with the market and stakeholders. According to Fombrun & van Riel [38], a strong reputation comprehensively evaluates a company's past performance and future potential, crucially influencing stakeholder trust and expectations. While a robust reputation can attract positive attention and resources, especially during stable times, it can also pose risks during crises by elevating stakeholder expectations to a level that may be challenging to satisfy consistently [39]. Wei et al. [21] and Sun et al. [40] illustrate that high reputational standing can act as a double-edged sword, where the expectations associated with a strong reputation may lead to negative outcomes if not managed carefully, particularly in times of environmental or corporate upheavals.

Stakeholder, signaling, and reputation theories provide a robust theoretical framework for understanding the dynamics between ESG performance, green technology innovation, corporate reputation, and firm performance within China's manufacturing sector. The integration of these theories provides a robust theoretical framework to address the main research question: "Does ESG performance impact the firm performance of Chinese manufacturing listed companies, and if so, what are the roles of green technology innovation and corporate reputation as mediating and moderating factors, respectively?" Stakeholder Theory emphasizes the importance of engaging with and meeting the expectations of various stakeholders to ensure sustainable corporate growth. This theory supports the investigation into how ESG performance impacts firm performance by suggesting that effective ESG practices align stakeholder expectations with corporate objectives, fostering trust and support. Signaling theory illustrates how firms can use ESG performance as a positive signal to reduce information asymmetry and improve corporate governance, thereby enhancing their market position. This theory examines how green technology innovation mediates the relationship between ESG performance and firm performance. Reputation theory offers insights into the impact of corporate reputation on a firm's ability to attract stakeholder attention and manage market expectations, which can influence firm performance positively or negatively. This theory justifies the investigation into the moderating effect of corporate reputation on the relationship between ESG performance and firm performance. Together, these theories provide a comprehensive framework to understand the dynamics between ESG performance, green technology innovation, corporate reputation, and firm performance within China's manufacturing sector. They collectively explain how advancements in green technological innovation and strategic management of corporate reputation can drive the positive impact of ESG practices on firm performance, addressing the complexities of the main research question.

2-3- ESG and Firm Performance

ESG, similar to the widely known Corporate Social Responsibility (CSR), sets itself apart by explicitly encompassing governance, while CSR indirectly addresses governance issues [17]. Consequently, ESG often emerges as a more comprehensive term than the CSR concept [41]. The international academic community has a growing focus on ESG, leading to extensive and in-depth discussions, primarily centering around the intricate relationship between corporate ESG performance and firm performance. This topic continues to elicit debate [42, 43].

Exploring the mechanism behind the beneficial returns of ESG performance on firm performance is still in the theoretical exploration phase. Existing scholarly research indicates a fragmented understanding of the connection between ESG performance and firm performance [43, 44]. Some scholars argue that this relationship is vague, uncertain, or contradictory [45-47]. Due to the multifaceted nature of factors driving ESG activities [48], many of which may remain unobserved, the overall relationship between ESG and firm performance could be either negligible or slightly positive [49].

The academic landscape presents divergent conclusions concerning the link between corporate ESG performance and firm performance. On the one hand, adherents of the neoclassical theory argue for an absence of correlation or a negative association between corporate ESG performance and firm performance [50, 51]. Their perspective suggests that corporate responsibility is inherently a cost, diverting resources from profit generation and potentially hindering corporate financialization, impacting financial performance [51]. Stakeholder theory, on the other hand, contends that satisfying the distinct societal expectations of diverse stakeholders is the primary means by which businesses generate sustainable value. Organizations need to use sustainability management to meet these demands continuously. Stakeholder theory suggests that ESG ratings improve stakeholder trust, which benefits the business's financial performance. This view dominates in academia. For instance, Velte's [52] research indicates that ESG ratings will eventually strengthen the company's financial situation when stakeholder trust rises. A substantial positive link between corporate profitability (ROA) and the ESG composite score was confirmed by the study by Gao et al. [53] A sample of the "100 Best Corporate Citizens" in the US was examined by Ismail & Azman [54], who found that a company's great financial success is facilitated by its aggressive pursuit of ESG performance. Furthermore, China's A-share listed companies were employed as research samples by Yuan & Xiong [55], and Shi & Jiang [30], who also confirmed the usefulness and applicability of the stakeholder theory in Chinese businesses.

From the standpoint of corporate social responsibility, actively carrying out social obligations has a significant impact on an organization's growth, in addition to helping to build a positive public and social image. This opinion is supported by the studies conducted by Byun & Oh [56] and Dutt & Dwivedi [57]. In terms of environmental responsibility, businesses that invest in green technologies can not only demonstrate to the public their capacity for sustainable development and garner greater attention from the market, but they can also gain from the financial policies that governments preferentially offer to incentivize businesses to adopt green practices and enhance the climate and environment to create a better environment for development. Furthermore, enhancing the corporate governance framework can help make more accurate and effective decisions. This fact was verified by Baral [58] and Umar et al. [59] through their examination of the independent director system and director independence.

