The Influence of Carbon Emission Disclosure On Enterprise Value Under Ownership Heterogeneity: Evidence From The Heavy Polluting Corporations

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Abstract

China has put forward the goals of “Emission Peak” and “Carbon Neutrality”. Therefore, whether the restriction of carbon information disclosure could promote the transformation and upgrading of heavily polluting corporations to raise their value and realize the “double carbon” goal is a problem worthy of in-depth study. This article analyzed the impact of carbon information disclosure on the enterprise value of heavily polluting corporations based on the perspective of ownership structure heterogeneity. The paper discussed the moderating effect of carbon information disclosure on enterprise value taking into account government environmental regulations, media evaluation, and corporate image management based on the Gatekeeper Theory. This article found that carbon information disclosure and enterprise value have a “U-shaped” relationship in the short term and a positive correlation in the long term. The government environmental regulation, media evaluation, and corporate image management produced different moderating effects under the difference in ownership structure. Government environmental regulations, media evaluation, and corporate image management made significant moderating effects on state-owned corporations in the short term, while they have no significant moderating effect in the long term. The results also showed that there were no significant effects on private corporations. In order to push heavily polluting corporations to implement environmental protection measures, government and corporations are necessary to promote the long-term mechanism of sustainable cleaner production.

1. Introduction

At the “Two Sessions” in 2021, “Emission Peak” and “Carbon Neutrality” were written into the Chinese government work report for the first time. China strives to reach the peak of carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. To achieve these dual goals, Intergovernmental Panel on Climate Change (IPCC) suggests China should increase its timeframe and strengthen environmental regulations on carbon emission (Pike, 2021). China Securities Regulatory Commission (CSRC) has revised the guideline for the content and format of information disclosure by a listed corporation in 2021, and added new chapters on environmental and social responsibility. The guideline also encouraged corporations to voluntarily disclose carbon emissions information. Carbon emission information disclosure shows carbon dioxide generated in the production process and reveals the standard of environmental management. In addition, it also depicts the degree to which corporations are undertaking their social responsibility and their technological sophistication.

Enterprise value is the market evaluation value of tangible assets and intangible assets of the corporations. Enterprise value not only reflects the time value and risk of corporate funds, but also the sustainable development ability of corporations. The enterprise value would be indirectly affected by the carbon emission information disclosure. This is because carbon information disclosure would influence the decision and behavior of corporate stakeholders such as the government, management, employees, investors, creditors, customers, etc., and these stakeholders would influence the enterprise’s future and present financial health as well as the prospect of corporate development (Yang and Qiao, 2021).

At present, scholars have carried out in-depth research on the impact of carbon emission information disclosure on enterprise value. Some scholars have stated that enterprise carbon information disclosure has played a positive role in promoting enterprise value. The disclosure of carbon information helps to reduce environmental risk costs (Hassl et al., 2005), obtain extensive attention from the capital market (Li et al., 2017), and also enhance the enthusiasm of consumers and investors. It not only enhances the reputation and trust of corporations but also obtains the support of government policies (Zha et al., 2021). Grigoris et al. (2017) thought carbon emission disclosure improves enterprise performance, thereby encouraging corporations to disclose their carbon emission information. Some scholars thought that there is no correlation between carbon information disclosure and enterprise value. Jiang (2010) and Wang (2013) found no significant correlation between carbon information disclosure and the enterprise value of listed corporations that disclose carbon emission information voluntarily in China. Alsaifi (2021) found that the carbon emission disclosure behavior could not enhance enterprise value in the UK and stated that the relationship between carbon emission disclosure behavior and corporate performance is not significant. On the contrary, some scholars found a negative correlation between environmental information disclosure and enterprise value. Shane (1983), Susmita (2001) and Murray (2006) found that environmental information disclosure is negatively related to enterprise financial performance. It has led to an increase in environmental investment costs (Murray et al., 2006) and a decrease in enterprise income and enterprise value (Sutantopura et al., 2012).

When implementing carbon emission discourse, the gatekeepers decide what information should be made public. The gatekeepers are the decision-makers who influence the carbon emission disclose to the public based on personal or social influences. Through this process, the sensitive and controversial information is removed by the gatekeeper, which helps to control the carbon emission discourse. As shown in Figure 1, the government, corporation and media are the gatekeepers (Rusche et al., 2021).

The government establishes the content, format and requirement of the carbon information disclosure to manage the environmental regulation. The corporations can selectively disclose the carbon information and decide the quality of the information to maintain company image. The media could expand or shrink the business influence of disclosing carbon information by appraising the carbon information. Therefore, the content, quality, and influence of the disclosure information are decided by the three gatekeepers.

The disclosure of carbon emission data is a response to the demand of various stakeholders for making the market decision. It not only reduces information asymmetry between stakeholders and corporations, but also makes an impact on the future value-added ability, business risk, enterprise strategy and enterprise duration. The internal stakeholders of the enterprise such as investors, senior executives, and employees would carry out structural reform to increase research investment, improve production efficiency, reduce resource consumption and environmental pollution, adopt advanced technology and equipment, and promote the competitiveness of corporations in the market. The external stakeholders, such as the government, consumers, suppliers, creditors, and the public, could broaden the information exchange channel with enterprises and further increase the opportunities of the investment on enterprises. Furthermore, the change of the corporation value will further affect the gatekeepers’ trust in the enterprise. This leads to the gatekeepers further influencing the enterprise information disclosure, and then affect the competitiveness as well as business performance of corporations. However, how the disclosure of enterprise carbon emission information affects the enterprise value under the influence of gatekeepers is a complex process that requires

answering difficult theoretical and practical research questions. Under the heterogeneity of ownership structure, the different performances of corporations have important theoretical and practical significance for formulating policies to promote the green development of corporations and reduction of carbon emission.

