Greening the Path to Success: Exploring ESG Performance and Voluntary Disclosure Practices

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Abstract:

The escalating global climate change has led to more severe environmental problems, which now serve as a major constraint on sustainable economic growth. This study focuses on analyzing the ESG performance and carbon information disclosure of Chinese A-share listed businesses from 2012 to 2020. It also investigates the influence of corporate ESG performance on their disclosure of carbon emission information. Studies have revealed that a company's ESG performance has a notable and positive impact on its disclosure of carbon-related information. When companies are non-state-owned ones, in non heavily polluting industries, and located in stricter environmental regulations, companies with superior ESG (Environmental, Social, and Governance) performance are more likely to provide information about their carbon emissions. The research findings offer empirical evidence for enhancing the transparency of carbon-related data by Chinese publicly traded enterprises and attaining the objectives of "dual carbon".

Keywords:- ESG performance; carbon emission; voluntary disclosure

1. Introduction

Investors' increasing interest and global awareness of the risks associated with environmental problems, social responsibility, and effective governance are motivating companies to improve their focus and commitment to non-financial aspects of their operations. Investors, employees and the government now have higher expectations for the firm to demonstrate attentiveness in all these areas, implement essential risk reduction measures, and provide comprehensive reporting. (Aydoğmuş et al., 2022). In 2013, a poll was conducted by the UN Global Compact, involving 1000 CEOs from various countries. According to the United Nations (2019), almost 93% of the CEOs who participated in the survey saw ESG matters as vital for their organizations' performance.

One reason for the market's increasing focus on carbon emission disclosure is driven by the understanding that it benefits companies in two ways: gaining stakeholder support and influencing firm value. Delmas and Nairn-Birch (2011) found in their research

that companies with higher levels of carbon emission disclosure are able to enhance their operational performance, as measured by profitability (Hardiyansah et al., 2021). Consequently, this disclosure is now viewed as advantageous due to its positive impact on the firm's worth.

Stakeholders are placing growing pressure on managers to reveal their climate change risks (Caroline et al.,2021). Climate change policies, such as emissions trading schemes, result in increased disclosure of carbon emissions in both regulated and volunteer sectors. The reference is from Simnett and Nugent's work published in 2007. NGOs are pressuring firms to enhance their transparency regarding the disclosure of carbon emissions. These trends indicate that the disclosure of carbon emissions has become a significant component of corporate governance. Hence, companies must proactively address stakeholder demands and implement effective strategies to enhance the quality of carbon emission disclosure, thereby achieving sustainable development objectives.

It is anticipated that companies would have a crucial role in reducing their greenhouse gas emissions to stabilize climate change (Luo and Tang, 2014). Consequently, firms are forced to provide more comprehensive information on their real achievements in their disclosures in order to demonstrate their commitment to environmental concerns (Meng et al., 2014). Furthermore, investors utilize environmental data to appraise investments and analyze their existing portfolios from an environmental standpoint (EY, 2014). This information helps them ascertain the worth and future potential of enterprises, as well as the expenses associated with pollution treatment (Bewley and Li, 2000).

The Ministry of Ecology and Environment of China has issued a recent report stating that certain industries, including petrochemical, chemical, steel, non-ferrous metal, and civil aviation, as well as specific enterprises emitting 260,000 tons or more of carbon emissions per year, are now obligated by law to prepare environmental reports and promptly disclose their carbon emissions. In the past, numerous state-owned firms exhibited hesitancy in engaging in carbon emission disclosure in the absence of official mandates. Based on a study, out of the 100 Chinese enterprises that were invited, 46% replied affirmatively to the CDP. Specifically, 11 companies completed the questionnaire, 35 provided relevant information, 39 did not reply, and 15 declined to participate (CDP China Report, 2011). On the other hand, the questionnaire was completed by 396 Fortune 500 businesses, resulting in an 80% response rate according to the CDP Global Report in 2011. Government regulations have mandated that carbon emission disclosure is now a crucial component of company environmental information reporting.

This study aims to investigate the correlation between ESG performance and voluntary disclosure. Companies share carbon information in order to reduce their equity costs, better their financial performance, and improve their image and societal trust. Legitimacy theory posits that high-carbon emitters tend to disclose more information in order to reduce the danger of legal action. The majority of existing research indicates a positive relationship between disclosure and lawsuit risk mitigation. Signaling theory says that companies with strong ESG performance reveal their successes in order to enhance their competitive advantage. On the other hand, voluntary disclosure theory proposes that stakeholders evaluate these disclosures to either reward or penalize organizations, which can have an impact on their value and executive compensation. As a result, companies with good ESG performance tend to release more information in order to minimize differences in knowledge, while companies with bad ESG performance tend to disclose less information in order to avoid attracting unfavorable attention. This study examines the impact of carbon emissions and disclosure quality on the vulnerability of companies to climate change risks using empirical methods.

Additionally, our research indicates that in privately-owned businesses, industries with lower levels of pollution, and with stricter environmental regulations, there is a positive correlation between the environmental, social, and governance (ESG) performance of the organization and the extent of disclosure of carbon-related information. This could be attributed to the fact that privately-owned businesses in China prioritize feedback from the financial market and assessments from interested parties. Enterprises operating in industries with less pollution have inherently lower emissions, resulting in reduced costs for carbon reduction and increased motivation to adopt carbon reduction strategies and publicly report their accomplishments. In regions with more stringent environmental restrictions, the government will enforce tougher oversight on businesses with higher levels of carbon emission intensity, resulting in increased transparency in the disclosure of carbon emission information by these organizations.

The study's findings provide valuable insights into the determinants of corporate transparency in environmental reporting. This study emphasizes the importance of investors in promoting voluntary disclosure of environmental, social, and governance (ESG) information. It suggests that actively engaging with investors is essential when there are no required regulations in place, as it helps improve transparency and risk management. Our findings remain reliable and take into consideration larger economic and regulatory developments by include year and industry fixed effects. Our work diverges from past research on

environmental disclosure by particularly examining the caliber of carbon emission declarations. This allows for a comprehensive comprehension of how these disclosures are presented and what factors impact their level of openness. This study fills a void in the existing body of research by specifically confining its scope to the topic of carbon emissions. Additional study, specifically include comparisons across other industries, is necessary to enhance the comprehension of ESG performance and voluntary disclosure. The results of our research provide useful insights for policymakers and practitioners who are looking to enhance the quality of carbon disclosure and advance sustainability efforts.