In conclusion, businesses can optimize their relationship with the external environment and improve their reputation by showcasing their excellent environmental, social, and governance performance. They can also influence the decisions of all stakeholders and send positive signals to them. Long-term acquisition of these intangible assets can greatly improve the company's capacity to withstand risk and provide it with a sustainable competitive edge, which will improve its financial performance. Following a thorough examination of a wide range of research publications regarding the correlation between the influence of ESG performance and business performance, it is determined that companies exhibiting exceptional ESG performance can advance their sustainable growth and boost their overall competitiveness. These businesses typically exhibit more operational consistency and offer investors more dependable long-term profits [29, 55]. Thus, it is assumed in this study that:

H1: *There is a positive impact of ESG performance on firm performance.*

2-4- Mediating Role of Green Technology Innovation

In the face of pressing climate change challenges, nations prioritize green development. Green technological innovation, recognized as a critical solution to environmental and resource issues [60], is increasingly adopted by corporations [16]. Defined as technologies that reduce environmental pollution and resource consumption [61], green technology is pivotal for firms aiming to expand and create value sustainably [62]. Research shows green innovation reduces production costs, conserves resources, boosts productivity, and increases sales, enhancing profitability and reducing financial risks [63-67]. Such innovations are essential for firms to develop core competencies that are valuable and hard to replicate [68].

As ESG principles become central, their alignment with green innovation highlights a shift towards sustainable development, which is essential for meeting stakeholder expectations [69]. Superior ESG performance often correlates with enhanced support for green initiatives, enabling firms to access crucial resources and bolster innovation [10, 70-72]. This dynamic suggests that successful ESG strategies meet stakeholder demands and foster significant improvements in financial performance through green technological advancements [73].

In fact, businesses that adopt ESG practices are better equipped to recognize and cater to the interests of different stakeholders, which enhances effective corporate governance, promotes organizational flexibility and change, and eventually leads to a successful management process transformation. ESG policies can also encourage green innovation and strengthen a company's sense of social, environmental, and governance responsibility. In addition to helping the business become more competitive, this innovation also helps it fulfill stakeholder expectations. Consequently, green innovation is positively impacted by ESG practices and has a beneficial impact on financial performance. The advancement of green technology innovation has led to an improvement in enterprise performance, which is reflected in the direct positive correlation between enterprise ESG performance and financial performance, as supported by the theories of stakeholders, signals, and reputation. On the one hand, businesses frequently boost their investments in technology innovation as part of their pursuit of an ESG strategy to satisfy stakeholders [74], which enhances their capacity for technological innovation [69]. However, the corporation has enhanced the social responsibility and environmental protection of the production process or product through new product creation and process optimization, which has increased revenue and improved financial performance [73].

Combining the viewpoints mentioned above, green technological innovation acts as a connecting mechanism in the trajectory through which ESG performance shapes firm performance, thus magnifying the influence of ESG performance on corporate outcomes. Drawing on these observations and in concordance with the discoveries of Chouaibi et al. [13] and Li et al. [75], this study formulates the second research hypothesis of this paper as follows:

H2: *Green technological innovation mediates the relationship between ESG performance and firm performance.*

2-5- Moderating Role of Corporate Reputation

Hedonic The complex interplay between ESG and firm performance, especially within the manufacturing sector, has garnered substantial interest from academia and the corporate world. Corporate reputation is at the heart of this inquiry, a critical intangible asset that significantly shapes stakeholder perceptions and a firm's ability to meet external expectations across environmental, social, and governance dimensions. A strong corporate reputation has been associated with multiple benefits, such as increased stakeholder trust, higher market valuations, and a competitive edge [76]. Studies confirm a positive link between a robust reputation and firm performance, indicating that companies with a solid reputation enjoy enhanced social resources, elevated societal status, and significant market advantages [20, 77].

In the context of ESG, the importance of corporate reputation is magnified as stakeholder expectations around sustainability escalate. Reputation risks related to ESG issues become pivotal in corporate strategy, influencing investment decisions [78]. The complex relationship between ESG performance and corporate reputation is emphasized by the potential for increased expenses and possible market value declines due to sustainability deficiencies [79]. Furthermore, the role of corporate reputation in mediating the impact of sustainable practices on competitive performance highlights the necessity to align ESG strategies with stakeholder expectations to enhance reputational capital [80].

Empirical research illustrates that corporate reputation not only influences but also moderates the effects of ESG practices on firm performance. Studies reveal that a positive reputation can amplify the benefits of environmental performance on market value, enhancing the perceived value of ESG initiatives [81]. Corporate reputation also serves as a crucial moderating factor in the relationship between sustainable practices and organizational outcomes, potentially strengthening or weakening the impact of these practices [82]. This study, therefore, investigates the moderating role of corporate reputation in the interaction between ESG performance and firm performance within the manufacturing sector. Therefore, it posits that:

H3: *Corporate reputation moderates the relationship between ESG performance and firm performance.*

3- Empirical Analysis

3-1- Sample and Data Sources

The population for this research consists of the entire cohort of listed manufacturing companies in China, totaling 2,718 firms. The period of study spans from 2011 to 2022. Given the extensive nature of this population, a comprehensive approach is adopted to ensure a robust examination of the impact of Environmental, Social, and Governance (ESG) practices on firm performance within this sector. The sampling process involves meticulous criteria to refine the population into a manageable and representative sample. This includes the exclusion of data with missing information,

the removal of companies with abnormal listing statuses, and the application of a truncation method at the 1% upper and lower bounds to address the influence of extreme outliers. Following these stringent selection principles, the study focuses on a final sample of 15,728 valid observational instances from the initial pool of 2,718 listed manufacturing companies.