In terms of the influence of government, Dension (1986) and Gray (1987) found that the implementation of government environmental regulation policies led to a decline in the production efficiency of corporations. Klaus (1996) and Gale (1999) proposed that government environmental regulation did not correlate with enterprise value. While Porter (1991) found that environmental regulation policies could stimulate technological innovation of corporations, improve production efficiency, and thus improve enterprise value.

In terms of the influence of media, some scholars found that media evaluation played a linear positive role in regulating enterprise value. Media, as an important external supervision mechanism of enterprise carbon information disclosure, could encourage corporations to make more active environmental management behaviors (Aerts and Cormier, 2009), increase R&D innovation of corporations and improve the efficiency of companies (Joe et al., 2007). Moreover, with additional focus by the media on corporations, the level of enterprise information disclosure by companies is enhanced (Bloomfield and Wilks, 2001) which reduces the information asymmetry (Bushee et al., 2010). Therefore, the trust and recognition of external investors and media to corporations would increase and enhance enterprise value (Liao and Welford, 2020). However, Wen (2017) stated that media evaluation did not play a linear regulatory role in the relationship between carbon information disclosure and enterprise value, but played an “inverted U-shaped” regulatory role. Lyon and Montgomery (2013) found that media evaluation forced corporations to face greater social pressure, which pressures them to disclose less carbon emission information. This leads to making wrong decisions that lowers enterprise performance and value.

In terms of the influence of corporation, corporate carbon emission disclosure could help corporations accumulate reputation capital (Jeong et al., 2020), reduce enterprise production costs (Yu et al., 2019), and influence enterprise decision-making behavior (Kothari et al., 2009). Thus, it would improve enterprise value (Rao, 2016; Yang, 2009). However, the level of carbon emission disclosure of corporations should be consistent with the life cycle of corporations, otherwise, the corporate image would be damaged or the management cost would be too high, leading to reducing the enterprise value (Horvathova, 2010).

In summary, the existing studies have researched the impact of carbon information disclosure and enterprise value from different perspectives. However, there are several topics worthy of further discussion. Firstly, the effects of carbon emission disclosure on the value of different corporations show various characteristics. Furthermore, the world's greenhouse gas emissions mainly come from heavily polluting corporations. As a result, this paper chooses Chinese heavily polluting corporations as the research subject to explore how the regulatory characteristics of different factors influence state-owned corporations and private corporations. Secondly, when studying regulatory factors, most scholars choose only one of the gatekeepers to explore its moderating influence on the relationship between carbon information disclosure and enterprise value (Rupley, 2012, Zha, 2021, Song et al., 2019, Wen and Zhou, 2017, Rubashkina, 2015, Jeong et al., 2020). However, the government management, enterprise operation, and media evaluation are the gatekeepers of the carbon emission information disclosure that operate as a system. Therefore, it is necessary to explore the moderating effect of these gatekeepers together. Thirdly, Zha (2021) used ROA (Return on Total Assets) to measure the short-term value of the enterprise, Lioui (2012) and Song (2019) used Tobin Q value to measure the long-term value of the enterprise. However, ROA reflects the margin profit generated by the rights of shareholder and funds of creditor, and the future vested interests of the enterprise, and Tobin Q value reflects the relationship between equity value and replacement cost, which is an indicator of enterprise investment value. Therefore, ROA and Tobin Q value cannot truly reflect the short-term value and long-term value of the enterprise. ROE (Return on Equity) reflects the profit rate generated by the funds invested by shareholders, the return rate of shareholders' equity investment, the company's earning ability and the company's fundamental situation and short-term profitability, therefore, it is used to measure the short-term value of the enterprise. Furthermore, ROA is an indicator to measure the net profit per unit of assets, reflecting the shareholders' and creditors' vested interests and future cash inflow, and the future potential profitability of corporations. Therefore, this paper uses ROE as an indicator to measure the short-term value of corporations and ROA as an indicator to measure their long-term value. In addition, this paper explores the impact of carbon information disclosure on enterprise value and the characteristics of moderating effects of government environmental regulation, corporate image and media evaluation in the short-term and long-term.

The rest of this research article is organized as follows. Section two proposes the research hypothesis of the influence of carbon emission information disclosure on enterprise value. Section three establishes the model. In Section four the results are presented. Section five discusses the impact of carbon information disclosure on the value of corporations with different ownership structures from the short-term and long-term perspectives. Section six summarizes and concludes the paper.

2. Research Hypothesis

In China, the heavily polluting listed corporations volunteer to disclose carbon information regularly, which shows that corporations emphasize environmental protection. This reflects the enterprise's level of undertaking their environmental protection responsibility, reduces information asymmetry between corporations, consumers and investors, enhances consumers' preference for corporations, enlightens investors and affects enterprise's value. Therefore, this paper puts forward the following assumptions.

2.1 The impact of corporate carbon emission disclosure on enterprise value

From the perspective of short-term operation, the heavily polluting corporations would emit carbon dioxide and pollute the environment during production. Carbon emission disclosure would inhibit the pollution behavior of corporations and encourage corporations to increase their capital and technical investment in environmental protection. Therefore, it increases the investment cost and decreases the income of corporations in the short term. However, with the optimization of the production process, the upgrading of technology and the gradual improvement of management, the operating cost of corporations would

be reduced. Furthermore, with continuous carbon information disclosure of corporations, the trust of consumers and investors will increase effectively enhancing the value of corporations. Therefore, this paper puts forward two hypotheses H1a and H1b.

H1a: In the short term, carbon emission disclosure and corporate value show a “U-shaped” relationship.

H1b: In the long term, there is a positive correlation between carbon emission disclosure and enterprise value.