2. Theoretical Analysis

2.1 Why do Companies Engage in Voluntary Carbon Disclosure?

Prior research indicates that voluntary corporate disclosure yields several favorable outcomes. For instance, firms engaging in voluntary information disclosure experience a reduced cost of equity (Brennan, Tamarowksi, 2000), and managers' decisions to disclose information led to enhanced shareholder value (Hickman, L. E. 2020). Here, we specifically examine organizations that choose to share carbon information on their own accord.

According to stakeholder theory, organizations must consider the interests of different stakeholder groups (such as investors, suppliers, customers, and creditors) while making choices in order to maximize total benefits. Voluntary carbon disclosure is of significant value to management, investors, and stakeholders.

For shareholders, voluntary carbon disclosure can yield financial benefits. A study conducted by Saka and Oshika (2014) demonstrates a positive correlation between carbon operational disclosure and the value of equity in the market.

For investors, they benefit from trustworthy non-financial information as it enables them to make more informed and logical investment choices. According to the signaling asymmetry theory, companies that have better environmental performance tend to enhance corporate transparency by willingly sharing carbon information. This is done to reduce the difference in information between companies and investors. By doing so, investors are able to gain a better understanding of the company's carbon performance, evaluate the company's risk, and make appropriate adjustments to their trading strategies.For instance, Chapple (2014) discovered that capital markets have a preference for low-carbon companies over high-carbon ones. Investors who prioritize sustainable investments

tend to favor companies that voluntarily disclose information about their carbon emissions (Ramelli et al., 2018). Additionally, disclosing environmental performance assists financial analysts in making more accurate earnings forecasts (Cormier and Magnan, 2014).

In terms of economic benefits, Cheng (2014) demonstrates that carbon disclosure has a favorable effect on financial performance, and that the caliber of carbon disclosure enhances a company's financial performance by reducing the cost of financing. This is because carbon disclosure and engagement with stakeholders enhance access to finance, thereby alleviating restrictions on capital availability. Nevertheless, certain academics contend that there is no correlation between the two factors, as voluntary carbon disclosure does not exert a substantial influence on financial performance (Kim and Lyon, 2011; Lee, 2012). Furthermore, they have discovered that any positive effect only becomes apparent in the long run, whereas in the short term, carbon disclosure actually has an adverse impact on financial performance. This is because some shareholders and investors interpret carbon disclosure announcements as unfavorable news (Lee 2015; Alsaifi et al. 2020b).

Furthermore, organizations that actively publish their environmental performance can acquire a commensurate competitive edge in terms of social performance, setting them apart from enterprises that do not reveal such information (Dhaliwal et al., 2011). Simultaneously, the act of voluntarily disclosing carbon emissions is anticipated to convey a favorable message to the financial market, indicating that businesses prioritize environmental responsibility. This, in turn, can bolster public confidence in these enterprises and enhance the trust stakeholders have in them, ultimately leading to an improved corporate image (Barnett and Salomon, 2012). According to Matsumura et al. (2014), enterprises can avoid environmental penalties levied by the government in the future by voluntarily disclosing carbon information and adapting to stricter environmental regulations.

2.2 Corporate ESG Performance and Carbon Emission Information Disclosure

Stakeholder theory posits that for a corporation to achieve sustainable development, it must not just prioritize the interests of shareholders but also acknowledge its responsibility towards other stakeholders. The company's management will be obligated by stakeholders to provide information in order to mitigate problems such as information asymmetry (Wen et al, 2017). Executives frequently receive pressure from investors to disclose and tackle social and environmental challenges, and this pressure has

been steadily growing over time (Flammer, 2021). Prior studies have shown that the connection between business ESG performance and carbon emission disclosure has been a subject of debate (Hong et al, 2014; Luo and Tang, 2014). Several authors propose that there exists an inverse relationship between the two variables (Wang, 2011; Fang et al., 2012). Nevertheless, the majority of researchers maintain that there exists a direct relationship between the two variables. Specifically, they argue that as a company's ESG performance improves, its carbon emissions decrease, and its carbon information disclosure becomes more comprehensive and accurate (Datt, 2017; Zhu, 2019; Giannarakis, 2016). In the following discussion, we will examine two possible scenarios and put forth hypotheses.

The legitimacy theory posits that the development of carbon reduction policies will give priority to industries with high carbon emissions. Moreover, there is a rising acknowledgement of the social obligation of these sectors, resulting in higher demands for the standard of their information sharing. This is corroborated by study undertaken by Mathews (1993), Patten (1992), and Wang Jianming (2011). To mitigate the possibility of legal action resulting from inadequate disclosure, companies with high carbon emissions will enhance their carbon information disclosure, hence improving the quality of such disclosures (Fang et al., 2012). Information disclosure is contingent upon multiple factors, including societal norms, political climate, regulatory frameworks, and the influence exerted by diverse stakeholders. These companies, who emit large levels of carbon and have a weak ESG performance, will be compelled to provide increasingly detailed information about their carbon intensity due to pressure from stakeholders (Cho et al., 2007; Clarkson et al, 2008). Hence, companies with low ESG performance are more likely to have a higher level of carbon information disclosure.

However, the prevailing viewpoint among scholars is that a company's carbon emissions decrease as its ESG performance improves, and its disclosure of carbon information becomes more reliable. From the signal theory standpoint, when a corporation performs exceptionally well, it will be motivated to publicly publicize its high performance. According to this idea, if a company excels in ESG practices and has minimal carbon emissions, it is highly motivated to publicly share its efforts to reduce carbon emissions in order to improve its competitive advantage. Conversely, as per the notion of voluntary disclosure, there has always been a disparity in information, and the actual performance of companies is kept private, making it challenging for stakeholders to directly access (Sun et al., 2023). Stakeholders can solely comprehend a company's ESG and carbon performance by means of voluntary disclosure. Subsequently, they can either reward or penalize the

company based on its carbon performance, thereby influencing the company's value and executive compensation. Managers of organizations that have strong ESG performance and low carbon emissions will be more inclined to reveal their carbon information. This is because they want to differentiate themselves from other companies and obtain social recognition. This motivation is supported by research conducted by Dye (1985), Verrecchia (1983), and Li et al. (1997).