This study employs an Archival Data Analysis Research approach, leveraging existing databases to compile the necessary data for analysis. The sources of data are as follows:

Green Technology Innovation: Data on green technology innovation is retrieved from the China National Research Data Sharing Platform (CNRDS), providing insights into the innovative practices adopted by manufacturing firms in their pursuit of sustainability.

Corporate Reputation: Information regarding corporate reputation is sourced from the Huazheng and CSMAR databases. These platforms offer comprehensive data on how firms are perceived in terms of their ethical, social, and governance practices.

ESG Performance: The Wind Financial Terminal database is utilized to gather data on the environmental, social, and governance practices of the companies. This includes annual ESG ratings that reflect the firm's commitment to sustainable development.

Firm Performance: Financial performance and other company-specific metrics are primarily sourced or derived from the CSMAR database. This includes operational outcomes that are indicative of the firm's economic health and efficiency.

Green Patent Applications: The count of green patent applications, serving as an indicator of the firms' innovation in sustainability, is obtained from the China National Research Data Service (CNRDS).

3-2- Variable Measurement

Dependent Variable: The study measures firm performance using Return on Assets (ROA), which reflects a company's immediate financial health. The choice of ROA as a performance metric aligns with methods used by scholars globally to examine the link between ESG performance and firm performance, highlighting its relevance and reliability as a measure in this research context [6, 7, 29, 52].

Independent Variable: ESG Performance is quantified using the ESG ratings from the Huazheng Index. The choice of the Huazheng ESG rating is due to its relevance to the Chinese context, comprehensive coverage, and regular updates, making it a widely recognized and used metric in both the professional and academic realms [75]. The Huazheng ESG Index is distinctive for its combination of quarterly assessments and continuous monitoring, ensuring the accuracy and timeliness of the data. In this study, firms' ESG performance levels are classified into nine categories, ranging from C to AAA. This grading system mirrors the methodology by Feng & Long [29] and Shi & Jiang [30], where each rating is assigned a numeric value from 1 to 9, with 1 representing the lowest (C) and nine the highest (AAA) ESG performance. This approach facilitates a structured analysis of the impact of ESG performance on firm outcomes, allowing for a nuanced examination of how varying levels of ESG commitment influence financial performance.

Mediating Variable: The study identifies Green Technological Innovation through the number of green patent applications filed by companies. Considering the sample size and the availability of data, the count of green patents serves as a practical measure of a company's innovation in sustainable technology. To accommodate instances where companies may have no patent applications, this analysis employs the natural logarithm of (the count of patent applications + 1) as the proxy variable. This approach ensures that the variable accurately reflects the mediating role of green technological innovation in the relationship between ESG performance and firm performance, even for firms that are just beginning to engage in green technological endeavors [17, 70].

Moderating Variable: To evaluate Corporate Reputation, this study creates a detailed scoring system by combining elements from both domestic and international rankings. This system, based on the approach by Guan & Zhang [83], utilizes twelve indicators to capture a broad perspective of corporate reputation from the viewpoints of consumers, society, creditors, shareholders, and corporate governance. These indicators are corporate assets, revenue, net profit, industry ranking for value, asset-liability ratio, current ratio, long-term liability ratio, earnings per share, dividends per share, being audited by a Big Four accounting firm, sustainable growth rate, and the proportion of independent directors. Each indicator is chosen for its ability to represent a facet of how stakeholders perceive a company's reputation, with higher values in these metrics indicating a stronger reputation. A factor analysis method is applied to quantify these indicators into a reputation score, subsequently grouping companies into ten categories based on their scores, from 1 (lowest reputation) to 10 (highest reputation).

Control variables: This study incorporates a range of control variables inspired by the factors commonly considered in research on corporate value, particularly aligning with the methodologies of Fang & Hu [10]. These variables, selected to account for financial and operational influences on firm performance outside of ESG initiatives, include Sales Gross

Profit Margin (GrossProfit) highlighting profitability, Asset Turnover Ratio (ATO) as a measure of operational efficiency, Cash Flow Ratio (Cashflow) indicating the ability to generate operational cash, Revenue Growth Rate (Growth) for assessing market expansion, Asset Growth Rate (AssetGrowth) to gauge investment in assets, and Institutional Ownership Ratio (INST) reflecting institutional investor confidence. Including these control variables aims to isolate the impacts of ESG performance, green technological innovation, and corporate reputation on firm performance, ensuring a focused analysis.

Table 1 provides an overview of the measurement techniques utilized for all variables considered in this study.

Table 1. Summary of variables

Variable Types	Variable Name	Negative Sign	Calculation Formula
Dependent Variable	Firm Performance	ROA	Net Profit/Total Assets
Independent Variable	ESG Performance	Score	Huazheng ESG ratings assigned values from 9 to 1 in descending order
Mediating Variable	Green Technological Innovation	Pat	Ln(Green Patent Applications + 1)
Moderating Variable	Corporate Reputation	CR	Factor analysis results based on 12 economic indicators
Control Variables	Gross Profit Margin	GrossProfit	Gross Profit/Total Revenue
	Asset Turnover Ratio	ATO	Total Revenue/Total Assets
	Cash Flow Ratio	Cashflow	Net Cash Flow/Total Assets
	Revenue Growth Rate	Growth	(Current year's total revenue - Previous year's total revenue)/Previous year's total revenue
	Asset Growth Rate	AssetGrowth	(Current year's total assets - Previous year's total assets)/Previous year's total assets
	Institutional Ownership Percentage	INST	Total shares held by institutions/Total outstanding shares

3-3- Data Analysis

By using quantitative research techniques, this study seeks to investigate the research issue and validate pertinent hypotheses. To guarantee the precision and dependability of the gathered information, the crucial elements were assessed and gathered from several sources. We employed a two-way fixed effects model for multiple linear regression analysis throughout the data analysis stage to precisely capture the relationship between the study variables while accounting for temporal and individual effects. The data analysis was done using the statistical program STATA17.0.