2.2 The moderating effect of media evaluation

Media influences the behavior of enterprise managers by transmitting information to the market and stakeholders. As an important medium of information dissemination, it could restrain the misconduct of corporations, promote corporations to enhance their awareness of social responsibility, and help to solve the problem of information asymmetry between corporations, consumers and investors. In addition, it could enhance the transmission effect of carbon information disclosure on enterprise value, which contributes to optimizing enterprise operation and management (Kothari, 2009). Consequently, this paper proposes the hypothesis H2.

H2: Media evaluation moderates the relationship between carbon emission disclosure and enterprise value.

2.3 The moderating effect of government environmental regulation

The government carries out macro-control on the market behavior of corporations through policy regulation and reduces improper behavior of corporations. Under various government regulatory environments, the impact of carbon emission disclosure on enterprise value would be different. Corporations will disclose carbon emission data if the government strictly enforces it. This helps the companies gain the trust of investors and enhances their income. On the contrary, corporations in areas with loose government control would reduce their sense of responsibility and overdraw corporate credit by “exploiting loopholes”. This could reduce investors’ trust, which causes the loss of economic benefits. Therefore, the corporations would obtain the investors’ attention and consumers’ trust. The corporations enhance their value when the quality of enterprise carbon emission disclosure is consistent with the level of regional environmental regulation. Therefore, this paper puts forward the hypothesis H3.

H3: Government environmental regulation moderates the relationship between carbon emission disclosure and enterprise value.

2.4 The moderating effect of corporate image management

Based on the long-term development strategy, the standardization of enterprise image management is made by managers to normalize the overall value criteria and daily behavior, which represents the market position and the characteristics of the enterprise. Timely and high-quality carbon information disclosure of corporations could enable companies increasing gain of trust among investors and consumers. This translates to increased reputation capital, increased income and improved valuation. Thus, this paper puts forward hypothesis H4.

H4: Enterprise image management moderates the relationship between carbon emission disclosure and enterprise value.

3. Model Construction And Data Sources

3.1 Modeling

A multiple regression model could explore the nonlinear relationship between the explained variable and the explanatory variable, and explain the moderating effect between the moderating variable and the explanatory variable. The following the multiple regression model was constructed.

$$\text{Model 1: } ROE_1 = \alpha + \beta_1 CED + \beta_2 GER + \beta_3 Media + \beta_4 CIM + \beta_5 DAR + \beta_6 Growth + \beta_7 Year + \beta_8 CC + \beta_9 Region + \epsilon$$

$$\text{Model 2: } ROE_2 = \alpha + \beta_1 CED + \beta_2 CED^2 + \beta_3 GER + \beta_4 Media + \beta_5 CIM + \beta_6 DAR + \beta_7 Growth + \beta_8 Year + \beta_9 CC + \beta_{10} Region + \epsilon$$

$$\text{Model 3: } ROA_3 = \alpha + \beta_1 CED + \beta_2 GER + \beta_3 Media + \beta_4 CIM + \beta_5 DAR + \beta_6 Growth + \beta_7 Year + \beta_8 CC + \beta_9 Region + \epsilon$$

$$\text{Model 4: } ROA_4 = \alpha + \beta_1 CED + \beta_2 CED^2 + \beta_3 GER + \beta_4 Media + \beta_5 CIM + \beta_6 DAR + \beta_7 Growth + \beta_8 Year + \beta_9 CC + \beta_{10} Region + \epsilon$$

Model 1 tests the linear correlation between carbon emission disclosure and the short-term value of corporations. Model 2 tests the “U-shaped” correlation between carbon emission disclosure and the short-term value of corporations. Model 3 tests the linear correlation between carbon emission disclosure and the long-term value of corporations. Model 4 tests the “U-shaped” correlation between carbon emission disclosure and the long-term value of corporations.

Model 5:

$$ROE_5 = \alpha + \beta_1 CED + \beta_2 CED^2 + \beta_3 Media + \beta_4 Media \times CED + \beta_5 Media \times CED^2 + \beta_6 GER + \beta_7 GER \times CED + \beta_8 GER \times CED^2 + \beta_9 CIM + \beta_{10}$$

Model 6:

$$ROA_6 = \alpha + \beta_1 CED + \beta_2 CED^2 + \beta_3 Media + \beta_4 Media \times CED + \beta_5 GER + \beta_6 GER \times CED + \beta_7 CIM + \beta_8 CIM \times CED + \beta_9 DAR + \beta_{10} Growth + \epsilon$$

Model 5 tests the “U-shaped” moderating effect of government environmental regulation, corporate image management, and media evaluation on the relationship between carbon emission disclosure and short-term enterprise value. Model 6 tests the moderating effect of government environmental regulation, corporate image management, and media evaluation on the relationship between carbon emission disclosure and long-term enterprise value.

3.2 Variable interpretation

The variable settings in the model are shown in Table 1.

Table 1
Variable Interpretation

Variable Type	Variable Name	Variable Symbol	Variable Interpretation
Explained variable	The short-term value of enterprise	ROE	Net profit/average net assets
	The long-term value of enterprise	ROA	Net profit/average total assets
Explanatory variable	Carbon emission disclosure	CED	Carbon emission disclosure evaluation index
Adjustment variable	Government environmental regulation	GER	Urban pollution source supervision information disclosure index
	Media evaluation	Media	If the number of positive evaluations is more than negative evaluation, Media = 1, otherwise, Media = 0
	Corporate image management	CIM	Enterprise reputation capital
Control variable	Debt to asset ratio	DAR	Total debt / Total assets
	The growth rate of net assets	Growth	(Ending net assets-opening net assets)/opening net assets
	Year	Year	Year
	Corporate competition	CC	Herfindahl-Hirschman index
	Region attributes	Region	If the area is developed areas, Region =1, otherwise, Region = 0

(1) Explanatory Variable

The core explanatory variable of this paper is the carbon emission disclosure (CED). The content analysis method was previously used to measure the carbon information disclosure of corporations (Li et al, 2019). The evaluation criteria are divided into six aspects: carbon risk, carbon strategy, carbon governance, carbon accounting, carbon performance and subsidies, carbon certification and verification. In each aspect, if the enterprise did not disclose any information, it scores 0. If it discloses general qualitative information, it scores 1 point. If it discloses detailed qualitative or quantitative disclosure, it results in the company scoring 2 points. The full score is 12 points. The evaluation criteria are shown in Table 2.