In contrast, underperforming organizations have the ability to mimic the actions of high-performing companies and present themselves as successful entities. When the costs that are made public are same, it becomes challenging to stop underperforming companies from copying successful companies. Nevertheless, recent studies indicate that companies with low carbon performance may incur greater costs for imitating their practices compared to companies with high carbon performance. This is because the former typically have established systems for collecting and accounting for carbon emissions, which form the foundation for disclosing carbon-related information (Luo et al., 2013). Nevertheless, organizations lacking in carbon performance typically lack the necessary infrastructure, hindering their ability to replicate the success of enterprises with strong performance. However, mere replication will cause underperforming organizations to reveal inaccurate information, thus harming their reputation and potentially leading to allegations and legal actions from stakeholders, including the government (Wei et al., 2017). Consequently, we anticipate that underperforming organizations would ultimately reveal less information than well-performing companies. Given the information provided, we put out the initial hypothesis for this investigation as follows:

H1: A higher level of ESG performance has a positive impact on the level of carbon information disclosure.

2.3 The Hypothesis of Heterogeneity in Three Aspects

2.3.1 Property Heterogeneity on ESG Performance Affects Carbon Information Disclosure

The varying nature of property rights in firms results in distinct levels of societal attention, social responsibility, and fulfillment of social obligations. Based on the nature of property rights, listed firms can be classified into two categories: state-owned enterprises (SOEs) and non-state-owned enterprises (Non-SOEs). Companies must leverage the assistance and resources of their stakeholders in order to manage external pressures and resource reliance, as suggested by the theories of external pressures and expectations. In order to alleviate this pressure, companies

must consistently adjust to evolving stakeholder expectations by fulfilling their ESG obligations. (Li et al., 2011; Wen et al., 2017). State-owned businesses (SOEs) have an inherent obligation to support national policies and are expected to play a leading role in doing so. As a result, stakeholders have lower expectations for SOEs' ESG performance, assuming that they will fulfill their social responsibilities without exceeding these basic requirements. Nevertheless, Non-SOEs prioritize their own survival and future growth over the execution of national policies. They utilize ESG performance as a crucial means to distinguish themselves from other Non-SOEs. Additionally, Che et al.'s (2022) research demonstrates that Non-SOEs exhibit a greater focus on meeting the social responsibility expectations of external stakeholders compared to SOEs. Consequently, when Non-SOEs exhibit superior ESG performance, they are more inclined to attract the interest of stakeholders (Liu, 2023).

State-owned firms, due to stricter regulatory oversight and greater initial disclosure obligations, will publish a larger amount of carbon-related information irrespective of their environmental, social, and governance (ESG) performance. Non-state-owned enterprises are subjected to less stringent disclosure requirements. As a result, companies with poor ESG performance are more likely to hide their true carbon information for signaling purposes. Therefore, we suggest our hypothesis:

H2: Compared to state-owned enterprises, non-state-owned ones with better ESG performance disclose more carbon information.

2.3.2 Environmental regulation Heterogeneity on ESG Performance Affects the Degree of Carbon Disclosure

Environmental regulation encompasses a set of laws, rules, and policies implemented by governments or regulatory organizations to mitigate environmental degradation and foster sustainable development. The purpose of these rules is to mitigate the adverse environmental impacts caused by companies and incentivize them to adopt more environmentally sustainable sectors. Nevertheless, variations in the level of economic development, political systems, and cultural contexts among countries result in significant differences in the strictness and enforcement of environmental rules across different regions and industries (Porter et al., 1995).

In industrialized countries, there is typically a requirement for moderately stringent environmental legislation in response to the increasing awareness of the public regarding environmental protection and the more stringent global environmental standards. The European Union's Carbon Emissions Trading System (EU ETS) imposes stringent limits on carbon emissions and mandates companies to participate in the carbon emission trading market, thereby incentivizing companies to reduce carbon emissions through technological advancements (Dupont et al., 2015). In contrast, several emerging countries have very lenient environmental legislation and firms face minimal pressure to comply, mostly driven by the imperative for economic expansion (Dasgupta et al., 2001).

In areas or organizations with stringent environmental rules, corporations may face increased expenses and potential legal liabilities. Thus, they are more inclined to provide environmental information in order to meet regulatory obligations and avoid penalties. Studies indicate that in countries with stringent environmental rules, corporations choose to provide carbon emission data in order to enhance transparency, foster trust with stakeholders, and alleviate regulatory pressure (Clarkson et al., 2008). This suggests that implementing stringent environmental rules could limit the adverse impact of high carbon emission intensity on the transparency of information disclosure. This is because corporations would be compelled to provide a greater amount of information.

Conversely, corporations operating in industries with lax environmental rules may lack the same incentives to provide detailed environmental information. Companies may opt to reduce the publication of carbon emission information in order to avoid incurring unnecessary compliance costs and public scrutiny, given the decreased pressure to comply. In this scenario, the level of information disclosure may be adversely affected by carbon emission intensity, since corporations may be more motivated to conceal environmental information that would be inconvenient for them if there is no external pressure.

Based on the above analysis, our study proposes the following hypotheses:

H3: Compared to enterprises in the areas with higher environmental regulations, those in the areas with lower environmental regulations disclose more carbon information.

2.3.3 Industry Heterogeneity on ESG Performance Affects the Degree of Carbon Disclosure

Carbon emission intensity in China varies significantly between industries due to changes in industrial structure and production methods. As a consequence, the extent to which firms in different industries disclose their carbon emissions will also vary. Since 2003, the China Securities Regulatory Commission has mandated that listed businesses in high-polluting industries report environmental information on a voluntary basis. Nevertheless, the signal conveyed by corporate carbon information disclosure is weaker for industries with higher carbon emissions, primarily because of variations in voluntary disclosure

methods and content, as well as lower environmental expectations from external stakeholders for companies in high polluting industries (Jiang, 2019). Simultaneously, voluntary disclosure prompts enterprises in high-polluting industries to hide their carbon intensity. This is because, even if these enterprises exhibit commendable carbon performance, they cannot compete with enterprises in non-high-polluting industries, resulting in a diminished enthusiasm for disclosure. Furthermore, companies that reveal more carbon emission information are more likely to attract the attention of regulatory authorities. This, in turn, causes high-polluting industry enterprises to lack the incentive to report their carbon information.

Conversely, in businesses that produce less carbon emissions, organizations demonstrate a greater level of consciousness regarding low-carbon practices, and external stakeholders exhibit a heightened interest in their carbon-related data. Efficient transmission of carbon management signals can effectively convey the advantages to investors (Moser and Martin, 2012; de Sousa Jabbour et al., 2018), leading to increased disclosure of carbon information. Thus, we propose the following hypotheses:

H4: Compared to enterprises in high-polluting industry, those in non-high-polluting industry with better ESG performance disclose more carbon information.

