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Research on Market Reaction to Corporate Carbon Information Disclosure—Evidence from China

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Abstract: *This study examines the impact of corporate carbon disclosure on the capital market reaction using 100 companies listed in China SSE Social Responsibility Index from 2018 to 2021 and reveals two significant findings. Firstly, there is a positive correlation between the quality of corporate carbon information disclosure and the company's stock price. Moreover, the higher the quality of carbon information disclosure, the more significant the positive market response it brings. Secondly, the impact of carbon information disclosure on stock price improvement is more evident in non-heavy polluting industries compared to heavily polluting industries. These findings can encourage enterprises to adopt sustainable development practices and improve the quality of their carbon information disclosure, ultimately promoting greener economic and social development.*

Keywords: *Carbon information disclosure, Market reaction, Decision usefulness*

1. Introduction

According to recent data, global energy-related carbon dioxide emissions have reached an unprecedented high, rising by 6% from 2020 to a staggering 36.3 billion tons [1]. This alarming trend is accelerating the pace of global warming, leading to more frequent and severe extreme weather events such as heat waves and rainstorms. As a result, the global ecological and socio-economic systems are facing significant threats and challenges. Urgent action is required to promote low-carbon development and mitigate the adverse effects of climate change. Improving the transparency of corporate carbon behavior data is crucial for promoting a low-carbon economy and ensuring the sustainable and healthy development of the capital market. While some governments mandate the disclosure of carbon emissions data for listed companies, most countries still give companies the freedom to disclose carbon information. China's current laws and regulations do not include specific provisions for carbon information disclosure, and there is no unified policy document for disclosing corporate carbon behavior information. As a result, many domestic enterprises do not prioritize carbon information disclosure, and the content and form of the disclosure can vary greatly. This lack of standardization has created a need for regulatory mechanisms that ensure the authenticity and completeness of corporate carbon information disclosure[2]. Clarifying the market's reaction to corporate carbon disclosure is crucial in promoting sustainable development practices among enterprises. This can lead to increased investment in low-carbon environmental protection and improved quality of carbon information disclosure. These efforts are of great practical significance in achieving China's carbon peaking and carbon neutrality goals and further promoting comprehensive green transformation in economic and social development.

The remainder of this study proceeds as follows. Section 2 is Literature Review and Hypotheses; Section 3 is Research Design; Section 4 is Empirical Test and Result Analysis; Section 5 is Robustness Test; and Section 6 is Conclusion and Policy Recommendations.

2. Literature Review and Hypotheses

2.1. Literature Review

Since the proposal of the 'low-carbon economy' in the UK's Energy White Paper in 2003, scholars have conducted extensive research on environmental and carbon information disclosure. Carbon information disclosure refers to the practice of enterprises disclosing their carbon emissions and reduction plans to external stakeholders after assessing their carbon footprint. This enables stakeholders to gain a comprehensive understanding of the risks and opportunities associated with climate change that

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the enterprise faces, as well as the utilization of existing resources and the treatment of environmental pollution in a more intuitive manner [3][4].

According to some foreign scholars, investors have a favorable perception of corporate carbon disclosure, as evidenced by their study of British and American companies [5]. This aligns with He's (2011) perspective [6], which suggests that disclosing carbon information can enhance the transparency of non-financial information in enterprises. This, in turn, can mitigate the information asymmetry between internal managers and external stakeholders of enterprises and thus reduces the risk of investors' assessment. Enterprises that release carbon data to the public can experience a positive reaction in the effective capital market. However, according to Chapple et al. (2013), high-carbon-emitting enterprises disclosing carbon information may experience negative reactions in capital markets [7]. Research indicates that environmental information can lead to short-term reactions in the capital market, resulting in changes in stock prices and trading volumes [8]. In addition, a few scholars are skeptical about the effectiveness of corporate carbon disclosure decisions, as they argue that investors may not invest ethically despite the disclosure of carbon information. These scholars believe that the inherent shortcomings of carbon disclosure may be ignored, and therefore, may not cause a significant market reaction [9].

2.2. Hypotheses

2.2.1. Market reaction to corporate carbon information disclosure

In a market characterized by information asymmetry, enterprises that actively disclose their carbon performance and carbon emission reduction plans can effectively reduce the degree of information asymmetry between internal managers and external investors. This can help avoid adverse selection by investors and enhance investor confidence. Moreover, carbon information disclosure by enterprises is conducive to reducing their carbon management risks and provides a basis for the development of low-carbon strategies and decision-making. According to signal transmission theory, disclosing high-quality carbon information can send positive signals to the outside world. For example, companies that disclose their carbon information effectively can demonstrate a strong sense of social responsibility and profitability. These signals suggest the company's long-term stability and potential for growth, meeting the expectations of stakeholders and enhancing the company's reputation in the capital market which can attract investors and positively impact their stock prices. In contrast, companies that fail to disclose carbon information may send negative signals to the outside, indicating that they may face higher carbon emissions and carbon performance management risks. Therefore, the paper proposes the first hypothesis:

H1: There is a positive correlation between the quality of corporate carbon disclosure and stock prices.