Table 2
Carbon information disclosure scoring

Disclosure Items	Description
Risk of carbon emission	Whether the enterprise facing the penalty or lawsuits for environmental pollution
Carbon emission reduction strategy	Whether the enterprise disclose emission reduction targets or plans or actions;
	The response degree of corporations to the government emission reduction targets and policies
Carbon emission reduction manage	Whether the enterprise takes some measures to reduce the carbon emission;
	Organization and management of carbon emission reduction
Carbon emission reduction accounting	Whether the enterprise discharges greenhouse gases;
	Enterprise carbon emission trading volume, transaction costs, etc.
Carbon emission reduction performance and subsidies	Economic benefits from carbon emission reduction;
	The incentive regulations related to carbon emission reduction
Carbon emission reduction certification and verification	ISO4001 certification or third-party inspection

(2) Explained variable

Return on Equity (ROE) = net profit/average shareholder equity×100%, it represents the short-term enterprise value.

Return on Total Assets (ROA) = total profit/total assets×100%, it represents the long-term enterprise value.

(3) Adjustment variable

Government Environmental Regulation (GER). The Urban Pollution Source Supervision Information Disclosure Index was developed by the Public Environmental Research Center, China (www.ipe.org.cn). It is used to measure the government's supervision to distinguish the environmental regulation level of local governments (Song et al., 2019).

Media Evaluation (Media). Collects and sorts out the media evaluation opinions in Wind Database (<http://www.wind.com.cn>), and search for positive and negative news of corporations from 2010 to 2019 through the corporate official website, social responsibility report, environmental report and news media. If the number of negative evaluations is more than the number of positive evaluations, the media evaluation will be 0. On the contrary, if the number of positive evaluations is more than the number of negative evaluations, the value of media evaluation will be 1.

Corporate Image Management (CIM). Corporate reputation capital is the sum of comprehensive reputation indicators composed of word of mouth, image, reputation, performance, industry status, public opinion response, and social responsibility, which is used to measure the corporate image. The reputation capital of heavily polluted listed corporations in China from 2010 to 2019 is obtained from Wind Database (<http://www.wind.com.cn>).

(4) Control variable

Seven indicators are selected as control variables, such as debt to asset ratio (DAR), the growth rate of net assets (Growth), year (Year), corporate competition (CC) and region attributes (Region).

The debt to asset ratio (DAR) is an index to evaluate the company's management ability and profitability, and measure the company's financial risk. $DAR = \text{Total debt} / \text{assets}$.

The growth of the enterprise is represented by the growth rate of enterprise net assets (Growth) which is collected from the Wind Database (<http://www.wind.com.cn>).

The variable Year which represents the year of the sample, could exclude the influence of time on carbon emission disclosure and enterprise value.

The variable corporate competition (CC) is expressed by Herfindahl-Hirschman Index (HHI) (Sutantoputra et al., 2012). HHI could measure the industrial concentration and change rate in market share. The calculation formula is as follows: $HHI = \sum_{i=1}^N (\frac{X_i}{X})^2$. Where N indicates the number of listed companies of heavily polluting corporates, X_i indicates the operating income of the enterprise in the current year, X means the sum of operating income of heavily polluting corporations. The smaller the value of HHI , the fiercer the competition among corporations.

The variable regional attribute (Region) classifies the enterprise location according to the degree of economic development, the top ten cities in GDP are developed areas, the rest are underdeveloped areas. The regional attribute value is 1 if the corporations in developed areas, otherwise, it is 0.

3.3 Data Sources

315 heavily polluting listed corporations were selected from Shanghai and Shenzhen A-share markets as research samples. 2,029 valid research samples were sorted out by collecting data from 2010 to 2019 and some samples were excluded which are ST companies, *ST companies, or samples with an outlier. Carbon emission disclosure data are collected by social responsibility reports which usually are shown as an annex to the annual report of enterprises, environmental reports (<http://www.cninfo.com.cn>) and Hexun Network (<http://www.hexun.com>). Financial index data comes from Wind Database (<http://www.wind.com.cn>). Some missing data was supplemented by Dongfang Fortune Network (<http://www.eastmoney.com>) and Juchao Information Network (<http://www.cninfo.com.cn>).

4. Empirical Analysis

4.1 Descriptive statistics

As shown in Table 3, the average value of CED is 0.6 and the standard deviation is 1.91, which indicates that the degree of carbon emission disclosure of heavily polluting listed corporations in China is relatively low. The standard deviation of ROE and ROA is 11.56 and 30.21 respectively, which indicates that there are great differences in the value of different corporations. The average value of GER is 57.91, and the standard deviation is 15.32, which indicates that the degree of environmental regulation in China is relatively high. The mean value of Media is 0.46 and the standard deviation is 0.5, which indicates that the media evaluation in various provinces and cities is consistent. The standard deviation of CIM is 132257, which indicates that there are great differences in different corporate image management.