3. Research Design

3.1 Sample Selection and Data Sources

This study specifically examines the ESG performance and carbon information disclosure of Chinese A-share listed businesses from 2012 to 2020. It aims to determine the influence of ESG performance on the disclosure of carbon information. This study performed the subsequent screening and processing of the sample: (1) Exclude listed firms classified as ST (Special Treatment) and *ST (Special Treatment for Delisting); (2) Filter out listed companies that have incomplete financial data and are missing essential indicators; (3) Eliminate samples that have a significant amount of missing data; (4) Apply the Winsorization technique to adjust the extreme values of crucial continuous variables in order to mitigate their influence. Ultimately, a total of 2215 observations were acquired.

This study examines the ESG performance of firms by referencing the research conducted by researchers Shen (2019) and Chapple (2013). It measures the carbon emission intensity of a company by calculating the ratio of its carbon emissions to its operational revenue. The firm obtains its main revenue, main cost, and industry main cost data from the CSMAR database and WIND database. The industry's total energy consumption data is obtained from

the China Energy Statistical Yearbook. As per the carbon dioxide calculation standard of Xiamen Energy Conservation Center, the conversion coefficient for carbon dioxide emitted from burning 1 ton of standard coal is 2.493. The specific calculation formula is as follows:

$$Intensity = \frac{CarbonEmissions}{Corporate operating income}$$

$$Carbon\ Emissions = \frac{Corporate\ operating\ \cos ts}{Industry\ operating\ \cos ts} \times$$

Total energy consumption of the industry $\times$
Carbon dioxide conversion factor

For the carbon information disclosure data of enterprises, this study refers to the research of scholars such as Liu (2024) and Sun (2023), and uses Python to crawl the financial statements of Chinese A-share listed companies to form a carbon information disclosure related dictionary. The frequency of relevant carbon information words appearing in the financial statements of enterprises is statistically and weighted to obtain the degree of carbon information disclosure of enterprises. The weighted calculation method is as follows:

$$CID = \begin{cases} \frac{(1 + \log(tf_{c,i}))}{(1 + \log(l_i))} * \log \frac{N}{df_c}, if\ tf_{c,i} >= 1 \\ 0, \end{cases}$$

Among them, N represents the total number of social responsibility reports of sample companies in the same industry in the same year; df_c represents the number of corporate social responsibility reports containing the keyword c; represents the original frequency of the keyword c included in the corporate social responsibility report for company i; indicates the total length of the corporate social responsibility report.

3.2 Variable Description

The dependent variable is the corporate carbon disclosure, and the independent variable, corporate ESG performance, is measured by carbon emission intensity.

Control variables are divided into three groups. The first group includes three variables based on financial measures, such as asset liability ratio, return on net assets and leverage, total operating income growth rate, book-to-market ratio, intangible assets ratio, fixed assets and size of the company, and the second group of variables is based on corporate governance measure, including shareholding ratio of the first major shareholder and proportion of independent directors on board. The third group of variables is based on industry measure, namely, HHI to measure the intensity of competition in the industry.

A precise description of all variables and control variables

is provided in Table 1.

Table 1 Variable Definition and Measurement

Type	Variable	Abbreviation	Measurement
Dependent variables	Carbon Disclosure Level	CID	$CID = \begin{cases} \dfrac{(1+\log(tf_{c,i}))}{(1+\log(l_i))} * \log \dfrac{N}{df_c}, & if\ tf_{c,i} >= 1 \\ 0, & \end{cases}$
Independent variables	Carbon Emission Intensity	intensity	$Intensity = \frac{Carbon\ Emissions}{Corporate\ operating\ income}$ $Carbon\ Emissions = \frac{Corporate\ operating\ cost}{Industry\ operating\ cost} * Total\ energy\ consumption\ of\ the\ industry * Carbon\ dioxide\ conversion\ factor$
Control variables	Shareholding Ratio of the First Major Shareholder (%)	OC1	Shareholding of the first largest shareholder
	Asset Liability Ratio	DA	Ratio of total liabilities to total assets
	Proportion of independent directors	PID	Ratio of independent directors to total number of board members
	Return on Net Assets	ROA	Ratio of net profit to total assets
	Total Operating Income Growth Rate	GOI	The difference between the amount of total operating income for the current period of the year and the increase of the amount of the same period of the previous year is divided by the amount of the same period of the previous year
	Book-to-market ratio	MB	Ratio of total assets to market capitalization
	Industry Competition Level	HHI	Herfindahl Index
	Intangible Assets Ratio	IA	Ratio of intangible assets to total assets
	Fixed assets; natural logarithm of fixed assets	LNPPE	Natural logarithm of fixed assets
	Company size; natural logarithm of total assets	LNSIZE	Natural logarithm of total assets

3.3 Econometric Model

To test hypothesis 1, we will investigate the regression of the following models using the fixed effects method. This is because it offers advantages over traditional regression methods by eliminating the effects of time-invariant causes and mitigating the omitted variable bias in incompletely specified models (Firebaugh et al., 2013). In addition, to ensure the accuracy of the data, we control for year (and industry effects (). is the random error term.

$$CID_{it} = \alpha_0 + \alpha_1 intensity_{it} + \alpha_2\ OC1_{it} + \alpha_3\ DA_{it} + \alpha_4\ PID_{it} + \alpha_5\ ROA_{it} + \alpha_5\ GOI_{it}$$
$$+ \alpha_7\ MB_{it} + \alpha_8\ HHI_{it} + \alpha_9\ IA_{it} + \alpha_{11}\ LNPPE_{it} + \alpha_{10}\ LNSIZE_{it} + \omega_{it} + \gamma_{it} + \varepsilon_{it}$$

4. Methodology

4.1 Descriptive statistical analysis

Table 2 Summary Statistics and Correlation

Variable	N	Mean	SD	Min	p25	p50	p75	Max
CID	2,215.000	0.095	0.230	0.000	0.000	0.000	0.085	1.645
intensity	2,215.000	0.095	0.051	0.000	0.073	0.089	0.109	1.304
OC1	2,215.000	0.395	0.189	0.036	0.255	0.364	0.515	0.900

DA	2,215.000	0.427	0.172	0.067	0.296	0.428	0.560	0.772
PID	2,215.000	0.371	0.052	0.308	0.333	0.333	0.400	0.556
ROA	2,215.000	0.079	0.087	-0.263	0.031	0.073	0.125	0.310
GOI	2,215.000	0.107	0.229	-0.346	-0.025	0.079	0.190	1.165
MB	2,215.000	0.651	0.259	0.134	0.453	0.660	0.848	1.222
HHI	2,215.000	0.175	0.125	0.024	0.084	0.140	0.227	0.736
IA	2,215.000	0.042	0.026	0.001	0.023	0.037	0.054	0.140
LNPPE	2,215.000	21.354	1.415	17.412	20.307	21.199	22.288	25.762
LNSIZE	2,215.000	23.459	1.157	21.223	22.598	23.367	24.228	26.409

Table 2 reports summary statistics and correlations. We report summary statistics for the main two variables (intensity and CID) and other relevant control variables.