According to legitimacy theory, if an enterprise's operations and development mode do not align with social norms or values, the legitimacy of its operation and development in the market will be threatened. This can result in difficulties for the enterprise's survival and growth. With stakeholders paying increasing attention to corporate carbon management, heavy industries - which are carbon-intensive - face greater challenges in reducing carbon emissions and maintaining legitimacy compared to other industries. Enterprises in high-polluting industries can improve their public image by disclosing real carbon data. However, this requires them to update their energy-saving and environmental protection equipment and adopt low-carbon emission reduction measures. Professionals must conduct follow-up investigations and statistical analysis, which will result in additional operational and management costs for enterprises [10]. While enterprises in non-heavily polluting industries face lower risks and costs when disclosing carbon information, which can attract investor attention and promote stock price growth. Building on this, we propose a second hypothesis:

H2: The market reaction to carbon information disclosure is stronger for non-heavy polluting enterprises compared to heavy polluting enterprises.

3. Research Design

3.1. Sample selection and data sources

This paper selects 100 listed companies of China SSE Social Responsibility Index from 2018 to 2021 as initial research samples. The SSE Social Responsibility Index is composed of the top 100 listed companies ranked by the Shanghai Stock Exchange based on their social contribution per share. These index stocks have demonstrated good social responsibility performance. As the quality of carbon

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information disclosure among enterprises in China is mixed, analyzing the carbon information disclosure of these enterprises can provide insights into their performance in terms of corporate social responsibility to enhance the explanatory power of this study. We screen the initial samples in a step-by-step manner, eliminating financial and banking enterprises first, followed by ST, ST* enterprises, and those listed in 2017 or later. Finally, we have excluded enterprises with missing or abnormal data to ensure the integrity of our sample.

This study matches financial data from 2017 to 2020 with carbon information published by the enterprise in the previous year, reflecting their carbon performance management status. Specifically, the carbon information disclosed by the enterprise in 2018 reflects the carbon data status of the enterprise in 2017. Data sources for both carbon information and financial data were obtained from the CSMAR database. To eliminate the influence of outliers on the results, major continuous variables were reduced by 1% up or down. Excel2019 and Stata2016 were utilized for data collation and regression operations.

3.2. Variable design

3.2.1. The variable being explained

Stock price (P). The stock price in an efficient market reflects the market reaction to corporate carbon disclosure. For this study, the stock closing price on the first trading day following the publication of carbon information in the annual report or social responsibility report was taken as the explained variable.

3.2.2. Core explanatory variable

Table 1: Evaluation table of carbon information disclosure index

	first-level index	second-level index	quantization assignment
Timeliness	The time of carbon disclosure	Time of disclosure in independent reports	Independent reports were all disclosed by April 1 of this year as 1, and no as 0
completeness	The carrier of carbon disclosure	The disclosure of the independent report	Only the annual report is disclosed as 1, the social responsibility or environmental report is 2, and the annual report, the social responsibility report and the environmental report are all disclosed as 3
	Carbon emissions	Greenhouse gas emissions	No disclosure is 0, qualitative disclosure is 1, and quantitative disclosure is 2
		Wastewater discharge	
		Other solid waste emissions	
	Carbon governance	Waste gas emission reduction and treatment	
		Wastewater emission reduction and treatment	
		Dust and smoke control	
		Treatment, recycling and comprehensive utilization of waste	
	Carbon strategy	Whether environmental targets are set	No is 0, it is 1
		Whether to establish an environmental protection concept	
		Whether to establish an environmental protection management system	
		Whether there is environmental education and training	
	Carbon risks and opportunities	Whether environmental accidents are disclosed	
		Whether have received environmental honors or awards	
reliability	Carbon Assurance	Whether it is certified by IS014001 environmental management system	

Carbon Disclosure Index (CDI). As the carbon-related information disclosed by enterprises belongs

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to non-financial information, existing researches mainly adopt the reputation method, index method, analytic hierarchy process, and content analysis method to conduct an integrated evaluation on the carbon information disclosed by enterprises. The content analysis method is not only widely applicable to large sample research but also relatively objective in the scoring process. In this paper, referring to existing research results [11], content analysis is adopted to construct carbon information disclosure scoring standards to reflect the status of enterprises' carbon information disclosure. The specific quantitative scoring criteria are shown in Table 1.