Table 3
Descriptive statistics for variables

Variable	N	Mean Value	Standard Deviation	Minimum Value	Maximum Value
<i>CED</i>	2030	0.60	1.91	0	11
<i>ROE</i>	2030	11.56	62.27	-2681	304.40
<i>ROA</i>	2030	9.16	30.21	-33.20	1181
<i>GER</i>	2030	57.91	15.32	9.50	85.30
<i>CIM</i>	2030	40354	132257	-90306	1988000
<i>DAR</i>	2030	38.02	20.24	2.91	106.50
<i>Growth</i>	2030	20.02	182.10	-116.70	6519.00
<i>CC</i>	2030	0.32	5.74	0	148.40
<i>Region</i>	2030	0.79	0.41	0	1

According to the heterogeneity of ownership structure, the samples are divided into state-owned enterprises and private enterprises. It can be found that there are significant differences between state-owned corporations and private corporations in carbon emission disclosure, government environmental regulation, media evaluation, corporate image management and enterprise value as shown in Table 4. The average difference of CED is 1.12, indicating that the average value of the carbon emission disclosure index of state-owned corporations is 112% higher than that of private corporations. The mean difference between the ROE and ROA is -11.76 and -6.10 respectively, indicating that the value of private corporations is higher than that of state-owned corporations. The mean difference between the GER and Media of state-owned corporations and private corporations are -1.04 and 0.05, respectively. The average difference of CIM is 1980.32, indicating that state-owned corporations pay more attention to corporate image management and their reputation capital is larger than private corporations.

Table 4
Statistical results of grouped samples

Variable	State-Owned Corporates			Private Corporates			Mean Difference
	N	Mean Value	Standard Deviation	N	Mean Value	Standard Deviation	
<i>CED</i>	500	1.44	3.12	1530	0.32	1.16	1.12
<i>ROE</i>	500	2.70	122.2	1530	14.46	15.69	-11.76
<i>ROA</i>	500	4.56	5.56	1530	10.66	34.52	-6.10
<i>GER</i>	500	57.13	16.57	1530	58.17	14.89	-1.04
<i>Media</i>	500	0.50	0.50	1530	0.45	0.50	0.05
<i>CIM</i>	500	41847	69326	1530	39866.68	147085.7	1980.32
<i>DAR</i>	500	48.22	21.39	1530	34.70	18.69	13.52
<i>Growth</i>	500	5.86	31.91	1530	24.63	208.68	-18.77
<i>CC</i>	500	1.13	11.54	1530	0.056	0.08	1.05
<i>Region</i>	500	0.76	0.43	1530	0.80	0.40	-0.04

4.2 Correlation analysis

The Pearson correlation analysis results are shown in Table 5. It can be found that the absolute value of the correlation coefficient among most variables is less than 0.1. The VIF value of the model is less than 5, it indicates that there is no multicollinearity among explanatory variables. The correlation coefficients between CED and ROE and ROA are -0.0935 and -0.0530 respectively, both of them are significant at the level of 1%, indicating that carbon emission disclosure is negatively correlated with enterprise value. The coefficient of GER and CED is 0.1489, which shows that government environmental regulation plays a positive role in improving carbon emission disclosure of corporations. The correlation coefficients between GER and ROE is -0.0450, GER and ROA is -0.0374 respectively, which indicates that government environmental regulation behavior would reduce enterprise profits and enterprise value. CIM is negatively correlated with media evaluation and GER. GER is negatively correlated with CC and positively correlated with variable Region. CIM is negatively correlated with variable Region. DAR is positively correlated with CC.

Table 5
Results of variable correlation analysis

<i>Variable</i>	<i>CED</i>	<i>ROE</i>	<i>ROA</i>	<i>GER</i>	<i>Media</i>	<i>CIM</i>	<i>DAR</i>	<i>Growth</i>	<i>CC</i>	<i>Region</i>
<i>CED</i>	1									
<i>ROE</i>	0.0935***	1								
<i>ROA</i>	-0.0530**	0.0851***	1							
<i>GER</i>	0.1489***	-0.0450**	-0.0374*	1						
<i>Media</i>	0.0104	0.0207	0.0425*	-0.0687***	1					
<i>CIM</i>	0.00370	-0.0321	-0.0301	-0.0476**	0.1325***	1				
<i>DAR</i>	0.1362***	0.0599***	-0.0135	0.0181	0.0453**	0.00890	1			
<i>Growth</i>	-0.0251	0.0415*	0.5660***	-0.0169	0.0314	-0.0139	0.0621***	1		
<i>CC</i>	-0.00990	-0.000700	-0.00500	-0.0712***	0.0154	0.00550	0.0458**	-0.00270	1	
<i>Region</i>	-0.0227	0.0194	0.0535**	0.2412***	-0.0253	0.1233***	-0.0310	0.0128	-0.0172	1

4.3 Multiple linear regression analysis

The panel data of state-owned corporations is suitable for the mixed regression model, and the panel data of private corporations is suitable for the fixed-effect model after the Hausman test. Therefore, this paper chooses the generalized least square regression model for regression analysis and uses the moderating effect model to analyze the influence of government environmental regulation, corporate image management, and media evaluation on the relationship between carbon emission disclosure and enterprise value of state-owned corporations and private corporations.

4.3.1 The impact of carbon emission disclosure on state-owned enterprise value

As shown in Table 6, when the explained variable is ROE in Model 1, the regression coefficient of the variable CED is -2.196 ($t = -1.23$), which has not passed the significance test. The regression coefficient of the variable CED is -20.890 ($t = -2.84$) and the regression coefficient of the variable CED^2 is 1.992 ($t = 2.62$) in Model 2, both of them have passed the significance test, indicating that carbon emission disclosure is helpful to enhance the short-term value of enterprises, and the main effect regression verifies the “U-shaped” relationship between carbon emission disclosure and short-term enterprise value, the assumption H1a is tested.

As shown in Table 6, when the explained variable is ROA, the regression coefficient of variable CED is -0.061 ($t = -1.14$) in Model 3, which has not passed the significance test. The regression coefficient of variable CED is -0.464 ($t = -1.84$) and the regression coefficient of variable CED^2 is 0.043 ($t = 1.81$) in Model 4, both have passed the significance test, indicating that carbon emission disclosure plays a promoting role in the long-term enterprise value.