The mean value of carbon intensity is 0.095, which indicates that most of the sample companies have low and fluctuating carbon intensity. The mean value of carbon disclosure quality is also 0.095, but with a large standard deviation (0.230), showing that there are significant differences between companies in terms of disclosure quality. The median and the 25th percentile are both 0, indicating that most companies perform poorly in carbon disclosure, with only a few having higher disclosure quality.

Various control variables, such as the ratio of shareholding of the first largest shareholder (OC1), gearing ratio (DA), proportion of independent directors (PID), return on net assets (ROA), and growth rate of gross operating income (GOI), show a certain degree of variability, which reflects the diversity of the sample firms in terms of their financial structure, governance structure, and operating performance. For instance, the means of fixed assets (LNPPE) and firm size (LNSIZE) are 21.354 and 23.459 respectively, and both of the two variables have small standard deviations, indicating that the sample firms are more centrally distributed in these areas.

Overall, the descriptive statistical analysis shows that carbon emission intensity and carbon disclosure quality are significantly different among the sample companies, and the distribution of control variables is more diverse among different companies. These results provide a solid foundation for the subsequent regression analysis.

4.2 Regression analysis

Table 3 Regression Analysis Between Intensity and CID

Variables	(1)	(2)	(3)
	CID	CID	CID
intensity	-0.319***	-0.311***	-0.346***
	(0.092)	(0.089)	(0.094)
OC1	0.007	0.002	0.050*
	(0.026)	(0.027)	(0.030)
DA	-0.035	-0.037	-0.071**
	(0.032)	(0.032)	(0.035)
PID	-0.006	-0.001	0.016
	(0.097)	(0.098)	(0.106)
ROA	-0.073	-0.070	-0.099*
	(0.058)	(0.060)	(0.059)
GOI	0.040*	0.036	0.025
	(0.024)	(0.024)	(0.024)
MB	0.038	0.044	0.019
	(0.028)	(0.031)	(0.034)
HHI	-0.109***	-0.105***	0.075*
	(0.027)	(0.027)	(0.042)

IA	0.228	0.233	0.359**
	(0.171)	(0.171)	(0.177)
LNPPE	-0.012	-0.013	-0.011
	(0.009)	(0.009)	(0.009)
LNSIZE	0.025***	0.027***	0.033***
	(0.010)	(0.010)	(0.010)
Year	No	Yes	Yes
Ind	No	No	Yes
_cons	-0.218*	-0.249**	-0.504***
	(0.114)	(0.112)	(0.116)
N	2215.000	2215.000	2215.000
r2	0.016	0.019	0.052

The regression analysis results reveal a significant negative relationship between carbon emission intensity and carbon disclosure quality. Specifically, the regression coefficients are -0.319, -0.311, and -0.346, all significant. This indicates that for each unit increase in carbon emission intensity, the carbon disclosure quality decreases by 0.319, 0.311, and 0.346 points, respectively. This negative relationship suggests that companies with higher carbon emissions tend to have lower-quality carbon disclosures, potentially due to higher disclosure costs or reputational risks.

Additionally, this study employs a fixed effects model to account for unobserved heterogeneity that might influence the regression results. In the first group of data, neither time effect nor industry effect was included. In the second group, only time effect was included without industry effect compared with the last group including industry effect without time effect.

By introducing time effects, the model considers the systematic impact of different years on carbon disclosure quality, controlling for external factors such as macroeconomic changes and policy adjustments across years. In the model controlling for time effects alone, the intercept changes from -0.218 to -0.249, with the significance level improving to 5%. This demonstrates that time variations have a significant impact on carbon disclosure quality, allowing for a more accurate estimation of the true impact of carbon emission intensity and reducing the bias caused by temporal factors.

Further, by incorporating industry effects, the model accounts for the systematic impact of different industries on carbon disclosure quality, such as variations in regulatory environments and industry-specific environmental standards. When both time and industry effects are controlled, the intercept significantly decreases to -0.504 and is significant. This indicates that industry characteristics significantly impact carbon disclosure quality, underscoring the necessity of considering industry differences when analyzing carbon disclosure quality. Despite the inclusion of these fixed effects, the negative impact of carbon emission intensity remains significant, indicating that high-emission companies consistently tend to have lower-quality carbon disclosures, regardless of the year or industry context.

4.3 Endogeneity

Table 4 Endogeneity Check

Variables	(1)	(2)	(3)
	CID	intensity	CID
L.intensity	-0.158***		
	(0.057)		
intensity			-1.549**
			(0.767)
mean_intensity_w		0.393***	
		(0.064)	

_cons	-0.573***	0.070**	-0.366**
	(0.125)	(0.028)	(0.154)
Controls	Yes	Yes	Yes
Year	Yes	Yes	Yes
Ind	Yes	Yes	Yes
N	1823.000	2215.000	2215.000
r2	0.056	0.075	

4.3.1 Endogeneity: Using a Lag of an Independent Variable and Control Variables

To mitigate the endogeneity problem due to simultaneity bias (Bellemare et al., 2017), we use lagged endogenous variables. Data disclosure on carbon intensity tends to be lagged and the lag in this measure can lead to endogeneity in the regression results, so we regress carbon intensity+1 and the control variables one period lagged. Results in column (1) of Table 4 show that the coefficient of CID is -0.158, which is significant. The less carbon emissions a company has, the better ESG performance it has and the more carbon disclosure it has, which suggests that the benchmark regression results are reliable and can alleviate the problem of endogeneity due to simultaneity bias.