To minimize subjectivity in scoring, we calculate the Carbon Disclosure Index (CDI) by dividing an enterprise's actual score for annual carbon information disclosure by the sum of full marks according to the standard. The CDI ranges from 0 to 1, with a higher value indicating a more detailed and higher quality carbon information disclosure.

3.2.3. Control variables

In reference to existing studies, the control variables selected in this paper are company performance (ROE), enterprise size (SIZE), asset-liability ratio (LEV), company growth (GROWTH), company establishment years (LNAGE), equity concentration (TOP1), industry (IND), and year (YEAR). The main variables designed in this study are shown in Table 2.

Table 2: Variable descriptions

Type	Symbol	Definitions
The variable being explained	P	Stock price
Core explanatory variables	CDI	The last carbon information disclosure index of enterprises
Control variables	SIZE	The natural logarithm of total assets
	LEV	Total company liabilities / total company assets
	LNAGE	The natural logarithm of the number of years the company has been incorporated The business period with the result of the years minus the date of establishment
	TOP1	The shareholding ratio of the largest shareholder
	ROE	(Net profit) / (Average owner's equity)
	GROWTH	(Main business income at the end of the current year - Main business income at the end of the previous year) / Main business income at the end of the previous year
	YEAR	Year dummy variable
	IND	Industry dummy variable

3.2.4. Model setting

Build the following regression model based on hypotheses:

$$P = \alpha_0 + \alpha_1 CDI + \alpha_2 SIZE + \alpha_3 LEV + \alpha_4 LNAGE + \alpha_5 TOP1 + \alpha_6 ROE + \alpha_7 GROWTH + \Sigma YEAR + \Sigma IND + \omega$$

4. Empirical Test and Result Analysis

4.1. Descriptive Statistics

As shown in Table 3, the average stock price (P) of sample enterprises is 20.96, which is greater than the median of 14.16, indicating that the overall stock price level of the sample enterprises is relatively high; The minimum and maximum values are 3.665 and 139.9 respectively, and the standard deviation is 21.69, which indicates that the stock prices of enterprises of different nature vary greatly. The minimum value of the Carbon Disclosure Index (CDI) is 0 .006, the maximum value is 0.88, the mean is 0.443, the median is 0.44, and the standard deviation is 0.189. The difference in the quality of carbon information disclosure of different sample enterprises is large and the quality of disclosure is low, indicating that the overall quality of carbon information disclosure of listed companies in China needs to be improved.

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Table 3: Descriptive statistics for major variables

Variable	N	Mean	Median	Sd	Min	Max
P	300	20.96	14.16	21.69	3.665	139.9
CDI	300	0.443	0.440	0.189	0.0600	0.880
SIZE	300	24.81	24.59	1.550	21.77	28.16
LEV	300	0.558	0.587	0.177	0.146	0.852
LNAGE	300	3.017	3.091	0.260	2.250	3.434
TOP1	300	41.37	42.05	13.51	4.999	71.24
ROE	300	0.122	0.112	0.0760	-0.158	0.349
GROWTH	300	0.120	0.103	0.221	-0.479	1.080

4.2. Correlation analysis

Table 4 shows that both CDI and the P demonstrate a positive correlation, indicating that capital market investors have had a positive response to corporate carbon disclosure. Additionally, the control variables ROE, GROWTH, LNAGE, and TOP1 are positively correlated with the stock price of the enterprise, suggesting that the financial performance, operating capacity, profitability, and other basic aspects of the enterprise have a positive impact on the stock price. This aligns with basic financial viewpoints. This study finds a noteworthy negative correlation between enterprise scale and stock price, suggesting that capital market investors may be less willing to invest in larger enterprises in the short term. However, the correlation coefficients among variables are all below 0.6 and the maximum value of variance inflation factor (VIF) is 2.09, indicating no significant multicollinearity issues among the variables studied.

Table 4: Pearson correlation coefficients

Variable	P	CDI	SIZE	LEV	LNAGE	TOP1	ROE	GROWTH
P	1							
CDI	0.108*	1						
SIZE	-0.422***	0.247***	1					
LEV	0.444***	-0.0190	0.577***	1				
LNAGE	0.0490	0.00800	-0.228***	-0.00100	1			
TOP1	0.0710	0.0840	0.235***	-0.156***	-0.328***	1		
ROE	0.530***	-0.125**	-0.259***	-0.380***	-0.00600	-0.00900	1	
GROWTH	0.128**	-0.0920	-0.0730	0.0190	-0.187***	-0.0380	0.293***	1

Note: ***, ** and * indicate that the statistical significance levels are 1%, 5% and 10%, respectively;

4.3. Regression results and analysis

According to Table 5, there is a significant positive correlation between the quality of corporate carbon information disclosure and stock price, with a regression coefficient of 24.445 at the 1% level. This verifies Hypothesis 1, which states that the quality of corporate carbon information disclosure has a significant positive impact on stock prices. Moreover, the market response becomes more positive and pronounced as the quality of carbon information disclosure increases. This paragraph highlights the significance of disclosing high-quality carbon information by enterprises, which has garnered the interest of capital market investors. It also emphasizes that companies disclosing such information are more recognized in the market.