- Descriptive statistical analysis: To better understand the fundamental properties and distribution of the data, perform an initial analysis on the condensed industry data to compute the fundamental statistics, such as the mean, standard deviation, and minimum and maximum values of each variable.
- Correlation analysis: To comprehend the fundamental connections between the variables and the underlying multicollinearity issue, the Pearson correlation coefficient between the primary variables was computed.
- Multiple linear regression analysis: To examine the relationship between ESG performance and enterprise performance and to confirm H1, a multiple linear regression model was built. The following is the Model 1:

$$\mathrm{ROA}_{it} = \alpha_0 + \alpha_1 \mathrm{Score}_{it} + \alpha_2 Controls_{it} + \gamma_i + \mu_t + \epsilon_{it} \quad (1)$$

where t stands for the year and i for the company. Score_{it} and ROA_{it} represent the ESG rating and financial performance of company i in period t, respectively. $\mathrm{Controls}_{it}$ represents the six control variables set in this study. The model's time-fixed effects are described by μ_t, and the model's individual fixed effects are described by γ_i. The incorrect term is ϵ_{it}.

- Mediation effect analysis: To investigate the mediation effect of green technology innovation, the three-step method of Baron & Kenny [84] was applied. Pat_{it} was added as the mediation variable to construct models 2 and (3), and a regression test was carried out in conjunction with model 1 to confirm H2. Models 2 and 3 look like this:

$$\mathrm{Pat}_{it} = \beta_0 + \beta_1 \mathrm{Score}_{it} + \beta_2 \mathrm{Controls}_{it} + \gamma_i + \mu_t + \epsilon_{it} \quad (2)$$

$$\mathrm{ROA}_{it} = \mu_0 + \mu_1 \mathrm{Score}_{it} + \mu_2 \mathrm{Pat}_{it} + \mu_3 \mathrm{Controls}_{it} + \gamma_i + \mu_t + \epsilon_{it} \quad (3)$$

- Moderation effect analysis: Verify hypothesis 3 and assess the regulatory effects of corporate reputation (CR_{it}) by using a regression model with interaction terms. The following is the Model 4:

$$\mathrm{ROA}_{it} = \eta_0 + \eta_1 \mathrm{Score}_{it} + \eta_2 \mathrm{CR}_{it} + \eta_3 \mathrm{CR}_{it} * \mathrm{Score}_{it} + \eta_4 \mathrm{Controls}_{it} + \gamma_i + \mu_t + \epsilon_{it} \quad (4)$$

4- Empirical Findings

4-1- Descriptive Statistics

Table 2 illustrates the descriptive statistics for the variables. The ROA for the sample companies spanning is 4.7040, accompanied by a standard deviation of 5.9632, indicating noteworthy variability in the asset return rates within the sample. The financial performance levels of the sample companies exhibit substantial diversity, with a minimum ROA of -20.5502 and a maximum of 22.3322. This highlights a range of profitability among sample companies, with some demonstrating robust profitability and others grappling with significant losses. We find that the average ESG performance score for the present sample companies stands at 4.2515, equivalent to a grade falling between B and BB. This signals a suboptimal condition, pointing to the relatively deficient ESG concepts and practices in the current phase of China's manufacturing industry. The ESG performance is evidently in its early developmental stages, with a substantial portion of companies scoring below the overall average, highlighting the need for enhancements in the overall rating situation.

The enterprise green technological innovation mean value was found to be 0.6354, with a standard deviation of 0.9942. This suggests that the amount of green technological innovation is somewhat variable. The degrees of green technology innovation vary among manufacturing businesses due to factors such as talent availability, competitive pressure, knowledge of sustainable development, corporate innovation culture, and R&D expenditure in green technology innovation. Corporate reputation (CR) characteristic statistics also show significant variation, with an average score of 5.7010 and a standard deviation of 2.7948. This suggests that corporate reputation scores are relatively variable, reflecting the wide range of reputations among the sampled companies. While a low corporate reputation could necessitate actions to repair the image, a great corporate reputation might indicate a positive perception of the organization in the market. Furthermore, notable variations exist in other metrics of the representative firms, suggesting that the sample chosen for this investigation was appropriate.

Table 2. Descriptive statistical analysis

Variable	N	Mean	Std. dev.	Min	Max
ROA	15,728	4.7040	5.9632	-20.5502	22.3322
SCORE	15,728	4.2515	1.0693	1.0000	6.0000
Pat	15,728	0.6354	0.9942	0.0000	4.3438
CR	15,728	5.7010	2.7948	1.0000	10.0000
GrossProfit	15,728	0.2884	0.1676	-0.0051	0.8238
ATO	15,728	0.6738	0.3748	0.1224	2.3104
Cashflow	15,728	0.0508	0.0633	-0.1397	0.2382
Growth	15,728	0.1709	0.3390	-0.4757	2.1260
AssetGrowth	15,728	0.1804	0.3127	-0.2623	2.1865
INST	15,728	42.5446	25.2397	0.3100	91.8661