4.3.2 Endogeneity: Using 2SLS

Although we include year and industry-year fixed effects in the baseline regression model to mitigate the endogeneity problem caused by omitted variables to a certain extent, there may still be other unobservable factors interfering. To mitigate possible endogeneity problems such as sample selection bias and two-way causality, we use two-stage least squares regression (2SLS). Endogeneity is addressed by introducing instrumental variables to ensure consistency and validity of the estimates. (Angrist and Imbens, 1995; Antonakis et al., 2010). In the first-stage regression, we selected the mean value of carbon emission intensity (mean_intensity_w) of other enterprises in the same industry and province as the instrumental variable, and used intensity as the dependent variable for the regression. This instrumental variable has a robust statistical connection with carbon intensity and does not display any association with the error term of the model. This satisfies the correlation and exogeneity criteria of the instrumental variable. The F statistic is 36.615, over the threshold of 10, leading to the rejection of the hypothesis of weak instrumental variable.

Results of the first stage are shown in column (2) of Table 4. When we choose the mean_intensity_w of carbon emissions of other enterprises in the same industry and province as the instrumental variable and maintain the consistency of other control variables with the original regression type, the estimated coefficient is significantly positive at 0.393, which is significant. This shows a strong correlation between instrumental variables and ESG performance. The results of the second-stage regression are shown in column (3) of Table 4.In terms of coefficient sign, significance level, and fitting effect, the results of most variables are not different from the original regression type, which shows the robustness consistent with the regression results of the baseline model. The regression coefficient of INTENSITY is -1.549 and is significant, excluding the effect of endogeneity problem, the better ESG performance of the company's carbon emission disclosure is still significant and numerically lower compared to the benchmark model. Therefore, the 2SLS regression results support hypothesis 1.

4.4 Robustness

After addressing the endogeneity issue in this study, in order to ensure the reliability of the research, this paper adopted a more rigorous fixed effects approach in the model, changed the variable measurement method and sample selection for robustness testing (Gamerschlag et al.,2010). Considering that some industry factors that change over time (such as industry-specific policies, industry competition levels, etc.) can also affect enterprise production and carbon emission intensity, introducing only industry fixed effects may not be able to control these omitted variables. Therefore, this study further incorporated industry time fixed effects to control for these time-varying industry factors, and results are significant as shown in column (1) of Table 5.

In terms of changing the measurement method of variables: (1) Considering that different organizations have different measurement methods for corporate carbon emission intensity, this article classifies the carbon emissions disclosed by enterprises into three ranges based on existing research, and calculates the sum of range one and range two as the intensity measurement method (Sun et al., 2023; Song et al, 2019). The results are significant as shown in column (2) of Table 5; (2) Given the impact of non important keywords on the results, keywords with a frequency of less than 10 related to corporate carbon

information disclosure were excluded. A new search dictionary was constructed and the Carbon Information Disclosure Index (CID1) was recalculated. Results are significant as shown in column (3) of Table 5.

In terms of changing sample selection: (1) Considering that companies with only one year of data may have just started releasing corporate social responsibility reports or may have recently gone public, excluding such companies and conducting regression analysis, the results are significant as shown in column (4) of Table 5; (2) Considering that outliers within a larger range may have an impact on the results, this study conducted a 5% tail reduction on all continuous variables. The results are significant as shown

in column (5) of Table 5; (3) Considering that some major policies will have an impact on the carbon emission intensity and carbon information disclosure of enterprises, this article excludes the annual data of this policy. China implemented stricter regulations on carbon emissions and initiated the establishment of a nationwide carbon market in 2016 and 2017. Furthermore, in 2020, China set aims for achieving carbon neutrality. This article omits data from 2016, 2017, and 2020 that could have been influenced by significant policy events. It then does regression analysis on the data from the remaining years. The results are statistically significant, as indicated in column (6) of Table 5.

Table 5 Robustness Check

Variables	(1) CID	(2) CID	(3) CID1	(4) CID	(5) CID	(6) CID
intensity	-0.380***		-0.344***	-0.353***	-0.577***	-0.301***
	(0.094)		(0.093)	(0.097)	(0.113)	(0.095)
intensity_s		-0.463***				
		(0.129)				
OC1	0.052*	0.050*	0.050*	0.052*	0.024	0.011
	(0.031)	(0.030)	(0.030)	(0.031)	(0.019)	(0.036)
DA	-0.058	-0.071**	-0.070**	-0.075**	-0.014	-0.066
	(0.036)	(0.035)	(0.034)	(0.035)	(0.021)	(0.045)
PID	0.010	0.017	0.009	0.024	-0.038	-0.011
	(0.112)	(0.106)	(0.106)	(0.107)	(0.074)	(0.127)
ROA	-0.119*	-0.099*	-0.098*	-0.101*	-0.057	-0.079
	(0.071)	(0.059)	(0.059)	(0.060)	(0.060)	(0.077)
GOI	0.022	0.025	0.022	0.027	0.020	0.019
	(0.026)	(0.024)	(0.024)	(0.025)	(0.019)	(0.035)
MB	0.020	0.019	0.017	0.021	0.010	0.018
	(0.036)	(0.034)	(0.034)	(0.034)	(0.021)	(0.043)
HHI	0.084*	0.075*	0.074*	0.090*	0.100**	0.078
	(0.049)	(0.042)	(0.042)	(0.047)	(0.040)	(0.065)
IA	0.344*	0.361**	0.342*	0.365**	0.426***	0.375*
	(0.190)	(0.177)	(0.176)	(0.180)	(0.137)	(0.227)
LNPPE	-0.012	-0.011	-0.011	-0.012	-0.014**	-0.012
	(0.010)	(0.009)	(0.009)	(0.010)	(0.006)	(0.013)
LNSIZE	0.034***	0.033***	0.032***	0.034***	0.031***	0.026**
	(0.011)	(0.010)	(0.010)	(0.010)	(0.006)	(0.013)
_cons	-0.462***	-0.506***	-0.495***	-0.521***	-0.381***	-0.324**
	(0.125)	(0.116)	(0.116)	(0.118)	(0.080)	(0.136)
Year	Yes	Yes	Yes	Yes	Yes	Yes
Ind	Yes	Yes	Yes	Yes	Yes	Yes

Year*Ind	Yes	No	No	No	No	No
N	2215.000	2215.000	2215.000	2184.000	2215.000	1395.000
r2	0.094	0.052	0.052	0.053	0.067	0.046