The coefficients of variable CED^2 in Model 4 are significantly lower than in Model 2, which shows that the impact of carbon emission disclosure of state-owned corporations on the short-term value of corporations is greater than that on the long-term value of corporations. This is because the marginal utility of carbon emission disclosure of corporations is diminishing, which makes it difficult for corporations to gain the trust of consumers and investors through long-term carbon emission disclosure, and therefore leads to the reduction of enterprise value. Moreover, at the initial stage of disclosure, stakeholders pay more attention to the data of the disclosure, in that case, enterprises invest more talents and funds in preparing the disclosure to reduce the information asymmetry between investors and enterprises. This is done with aim to obtain the trust and capital investment of investors and therefore it improves the value of enterprises. In addition, because the regression coefficient of variable CED^2 is positive, carbon emission disclosure would improve enterprise value in the long run, so the assumption H1b is tested.

Table 6
Regression results of owner effect of state-owned corporations

Variable Name	Model 1	Model 2	Model 3	Model 4
	ROE	ROE	ROA	ROA
<i>CED</i>	-2.196 (-1.23)	-20.890*** (-2.84)	-0.061 (-1.14)	-0.464* (-1.84)
<i>CED</i> ²		1.992*** (2.62)		0.043* (1.81)
<i>GER</i>	-0.324 (-0.88)	-0.184 (-0.50)	-0.052*** (-3.29)	-0.049*** (-3.09)
<i>CIM</i>	-8.84×10 ⁻⁵ (-1.11)	0	2.52×10 ⁻⁶ (0.84)	2.44×10 ⁻⁶ (0.82)
<i>Media</i>	12.606 (1.16)	12.931 (1.19)	0.860** (2.10)	0.867** (2.12)
<i>DAR</i>	-0.394 (-1.54)	-0.424* (-1.66)	-0.116*** (-11.21)	-0.117*** (-11.18)
<i>Growth</i>	0.687*** (4.06)	0.703*** (4.18)	0.047*** (3.44)	0.047*** (3.45)
<i>CC</i>	0.011 (0.02)	0.015 (0.03)	0.001 (0.12)	0.001 (0.14)
<i>Region</i>	2.109 (0.15)	1.472 (0.11)	1.114** (2.31)	1.101** (2.28)
<i>C</i>	35.159 (1.48)	32.406 (1.37)	11.580*** (11.60)	11.521*** (11.63)
<i>N</i>	499	499	499	499
<i>R-Square</i>	0.0513	0.0644	0.3107	0.3137
<i>Adj. R-Square</i>	0.0358	0.0472	0.2995	0.3010
Note: T statistics are shown in parentheses, and ***, **, and * indicate significance at 1%, 5%, and 10% levels respectively.				

4.3.2 The impact of carbon emission disclosure on private enterprise value

As shown in Table 7, when the explained variable is ROE, the coefficient of the variable CED is -1.711 (t = 5.51) in Model 1. When the explained variable is ROA, the coefficient of the variable CED is -1.157 (t = -1.69) in Model 3. All of them have passed the significance test, which indicates that the improvement of carbon emission disclosure level could significantly decrease the enterprise value.

When the explained variable is ROE, the regression coefficient of the variable CED is -4.271 (t = -6.33) and the regression coefficient of the variable CED² is 0.397 (t = 4.26) in Model 2, both passed the significance test. This indicates that the increase of carbon emission disclosure is helpful to enhance the short-term value of enterprises and the main effect regression tests the “U-shaped” relationship between carbon emission disclosure and private enterprise value, so the assumption H1a is tested. When the explained variable is ROA, the regression coefficient of variable CED is -2.819 (t = -3), and the regression coefficient of variable CED² is 0.258 (t = 2.32) in Model 4, which passed the significance test, indicating that carbon emission disclosure plays a role in promoting the long-term private enterprise value, so the assumption H1b is tested, and the regression coefficient of variable CED² in Model 4 is significantly smaller than that in Model 2. The reason is the same as in state-owned enterprises.

Table 7
Regression results of owner effect of private corporations

Variable Name	Model 1	Model 2	Model 3	Model 4
	ROE	ROE	ROA	ROA
<i>CED</i>	-1.711*** (-5.51)	-4.271*** (-6.33)	-1.157* (-1.69)	-2.819*** (-3.00)
<i>CED</i> ²		0.397*** (4.26)		0.258** (2.32)
<i>GER</i>	-0.113*** (-4.16)	-0.104*** (-3.85)	-0.026 (-0.44)	-0.020 (-0.42)
<i>CIM</i>	-3.09×10 ⁻⁵ *** (-2.84)	-2.83×10 ⁻⁵ *** (-2.61)	1.74×10 ⁻⁵ (0.72)	0.00002 (0.94)
<i>Media</i>	-0.776 (-0.48)	0	0	0
<i>DAR</i>	-0.081*** (2.69)	-0.086*** (2.85)	-0.380*** (5.69)	0.383 (1.10)
<i>Growth</i>	0.003* (1.75)	0.003 (1.61)	0.067*** (17.01)	0.067*** (27.91)
<i>CC</i>	2.881 (0.68)	2.743 (0.65)	45.484*** (4.84)	45.394 (1.03)
<i>Region</i>	5.617*** (2.76)			
<i>C</i>	19.745*** (9.90)	19.239*** (9.69)	-5.482 (-1.25)	-5.810 (-0.33)
<i>N</i>	1530	1530	1530	1530
<i>F-statistic</i>	13.79	14.56	67.48	192.43
<i>Prob (F-statistic)</i>	0.0000	0.0000	0.0000	0.0000
Note: T statistics are shown in parentheses, ***, ** and * indicate significance at 1%, 5% and 10% levels respectively.				