4-2- Correlation Analysis and Multicollinearity Diagnosis

Upon conducting a correlation analysis to explore the dynamics between ESG performance, green technological innovation, and firm performance, findings detailed in Table 3 revealed initial relationships through Pearson correlation coefficients. Notably, the analysis showed a moderate positive correlation between ROA and the ESG rating score (0.224), this indicates that a rise in ROA coincides with the trend of improving corporate ESG performance. The positive connection suggests that improved ESG practices are linked to improved financial success, even though the association was not very high. There exists a moderately positive correlation of 0.157 between enterprise ESG performance and green technology innovation (Pat), with a significant level of 1%. This suggests that a business's ESG performance positively influences green technology innovation to a higher extent. A slight negative correlation between ROA and green technological innovation (Pat) (-0.015), this finding would suggest that the direct influence of green technological innovation on financial performance is restricted in the short run, which is consistent with the long-term nature of the innovation returns. Furthermore, a significant positive connection (0.664***) has been observed between ROA and corporate reputation (CR), underscoring corporate reputation’s role plays in influencing financial success. These correlations suggest meaningful relationships among the variables, supporting the investigation's hypotheses.

Further reinforcing these findings, a variance inflation factor (VIF) test was conducted on both explanatory and control variables to specifically address potential multicollinearity. The results yielded an average VIF of 1.27, comfortably below the conventional threshold of 5. This indicates that multicollinearity is not a concern within our dataset, suggesting that the moderate to strong correlations observed among variables, as outlined in Table 2, do not compromise the analysis. The absence of multicollinearity, confirmed by both the correlation coefficients and the VIF

results, ensures the statistical integrity and robustness of the research model, allowing for reliable interpretation of the effects of ESG performance, green technological innovation, and corporate reputation on firm performance.

Table 3. Correlation analysis

	ROA	Score	Pat	CR	GrossProfit	ATO	Cashflow	Growth	AssetGrowth	INST
ROA	1									
Score	0.224***	1								
Pat	-0.015*	0.157***	1							
CR	0.664***	0.292***	0.251***	1						
GrossProfit	0.411***	0.044***	-0.146***	0.214***	1					
ATO	0.212***	0.048***	0.050***	0.254***	-0.364***	1				
Cashflow	0.455***	0.106***	-0.011	0.373***	0.234***	0.188***	1			
Growth	0.303***	0.005	0.037***	0.195***	0.078***	0.178***	0.015*	1		
AssetGrowth	0.293***	0.033***	0.020**	0.187***	0.101***	0.085***	-0.023***	0.544***	1	
INST	0.163***	0.090***	0.155***	0.370***	-0.031***	0.196***	0.141***	0.045***	0.052***	1

t statistics in parentheses.

* p < 0.1, ** p < 0.05, *** p < 0.01.

4-3- Benchmark Regression

In the benchmark regression using a bidirectional fixed-effects model, detailed in Table 4, the analysis first examines the impact of corporate ESG performance (Score) on financial performance (ROA). The findings indicate a positive and statistically significant relationship at the 1% significance level, with a coefficient of 0.687. After incorporating control variables, this positive correlation remains significant, evidenced by a coefficient of 0.398, supporting Hypothesis 1 that improved ESG scores enhance firm performance. Numerous empirical research [29, 52-55] provide support for this finding, indicating that ESG practices have value effects and are important in affecting enterprise success. Concurrently, the model's goodness of fit demonstrates improvement, underscoring the appropriateness of the selected control variables. These results suggest that enhancing ESG performance not only averts escalating cost burdens that may impact profitability but also ushers in more financing opportunities and resource advantages. It mitigates operational risks, fosters a more favorable business environment, shapes stakeholder preferences, expands market share significantly, and instigates a marked enhancement in corporate financial performance. Consequently, Hypothesis 1 receives confirmation.

Table 4. Benchmark regression results

	(1) ROA	(2) ROA
Score	0.687***	0.398***
	(13.787)	(10.457)
GrossProfit		31.430***
		(61.650)
ATO		7.108***
		(38.518)
Cashflow		11.561***
		(18.913)
Growth		1.408***
		(12.162)
AssetGrowth		1.795***
		(15.194)
INST		0.025***
		(7.934)
_cons	3.800***	-11.883***
	(14.646)	(-38.852)
Fix	Yes	Yes
N	15728	15728
R^2	0.054	0.452

t statistics in parentheses.

* p < 0.1, ** p < 0.05, *** p < 0.01.

4-4- Robustness Checks

To fortify the reliability of our main findings, this study subjected them to rigorous robustness checks, employing three distinct approaches: adjusting the sample period, conducting cluster analysis, and utilizing quantile regression. The outcomes of these robustness tests are delineated in Table 5, with each column presenting a specific approach. Across these three robustness checks, the results consistently affirm the substantial positive impact of ESG performance on firm performance. Notably, in the individual cluster analysis and quantile regression models, this impact becomes more pronounced, further reinforcing our research hypothesis. The model's resilience in these checks contributes to enhancing the credibility of the obtained results.