The industry-specific differences are taken into account while determining the heavy pollution industry code, which is classified under B06, B07, B08, B09, B10, B11, B12, C17, C18, C19, C22, C25, C26, C27, C28, C29, C31, C32, and D44 as per the revised Guidelines on the Classification of Listed Companies by Industry in 2012.

The regression results presented in Table 5 show that there is a significant positive correlation between the carbon information disclosure level and the stock price of enterprises in non-heavy polluting industries, with a correlation coefficient of 15.720, significant at a 1% level. This suggests that compared to carbon-intensive industries, enterprises in non-heavy polluting industries have lower risks and costs associated with disclosing carbon management data. As a result, investors are more willing to accept a lower return on investment. which drives enterprises to obtain stock premiums. However, The correlation coefficient between the carbon information disclosure level of enterprises in heavily polluting industries and the stock price is 28.650, which is not significant. This may be because there is a growing consensus

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on the importance of green and low-carbon development in society, which has led to an expectation that polluting enterprises should improve the quality of their carbon information disclosure. The public and society often overlook positive signals from industries with high levels of pollution. It can be challenging to demonstrate the economic impact of disclosing corporate carbon information. The three regression models presented in this paper have adjusted R2 values of 0.523, 0.619, and 0.444, respectively, indicating that the regression model fits well.

Table 5: Regression results

variables	Stock price(P)		
	Full sample	Non-heavy polluting industries	Heavily polluting industries
CDI	24.445***	15.720***	28.650
	(6.439)	(5.619)	(24.094)
SIZE	-4.069***	-4.638***	-4.246
	(1.102)	(0.987)	(4.431)
LEV	4.016	11.478	10.570
	(10.175)	(9.514)	(35.876)
LNAGE	-11.431*	-10.346**	-40.785
	(2.723)	(2.251)	(10.680)
TOP1	0.291***	0.174*	0.391
	(0.109)	(0.089)	(0.461)
ROE	125.105***	114.858***	153.610***
	(16.093)	(14.528)	(47.245)
GROWTH	7.957	0.111	15.796
	(4.883)	(4.086)	(14.866)
Constant	100.632***	137.825***	171.452
	(33.976)	(28.651)	(202.810)
IND	YES	YES	YES
YEAR	YES	YES	YES
Observations	300.000	217.000	83.000
R2	0.582	0.674	0.573
Adjustment - R2	0.523	0.619	0.444

Note: ***, ** and * indicate that the statistical significance levels are 1%, 5% and 10%, respectively; T values in parentheses.

5. Robustness test

In order to enhance the validity of the empirical findings presented in this paper, a robustness test was conducted by substituting the explanatory variables. The study finds that there is no significant change in the stock closing price on the fifth trading day after the release of annual, social responsibility, or environmental reports. This suggests that the carbon information disclosed by companies positively affects the capital market, leading to an increase in stock prices. These findings demonstrate the robustness of the study.

6. Conclusions and Policy Recommendations

6.1. Conclusions

This study utilizes data from the Top 100 enterprises in Shanghai Social Responsibility Index from 2018 to 2021 to establish a regression model aimed at examining the market reaction toward enterprises' carbon information disclosure. The study find that companies disclosing high-quality carbon information are recognized by the market, resulting in a more significant positive market reaction. Additionally, the quality of carbon information disclosure had a more substantial positive impact on stock prices for non-heavy polluting enterprises compared with carbon-intensive enterprises.

6.2. Policy Recommendations

The practical implications of this study extend to corporate management, policymakers, regulators,

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and investors. For enterprises, enterprises that prioritize sustainable development should consider optimizing their industrial structures, increasing investments in energy conservation and emission reduction, and improving the quality of carbon information disclosure. These actions can enhance their core competitive advantages and promote sustainable development. For the government, to promote sustainable and healthy development of the capital market, the government should establish a personalized legal and regulatory system for carbon information disclosure based on industry characteristics. This should be accompanied by policies that guide the industry toward more transparent and open carbon information disclosure. Furthermore, the government should increase supervision and penalties for violations to create a fair and transparent environment for enterprises to disclose their carbon information. For investors, investors should not only focus on the short-term economic benefits of enterprises, but also pay attention to their measures and performance in areas such as low-carbon emissions, environmental protection, and green development. It is important to make comprehensive evaluations and decisions based on the perspective of long-term development. With the low-carbon economic development model, there is a huge potential for environmental benefits and the fulfillment of social responsibilities by enterprises.

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