4.3.3 The moderating effect of gatekeepers in state-owned corporations

(1) The moderating effect of media

As shown in Table 8, when the explained variable is ROE, the regression coefficient of the variable Media×CED is 40.533 (t = 2.83) and the regression coefficient of the variable Media× CED² is -3.788 (t = -2.53). Both passed the significance test, indicating that media evaluation has a “U-shaped” moderating effect on the relationship between carbon information disclosure and the short-term value of state-owned corporations. When the explained variable is ROA, the regression coefficient of the variable Media×CED is 0.247 (t = 1.81), which passed the significance test. This indicates that media evaluation plays a role in promoting the influence of carbon emission disclosure on the long-term value of state-owned corporations. Therefore, the assumption H2 is tested.

(2) The moderating effect of government

As shown in Table 8, when the explained variable is ROE, the regression coefficient of variable GER×CED is -3.021 (t = -4.09) and the regression coefficient of variable GER×CED² is 0.281 (t = 3.76). Both passed the significance test, indicating that government environmental regulation has a “U-shaped” regulatory effect in the impact of carbon emission disclosure on the short-term value of state-owned corporations.

When the explained variable is ROA, the coefficient of variable GER×CED is -0.147 (t = -2.59) and passed the significance test. This shows that government environmental regulation weakens the impact of carbon emission disclosure on the long-term value of state-owned corporations. Therefore, the assumption H3 is tested.

(3) The moderating effect of corporation

As shown in Table 8, when the explained variable is ROE, the regression coefficient of the variable CIM×CED is -0.0036 (t = -3.78) and the coefficient of the variable CIM×CED² is 0.00003 (t = 3.52). Both passed the significance test, depicting that the corporate image management of state-owned corporations has a

“U-shaped” moderating effect on the impact of carbon emission disclosure on the short-term value.

When the explained variable is ROA, the regression coefficient of $CIM \times CED$ is 8.9810^{-8} ($t = 0.11$). This value fails the significance test. This indicates that the corporate image management of state-owned corporations has no significant moderating effect on the relationship between carbon emission disclosure and long-term enterprise value. Therefore, the assumption H4 is partially tested.

Table 8
Regression results of moderating effect of state-owned corporations

Variable	Adjustment Variable GER		Adjustment Variable Media		Adjustment Variable CIM	
	ROE	ROA	ROE	ROA	ROE	ROA
<i>CED</i>	178.917*** (3.63)	0.498 (1.05)	-43.041*** (-4.10)	-0.763*** (-2.64)	-5.558 (-0.67)	-0.651** (-2.27)
<i>CED</i> ²	-16.595*** (-3.33)	0.039 (1.31)	4.054*** (3.65)	0.055* (1.86)	0.509 (0.59)	0.057* (1.92)
<i>GER</i>	0.086 (0.23)	-0.041*** (-2.8)				
<i>GER</i> × <i>CED</i>	-3.021*** (-4.09)	-0.143** (-2.53)				
<i>GER</i> × <i>CED</i> ²	0.281*** (3.76)					
<i>Media</i>			-0.335 (-0.03)	0.521 (1.11)		
<i>Media</i> × <i>CED</i>			40.553*** (2.83)	0.247* (1.81)		
<i>Media</i> × <i>CED</i> ²			-3.788** (-2.53)			
<i>CIM</i>					0.0004 (0.45)	1.07×10^{-6} (0.3)
<i>CIM</i> × <i>CED</i>					-0.0036*** (-3.78)	7.24×10^{-8} (0.09)
<i>CIM</i> × <i>CED</i> ²					0.00003*** (3.52)	
<i>DAR</i>	-0.357 (-1.44)	-0.115*** (-11.71)	-0.345 (-1.36)	-0.115*** (-11.45)	-0.3156 (-1.26)	-0.114*** (-11.43)
<i>Growth</i>	0.719*** (4.35)	0.047*** (7.17)	0.715*** (4.29)	0.047*** (7.21)	0.7128*** (4.29)	0.048*** (7.17)
<i>CC</i>	0.052 (0.11)	0.003 (0.19)	0.041 (0.09)	0.009 (0.51)	0.0249 (0.05)	0.009 (0.52)
<i>Region</i>	2.564 (0.19)	1.190** (2.23)	-4.324 (-0.35)	0.459 (0.93)	-3.058 (-0.24)	0.311 (0.61)
<i>C</i>	15.962 (0.68)	11.424*** (12.42)	25.650 (1.51)	9.47*** (14.17)	21.394 (1.29)	9.769*** (14.81)
<i>N</i>	499	499	499	499	499	499
<i>R-Square</i>	0.0931	0.3160	0.0778	0.3014	0.089	0.2908
<i>Adj. R-Square</i>	0.0764	0.3049	0.0608	0.2900	0.0722	0.2792

4.3.4 The moderating effect of gatekeepers in private corporations

(1) Moderating effect of media

As shown in Table 9, when the explained variable is ROE, the regression coefficient of the variable $\text{Media} \times \text{CED}$ is 1.973 ($t = 1.43$), and the regression coefficient of the variable $\text{Media} \times \text{CED}^2$ is -0.078 ($t = -0.39$). As the result, it fails the significance test. This means that the media evaluation has no significant moderating effect on the impact of carbon emission disclosure on the value of private corporations. Therefore, the assumption H2 has not been tested.

(2) Moderating effect of government

As shown in Table 9, when the explained variable is ROE, the regression coefficient of variable $\text{GER} \times \text{CED}$ is 0.048 ($t = -0.64$), and the regression coefficient of variable $\text{GER} \times \text{CED}^2$ is -0.010 ($t = -0.4$), which fails the significance test. When the explained variable is ROA, the regression coefficient of variable $\text{GER} \times \text{CED}$ fails to pass the significance test, and the government environmental regulation has no significant moderating effect on the impact of carbon emission disclosure level on the long-term value of private corporations. So, the assumption H3 has not been tested.