Table 5. Robustness test results of baseline regression

	(1) ROA	(2) ROA	(3) ROA
Score	0.266***	0.398***	0.620***
	(5.502)	(7.401)	(20.845)
GrossProfit	35.033***	31.430***	15.045***
	(49.603)	(27.626)	(70.337)
ATO	8.804***	7.108***	3.842***
	(32.303)	(18.633)	(39.514)
Cashflow	9.999***	11.561***	23.172***
	(12.629)	(13.201)	(42.970)
Growth	1.165***	1.408***	2.014***
	(8.067)	(8.865)	(17.852)
AssetGrowth	1.841***	1.795***	2.460***
	(12.593)	(12.476)	(20.614)
INST	0.023***	0.025***	0.009***
	(4.772)	(5.679)	(6.966)
_cons	-14.359***	-11.883***	-5.721***
	(-37.504)	(-23.857)	(-27.401)
Fix	Yes	Yes	Yes
N	11605	15728	15728
R^2	0.445	0.452	

t statistics in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4-5- Heterogeneity Analysis

The majority of research has demonstrated that variations in property rights result in significant variations in the obligations of businesses operating in China's unique market environment. Due to these variations, there is a clear discrepancy in the drive and readiness of businesses with varying property rights, as well as in the level of focus on the disclosure and assessment of ESG data. The institutional environment and degree of economic growth vary greatly throughout areas, which imparts regional peculiarities to the ESG practices of businesses. Furthermore, in order to effectively react to outside pressure, polluters may need to make their corporate performance more sensitive to ESG performance. The investigation of how various business characteristics, industry kinds, and geographical locations affect the consequences is crucial to understanding how ESG performance might enhance corporate performance. Thus, this study utilizes heterogeneity analysis to examine the differential impacts of ESG practices on firm performance, with Table 6 showcasing the variations across corporate nature, industry types, and geographical locations.

Notably, non-state-owned enterprises (non-SOEs) and firms in the eastern region of China show stronger positive correlations between ESG performance and firm performance, with coefficients of 0.344 for non-SOEs and 0.397 for eastern enterprises, respectively. This suggests non-SOEs and eastern firms, likely due to their focus on economic returns and regional emphasis on environmental and social governance, benefit more from ESG practices. Additionally, pollution-intensive versus non-polluting companies show significant positive impacts of ESG on ROA, with non-polluting firms experiencing a more pronounced effect, indicated by a 0.422 coefficient, pollution-intensive companies encounter more ESG pressure compared to non-polluting counterparts. These findings align with the empirical study carried out by Yang et al. [85]. These findings reveal that the positive influence of ESG on firm performance is more distinct in non-SOEs, companies in the eastern region, and non-polluting industries, underscoring the nuanced nature of ESG's impact across different firm characteristics.

Table 6. Heterogeneity analysis

	State-owned	Non-state-owned	East	Midwest	Polluting enterprise	Non-polluting enterprise
	ROA	ROA	ROA	ROA	ROA	ROA
Score	0.192***	0.344***	0.397***	0.353***	0.219***	0.422***
	(2.955)	(7.306)	(8.652)	(5.209)	(3.359)	(9.144)
GrossProfit	33.118***	30.557***	33.850***	26.187***	42.288***	28.129***
	(36.839)	(48.503)	(52.942)	(31.213)	(44.024)	(45.881)
ATO	5.890***	7.817***	7.194***	6.790***	6.708***	7.276***
	(21.987)	(32.134)	(32.562)	(20.439)	(23.050)	(30.683)
Cashflow	9.058***	12.240***	10.144***	14.757***	8.930***	11.857***
	(9.106)	(16.206)	(13.765)	(13.676)	(8.743)	(15.772)
Growth	0.881***	1.459***	1.539***	1.112***	1.088***	1.368***
	(3.857)	(10.709)	(10.968)	(5.503)	(5.078)	(10.022)
AssetGrowth	1.260***	1.865***	1.755***	1.834***	1.616***	1.795***
	(4.995)	(13.767)	(12.638)	(8.226)	(7.841)	(12.666)
INST	0.013**	0.029***	0.027***	0.017***	0.009	0.030***
	(2.172)	(7.726)	(7.337)	(2.790)	(1.634)	(8.167)
_cons	-10.011***	-11.650***	-12.479***	-10.122***	-11.460***	-11.497***
	(-17.976)	(-30.448)	(-33.651)	(-18.562)	(-22.440)	(-30.056)
Fix	Yes	Yes	Yes	Yes	Yes	Yes
N	4198	11197	11366	4353	4371	11357
R^2	0.450	0.456	0.461	0.437	0.546	0.429

t statistics in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4-6- Mediating Effect of Green Technological Innovation and Moderating Effect of Corporate Reputation

Table 7 elucidates the mediating role of Green Technological Innovation (Models 1-3) and the moderating role of Corporate Reputation (Model 4) in the dynamic between ESG practices and firm performance. Model 1 highlights a significant positive impact of the ESG Score on financial performance, with a coefficient of 0.398 at the 1% level, underscoring the beneficial effects of ESG practices. In Model 2, the ESG Score and technological innovation (Pat) positively interact at the 1% significance level, indicating that advancements in ESG performance are closely linked with increases in innovation efforts. Businesses are more driven to innovate in green technologies in response to the stricter environmental regulations and pressures to establish moral and practical legitimacy. This helps them offset the costs associated with pollution and enhance their brand as a reputable company. Thus, improved ESG performance will encourage the development of new green technologies. Model 3 further supports this, showing both ESG Score and Pat positively associated with ROA at the 1% significance level. This supports Hypothesis 2, indicating that higher ESG performance promotes technological innovation, which subsequently improves financial performance. Some papers support this view [13, 75], which states that green innovation technology acts as a bridge between company performance and ESG performance. Companies exhibiting superior ESG performance prioritize long-term development, manifesting a heightened emphasis and investment in technological innovation. Additionally, positive ESG performance actively secures support in various realms, encompassing information, talent, funding, and policies, thereby nurturing a conducive environment for innovation synergy. This, in turn, creates a competitive advantage, ultimately amplifying financial performance. Consequently, technological innovation functions as an intrinsic conduit through which the enhancement of ESG performance positively reverberates onto financial performance.