5. Further analysis

5.1 Heterogeneity analysis

5.1.1 Property Heterogeneity

Non-state-owned firms will attract greater attention from external stakeholders, such as customers and investors, in comparison to state-owned enterprises, as they take on economic obligations. State-owned firms and non-state-owned enterprises are motivated by different factors when it comes to disclosing their social responsibilities in terms of environmental management and protection. Non-state firms are motivated by various variables including their own interests, level of governance, and government regulatory pressure. In contrast, state-owned enterprises depend on government departments and are more likely to engage in rent-seeking activity. State-owned firms benefit from a strong connection between their management and government people. Consequently, state-owned firms experience less pressure to decrease carbon emissions and reveal their carbon performance in comparison to privately-owned firms. This paper classifies the sample into state-owned corporations and non-state-owned enterprises according to their property rights and investigates the impact of their carbon emission intensity on carbon disclosure. The outcomes are displayed in columns (1) and (2) of Table 6. Non-state-owned firms have superior ESG performance and demonstrate a higher level of carbon information disclosure. H2 is valid.

5.1.2 Environmental regulation Heterogeneity

Furthermore, this article takes into account that due to varying levels of local government regulation, there are significant differences in environmental regulations in different regions, and the degree of corporate information disclosure also varies under different environmental regulations. In areas with stringent environmental regulations, the government has strong supervision over enterprises and higher requirements for environmental information disclosure, which can promote enterprises to assume green responsibilities (Xu Jia et al., 2020) and disclose more of their carbon information. In areas with lax environmental regulations, corporate disclosure of carbon information is primarily voluntary, leading corporations to lack motivation to reveal their carbon data. This article categorizes the sample into two categories, namely high environmental regulation intensity and low environmental regulation intensity, based on the median of the comprehensive utilization rate of industrial solid waste in various cities in China from 2012 to 2020. The results are displayed in columns (3) and (4) of Table 6. In regions with less stringent environmental regulations, firms tend to provide a greater amount of carbon information, assuming that H3 is valid.

5.1.3 Industry Heterogeneity

Finally, the carbon emission intensity of firms in China varies significantly due to the distinct industrial structures and manufacturing methods employed across different industries. However, industries with higher carbon emissions have a weaker signal conveyed by corporate carbon information disclosure due to variations in voluntary disclosure methods and content, as well as lower environmental expectations from external stakeholders for companies in high polluting industries (Jiang, 2019). Moreover, the greater the extent to which carbon emission information is revealed, the higher the probability that corporations will attract significant scrutiny from regulatory bodies, hence diminishing the incentive for high-polluting industry companies to publish carbon information. This article categorizes enterprises into two groups: enterprises in high-polluting industry and enterprises in non-high-polluting industry. The classification is based on the 14 pollution industries listed in the "Catalogue of Environmental Verification Classification Management for Listed Enterprises" published by the Chinese Ministry of Environmental Protection in 2008 (Guo, 2019). The results are displayed in the (5) and (6) columns of Table 6. Companies in industries with low pollution levels tend to have a greater level of carbon information disclosure. Thus H4 is valid.

Table 6 Heterogeneity

Variables	State-owned company	Non-state-owned company	High environmental regulation	Low environmental regulation	State-owned company	Non-state-owned company
	CID	CID	CID	CID	CID	CID
intensity	-0.139	-0.511***	-0.486***	-0.234**	-0.370	-0.407***
	(-1.52)	(-2.77)	(0.154)	(0.114)	(0.229)	(0.115)
OC1	-0.393***	0.018	0.013	0.067	0.323	0.024
	(-2.79)	(0.13)	(0.085)	(0.059)	(0.209)	(0.050)
DA	0.149	0.063	-0.049	-0.079	-0.221	-0.027
	(1.62)	(0.80)	(0.098)	(0.082)	(0.166)	(0.063)
PID	0.020	-0.326	-0.085	0.035	-0.007	-0.055
	(0.12)	(-1.52)	(0.253)	(0.186)	(0.259)	(0.174)
ROA	0.126	-0.131	-0.123	-0.096	-0.430	-0.039
	(1.35)	(-1.32)	(0.106)	(0.123)	(0.288)	(0.081)
GOI	-0.032	0.018	0.044	0.009	0.054	0.019
	(-1.22)	(0.61)	(0.041)	(0.030)	(0.075)	(0.027)
MB	0.092	-0.016	-0.002	0.051	-0.314	0.066
	(1.40)	(-0.24)	(0.073)	(0.058)	(0.210)	(0.046)
HHI	0.150	0.029	0.143	0.014	-0.149	0.136*
	(1.48)	(0.33)	(0.110)	(0.084)	(0.145)	(0.074)
IA	-0.003	-0.401	0.903*	0.121	0.245	0.351
	(-0.01)	(-0.94)	(0.523)	(0.335)	(0.624)	(0.309)
LNPPE	-0.009	-0.013	-0.013	-0.012	0.088	-0.027**
	(-0.37)	(-0.58)	(0.021)	(0.021)	(0.061)	(0.014)
LNSIZE	0.004	0.007	0.041**	0.030	-0.055	0.045***
	(0.13)	(0.22)	(0.020)	(0.022)	(0.051)	(0.016)
Year	YES	YES	Yes	Yes	Yes	Yes
Ind	YES	YES	Yes	Yes	Yes	Yes
_cons	0.207	0.407	-0.554*	-0.358	-0.263	-0.387**
	(0.35)	(0.68)	(0.285)	(0.226)	(0.325)	(0.194)
N	1,128	1,087	1039.000	1175.000	443.000	1771.000
r2	0.026	0.031	0.086	0.067	0.145	0.046
Chow Test			1.45			
P-value			0.0336**			

5.2 Moderating Effect

5.2.1 Interaction term analysis of carbon intensity and cost of debt

Cost of debt, defined as the financial burden a firm incurs through debt financing, is calculated as the sum of short-term borrowings, non-current liabilities due within one year, and long-term borrowings at year-end, divided by total assets at year-end (Rajan et al., 1995). This metric reflects a company's financial leverage and debt burden, serving as a key indicator of financial health. High debt costs impose greater financial pressure on firms, potentially influencing their operational decisions, particularly regarding information disclosure.

We sourced each company's cost of debt from the CSMAR database. This study examines the interaction between carbon emission intensity and cost of debt (intensity_debt) to reveal the significant moderating effect of debt

cost in the relationship between carbon emission intensity and information disclosure levels. The regression coefficient of this interaction term is significantly negative, indicating that as the cost of debt increases, the negative impact of carbon emission intensity on information disclosure becomes more pronounced. This relationship can be explained through the following theoretical perspectives.