Model 4, focusing on the moderation effect of Corporate Reputation (CR), reveals a positive correlation between ESG and ROA (coefficient: 0.270) at the 1% significance level, suggesting that the positive effect of ESG on firm performance is maintained, even when factoring in corporate reputation. However, the interaction term CR*Score is notably negative (-0.029) at the 1% significance level, indicating that a higher corporate reputation negatively moderates the relationship between ESG performance and firm performance. This indicates that a strong business reputation reduces the beneficial effect of ESG performance on ROA. The observed inverse relationship indicates that although ESG performance directly boosts a company's financial success, the overall advantage of this boost may decrease for companies with a strong reputation. One possible explanation for this could be that well-known companies have benefited financially greatly from their positive reputations; hence, more advancements in ESG performance could only have a minor impact on financial performance. The test result is consistent with the earlier research conducted by Singh

& Misra [82], suggesting that business reputation can operate as a buffer in this situation and lessen the marginal influence of ESG performance on ROA. This result substantiates Hypothesis 3, demonstrating that although a high corporate reputation usually boosts business performance, it may also lessen the positive effects of ESG practices on financial outcomes.

Table 7. The Mediating Role of Green Technological Innovation and the Moderating Role of Corporate Reputation

	(1) ROA	(2) Pat	(3) ROA	(4) ROA
Score	0.398***	0.012***	0.394***	0.270***
	(10.457)	(6.776)	(10.325)	(4.409)
GrossProfit	31.430***	-0.052**	31.448***	18.067***
	(61.650)	(-2.131)	(61.682)	(39.890)
ATO	7.108***	-0.035***	7.121***	4.619***
	(38.518)	(-4.024)	(38.566)	(29.754)
Cashflow	11.561***	-0.025	11.569***	7.683***
	(18.913)	(-0.848)	(18.929)	(15.186)
Growth	1.408***	0.001	1.407***	0.707***
	(12.162)	(0.167)	(12.160)	(7.385)
AssetGrowth	1.795***	-0.004	1.796***	1.055***
	(15.194)	(-0.784)	(15.209)	(10.799)
INST	0.025***	0.000***	0.024***	-0.010***
	(7.934)	(3.229)	(7.876)	(-3.846)
Pat			0.357*	
			(1.934)	
CR				1.524***
				(34.680)
CR*Score				-0.029***
				(-2.951)
_cons	-11.883***	-0.033**	-11.871***	-11.248***
	(-38.852)	(-2.279)	(-38.810)	(-34.421)
Fix	Yes	Yes	Yes	Yes
N	15728	15728	15728	15728
R^2	0.452	0.033	0.453	0.629

t statistics in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5- Discussion

This study uncovers crucial insights that highlight the beneficial influence of ESG practices on firm performance. This discovery is aligned with prior research, including [29, 52-55, 86], highlighting the beneficial link between enhanced ESG practices and firm profitability. Several techniques, including quantile regression, cluster analysis, and sample period correction, were used to confirm this result, which is still robust. The preference of investors and consumers for companies with strong ESG performance emphasizes the critical role of ESG in modern corporate strategies. This trend suggests that adhering to ESG principles satisfies ethical, social, and environmental standards and translates into tangible financial benefits by attracting investments, cultivating consumer loyalty, and improving operational efficiency. This outcome supports the idea that company financial health concerns consider the ESG element. It also reacts to stakeholders' and investors' increasing focus on ethical and sustainable business practices.

Additionally, through the discovery of unique patterns that highlight the complexity of ESG integration, this study contributes to a deeper understanding of the varied implications of ESG across different enterprise types and geographic locations. This paper's research findings are in line with those of Yang et al. [85]. The findings reveal that non-state-owned enterprises and companies in China's economically prosperous eastern region exhibit notably stronger positive responses to ESG practices. This variation is linked to the profit-driven nature of private firms and the heightened sustainability mandates prevalent in regions with advanced economies and greater environmental awareness. Furthermore, companies operating within non-polluting industries demonstrate enhanced financial outcomes, providing compelling evidence of the tangible economic benefits associated with rigorous ESG adherence. These insights not only highlight the strategic value of tailored ESG approaches considering regional and sectoral contexts but also point to the

potential for ESG to drive significant financial advantages and sustainability in diverse corporate landscapes. This sophisticated understanding highlights the need for strategies that are precisely tailored to the unique traits and motivations of various organization types and their regional environments, challenging oversimplified, one-size-fits-all conceptions of the benefits of ESG.