First, high cost of debt usually means that companies are under greater financial pressure. In this case, companies may prioritize how to maintain financial stability and solvency, thereby cutting expenditures that do not directly bring economic benefits, such as the disclosure of environmental information. Jensen's (1986) agency theory supports this view: when a company faces financial pressure, management tends to reduce investment in non-core areas to ensure the financial health of the company (Jensen, 1986). In this scenario, companies with higher carbon emission intensity may choose to reduce the transparency of information disclosure to reduce related compliance and communication costs, thereby alleviating the pressure brought by debt financing costs. Additionally, Resource dependence theory (Pfeffer et al.,2015) also states that

companies will take actions to respond to uncertainty in the external environment. In an environment of high cost of debt, companies face increased external uncertainty. Selective disclosure or reduction of information disclosure can be understood as one of the strategies for companies to respond to external environmental pressures to ensure their favorable position in resource competition. Furthermore, when a company's cost of debt rises, its decisions tend to be driven more by creditor interests than by social or environmental responsibilities. Creditors are regularly more concerned with a company's solvency and short-term budgetary well-being than with its long-term environmental performance. This change in the priority of interests may cause companies, in the context of high carbon emission intensity, to further reduce the incentives to disclose carbon emission information to the outside world to ensure compliance with creditor interest requirements and financial indicators. This is consistent with the capital structure theory of Myers (1977), that is, when companies are highly leveraged, they tend to give priority to the interests of debt holders rather than the long-term interests of shareholders (Myers & Majluf, 1977).

Table 7 Moderation Effect analysis

Variables	(1)	(2)
	CID	CID
intensity	-0.098	0.040
	(0.129)	(0.044)
DEBT	0.512***	
	(0.164)	
intensity_debt	-4.571***	
	(1.426)	
lnmed		0.029***
		(0.007)
intensity_lnmed		-0.159***
		(0.029)
_cons	-0.586***	-0.414***
	(0.131)	(0.130)
Controls	Yes	Yes
Year	Yes	Yes
Ind	Yes	Yes
N	2017.000	2200.000
r2	0.059	0.060

5.2.2 Interaction term analysis of carbon intensity and media attention

The number of media reports comes from the CNRDS database. Media attention is defined as the number of media reports on a company in a given year, and its logarithm is taken (Dyck, Volchkova, & Zingales, 2008). This indicator measures the extent to which a company attracts media

and public attention during a specific period of time and is an important indicator of a company's external exposure.

In column (2) of table 7, the study examined the interaction term (intensity_lnmed) between carbon emission intensity and media attention, and its regression coefficient was also significantly negative, indicating that media attention, as a moderating variable, strengthens the impact of carbon emission intensity on information disclosure levels.

According to reputation management theory (Fombrun & Shanley, 1990), which suggests that companies faced with high media exposure, tend to adopt more cautious disclosure strategies to protect their reputation. When media attention is high, a company's actions are more likely to be scrutinized by the public and regulatory bodies. For companies with high carbon emission intensity, increased environmental disclosures might lead to more negative media coverage, thereby harming the company's reputation and market image. To control public opinion and reduce the risk of negative exposure, companies may choose to limit their environmental disclosures. Besides, in environments where media attention is high, companies may engage in strategic information management, selectively disclosing favorable information while withholding or minimizing the disclosure of unfavorable information. For companies with high carbon emission intensity, expanded environmental disclosures might lead to more negative media coverage, subsequently hurting the company's reputation and market image. To control public opinion and decrease the chance of negative introduction, companies may select to constrain their environmental disclosures. Other than that, in situations where media attention is high, companies may engage in strategic information management, specifically unveiling favorable data while withholding or minimizing the divulgence of unfavorable data. For companies with high carbon emission intensity, diminishing the disclosure of negative environmental information can offer assistance in moderate unfavorable responses from the public. This selective disclosure behavior is well-supported by the impression management theory, which states that companies control the discharge of data to shape external perceptions of their activities (Healy & Palepu, 2001). Also, by constraining the discharge of negative data, companies endeavor to dodge activating solid responses from the public (Coombs, 2007).

By analyzing the interaction terms between carbon emission intensity, cost of debt and media attention, the study uncovers how these moderating variables significantly strengthen the negative impact of carbon emission intensity on information disclosure levels under different conditions. Cost of debt and media attention serve as moderator variables, which not only increases corporate financial and public opinion pressure, but also prompts companies to adopt more conservative information disclosure strategies.

6. Conclusion

The current study was conducted to investigate the correlation between ESG performance and carbon information disclosure. The findings of this study suggest that organizations with higher ESG performance are more inclined to provide information.

Based on stakeholder theory, signaling theory, and voluntary disclosure theory, it can be inferred enterprise's ESG performance and its level of disclosure of carbon information are highly positively correlated. Companies who have a good Environmental, Social, and Governance (ESG) performance and emit less carbon are inclined to reveal their efforts in reducing carbon emissions in order to demonstrate their leadership in the ESG field and improve their competitive standing. Companies that perform well in ESG practices are motivated to provide their carbon emissions data in order to receive acknowledgment from society, earn the trust of investors, and reduce the imbalance of information. This, in turn, enhances their overall worth and raises the levels of compensation for their executives.

Secondly, the conclusion can be drawn that companies make voluntary carbon disclosures for several reasons, including the benefits to various stakeholders such as investors, shareholders, and firms. From an investor perspective, reliable non-financial disclosure allows for more informed decision-making, reduces information asymmetry, aids in risk assessment, and helps investors adjust their trading strategies accordingly. Economically, voluntary carbon disclosure can positively impact financial performance by improving access to finance and reducing capital constraints. Socially, proactive environmental disclosure can provide firms with a competitive advantage, enhance social trust, and improve corporate image by signaling environmental responsibility. Overall, voluntary carbon disclosures play a crucial role in enhancing transparency, reducing risks, and improving firm performance, ultimately benefiting both shareholders and stakeholders.

This work enhances the current knowledge by implementing an empirical analysis of the effects of carbon emissions on the quality of carbon disclosure. Empirical evidence implies that a positive association between ESG performance and disclosure quality. Moving forward, further research is required to develop a deeper understanding of the relationships between ESG performance and voluntary disclosure on the cross-industry comparison.

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