Notably, this study identified green technological innovation as a significant mediator between ESG performance and corporate success, resonating with findings from Chouaibi et al. [13], Li et al. [75] and Choi & Yoo [87]. Uncovering these mediating roles reveals novel insights: green technological innovation aligns with sustainability goals and directly contributes to enhanced operational and financial metrics, thereby turning eco-friendly practices into profitable strategies. This finding highlights firms' need to invest in innovation, thereby enhancing their market competitiveness and sustainability through ESG strategies. Green technological innovation mediates the relationship between ESG performance and corporate success by enabling firms to translate their sustainability efforts into tangible operational and financial improvements. By investing in environmentally friendly technologies, companies can significantly reduce their environmental impact while unlocking operational efficiencies, cost savings, and new market opportunities. This aligns with increasing consumer demand for sustainable products and positions firms favorably in anticipation of stricter environmental regulations. Moreover, demonstrating a commitment to sustainable innovation attracts investors, enhancing access to capital and competitive advantage. Thus, green technological innovation is a critical pathway through which ESG efforts are converted into enhanced firm performance, showcasing the strategic importance of integrating innovation with sustainability agendas for long-term business success [75].

Additionally, the research revealed a counterintuitive aspect where corporate reputation negatively moderated the relationship between ESG performance and firm success. This finding suggests a complex dynamic where high-reputation firms might face diminishing returns from further ESG investments due to elevated external expectations, as observed by Singh & Misra [82] and Li et al. [88]. The negative moderation effect of corporate reputation on the relationship between ESG performance and firm success suggests a complex dynamic where firms with high reputations face diminishing returns from further ESG investments due to elevated external expectations. High-reputation companies are often held to higher standards by stakeholders, creating a scenario where incremental improvements in ESG efforts are expected rather than rewarded, leading to a 'reputation trap.' In this trap, any perceived shortfall in ESG efforts is scrutinized more intensely, disproportionately affecting the company's success. This dynamic indicates that while maintaining a strong reputation is crucial, it also challenges meeting the heightened demands for ESG excellence. Consequently, high-reputation firms must strategically manage their ESG initiatives and stakeholder communications to navigate this delicate balance, ensuring that their sustainability efforts continue positively impacting firm success without falling into the diminishing returns of heightened expectations [21].

The insights from this study highlight the multifaceted nature of ESG's impact on firm performance, indicating that green technological innovation, corporate reputation, and various contextual factors play critical roles in this dynamic. The practical implications of these findings are profound, suggesting that managers and policymakers need to consider the nuanced effects of ESG on corporate strategy and performance. For managers, adopting a holistic approach to ESG integration is essential, recognizing its potential financial benefits and the opportunities presented by green innovation. Investing in eco-friendly technologies and processes can enhance sustainability and drive profitability and competitiveness. Furthermore, managers should carefully assess the interplay between ESG initiatives and their firm's reputation, ensuring that efforts align with stakeholder expectations while maintaining a balanced and sustainable approach.

Conversely, policymakers can leverage these findings to create a supportive regulatory environment that incentivizes ESG adoption and green innovation. This could include financial incentives, tax credits, and supportive policies encouraging research and development in environmentally friendly technologies. Additionally, policymakers can promote transparency and standardized ESG reporting frameworks, enabling investors and consumers to make informed decisions based on reliable sustainability data.

6- Conclusion

This study's investigation into the ESG-performance nexus within 2,718 Chinese manufacturing enterprises from 2011 to 2022 underscores the positive correlation between robust ESG practices and enhanced corporate financial outcomes. The findings demonstrate that ESG adherence fulfills ethical and environmental standards and translates into significant financial benefits, attracting investments and fostering consumer loyalty. Moreover, the role of green technological innovation as a mediator and the negative moderation effect of corporate reputation highlights the intricate dynamics of ESG's impact on firm performance. These insights suggest a strategic imperative for firms to integrate ESG considerations with innovation efforts to maintain competitiveness and sustainability.

The study suggests that managers should consider ESG a strategic asset, leveraging green technological innovation to translate sustainability efforts into tangible business outcomes. Additionally, the nuanced role of corporate reputation in ESG strategy underscores the need for a balanced approach to managing stakeholder expectations related to ESG achievements. Policymakers are encouraged to support ESG adoption through incentives and clearer reporting frameworks, facilitating a conducive environment for sustainable business practices.

6-1- Research Limitations and Further Expectations

The research is limited to the Chinese manufacturing sector, possibly introducing sector-specific biases. Data availability issues and the lack of a standardized ESG rating system pose further challenges. Future research should broaden the scope to include diverse industries and more nuanced ESG metrics, offering deeper insights into ESG's multifaceted impacts. Expanding the exploration of mechanisms beyond green technological innovation and corporate reputation could provide more comprehensive policy and strategic recommendations for integrating ESG into corporate and national sustainability agendas.

7- Declarations

7-1- Author Contributions

Conceptualization, C.X., L.P., S.M., S.T., and H.S.; methodology, C.X., L.P., and S.T.; validation, C.X. and L.P.; formal analysis, C.X. and L.P.; investigation, C.X. and L.P.; resources, C.X.; data curation, C.X.; writing—original draft preparation, C.X., L.P., S.M., S.T., and H.S. writing—review and editing, C.X. and L.P.; supervision, L.P.; project administration, L.P.; funding acquisition, L.P. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7-3- Funding

This paper is funded by the Walailak University International Mobility Fund for Research Collaboration.

7-4- Acknowledgements

We are very grateful to our supervisor for their patient guidance and meticulous support in our academic research. Additionally, we appreciate the collaborative efforts of team members in advancing this research. We also want to thank our family and friends for their continuous encouragement and support throughout our academic journey. Thank you for your companionship and assistance.

7-5- Institutional Review Board Statement

Not applicable.

7-6- Informed Consent Statement

Not applicable.

7-7- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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