(3) Moderating effect of corporations

As shown in Table 9, when the explained variable is ROE, the regression coefficients of variable $\text{CIM} \times \text{CED}$ and variable $\text{CIM} \times \text{CED}^2$ fail the significance test. When the explained variable is ROA, the regression coefficient of $\text{CIM} \times \text{CED}$ does not pass the significance test, indicating that corporate image management has no significant moderating effect on the impact of carbon emission disclosure level on the long-term value of private corporations. Therefore, the assumption H4 has not been tested.

Table 9
Regression results of moderating effect of private corporations

Variable	Adjustment Variable GER		Adjustment Variable Media		Adjustment Variable CIM	
	ROE	ROA	ROE	ROA	ROE	ROA
CED	-7.556	-3.648	-5.807***	-3.123*	-4.416***	-2.638*
	(-1.54)	(-0.77)	(-6.65)	(-1.88)	(-6.19)	(-1.69)
CED ²	1.097	0.247	0.502***	0.269	0.368***	0.240
	(1.50)	(1.19)	(4.39)	(1.29)	(3.55)	(1.14)
GER	-0.103***	-0.023				
	(-3.76)	(-0.37)				
GER×CED	0.048	0.014				
	(0.64)	(0.20)				
GER×CED ²	-0.010					
	(-0.94)					
Media						
Media×CED			1.973	0.548		
			(1.43)	(0.39)		
Media×CED ²			-0.078			
			(-0.39)			
CIM					-2.88×10 ⁻⁵ ***	1.76×10 ⁻⁵
					(-2.62)	(0.72)
CIM×CED					-1.09×10 ⁻⁵	-4.77×10 ⁻⁶
					(-1.26)	(-0.52)
CIM×CED ²					3.41×10 ⁻⁶	
					(1.01)	
DAR	0.094***	0.378***	0.097***	0.380***	0.090***	0.386***
	(3.13)	(5.68)	(3.20)	(5.70)	(2.97)	(5.76)
Growth	0.003	0.066***	0.003	0.066***	0.003	0.066***
	(1.58)	(16.95)	(1.56)	(16.95)	(1.53)	(16.94)
CC	2.883	45.261***	2.795	42.149***	2.848	45.390***
	(0.68)	(4.82)	(0.66)	(4.80)	(0.67)	(4.83)
C	3.75×10 ⁻⁷	-4.55×10 ⁻⁷	1.36×10 ⁻⁷	-4.92×10 ⁻⁷	1.97×10 ⁻⁷	-5.30×10 ⁻⁷
	(0.00)	(-0.00)	(0.00)	(-0.00)	(0.00)	(-0.00)
N	1530	1530	1530	1530	1530	1530
F-statistic	11.97	57.98	12.23	67.69	10.98	58.11
Prob (F-statistic)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

4.4 Robustness test

The explained variables lagging behind one period and two periods are used as instrumental variables to test the robustness of the model. After lagging behind the explained variables of state-owned corporations for two periods, the main effect regression results are still significant. When the explained variables with two periods of delay are used to test the moderating effects, it shows that government environmental regulation, media evaluation, and corporate image management still have significant moderating effects on the relationship between enterprise value and carbon emission disclosure in the short term. In the long run, government environmental regulation and media evaluation have significant moderating effects on the relationship between enterprise value and carbon emission disclosure. After lagging behind the explained variables of private corporations for one period, the main effect regression results are also significant. The moderating effects show that government environmental regulation, media evaluation, and corporate image management have significant moderating effects on the relationship between enterprise value and carbon emission disclosure in the short term. However, the moderating

effects show that government environmental regulation, media evaluation, and corporate image management have no significant moderating effects on the relationship between private enterprise value and carbon emission disclosure.

The Granger Causality Test is carried out on the explanatory variables and the explained variables lagging behind one period to further investigate whether there is a causal inversion between CED and ROE, CED and ROA. The test results show that the influence of the explanatory variables lagging behind one period on the explained variables does not pass the significance test. Furthermore, the Granger Causality Test is also carried out on the explanatory variables lagging behind one period and two periods. Similarly, the explanatory variables for the current period, lagging behind one period, and two periods were analyzed as well. The test results proved that there is no causal inversion between CED and ROE and ROA, so the regression results are robust.

5. Discussion

5.1 Impact of carbon emission disclosure on enterprise value

Based on the heterogeneity of ownership structure, this paper empirically analyzed the impact of carbon emission disclosure on the short-term and long-term enterprise value, and further analyzed the moderating effect of corporate image management, government environmental regulation, and media evaluation on the relationship between carbon emission disclosure and enterprise value. Under the pressure of the “double carbon” goal of China and the interests to enhancing the value of corporations, it has become necessary to restrict their behavior of carbon emission.

Although carbon emission disclosure behavior is an important way for corporations to create a positive image and attract investment in the initial stage, the income generated by capital investment in technology research and equipment renovation is less than the cost. This results in the operating cost exceeding the income. Under the information asymmetry between corporations and investors, the investors would reduce their confidence in the future of enterprises with the decreasing of their profit caused by carbon emission disclosure. Therefore, carbon emission disclosure is negatively correlated with enterprise value in the short term.

With the increasing frequency of carbon emission disclosure and the completion of technology research and equipment renovation, the operating cost of the enterprise will significantly reduce. At the same time, the enterprise conveys a responsible image to the public. This increases the possibility of stakeholders raising their investment in the enterprise. Furthermore, the government is more inclined to help corporations that are aware of environmental protection duties. Therefore, carbon emission disclosure is positively correlated with enterprise value in the long run.

It can be seen that carbon emission disclosure and enterprise value have a “U-shaped” relationship. Therefore, heavily polluting enterprises should actively abide by the government's environmental policies, and establish a corporate culture of emission reduction, pay more attention to how they are portrayed by the media when it comes to executing their environmental protection responsibilities. Firstly, enterprise managers should realize that carbon emission disclosure contributes to the improvement of enterprise's image and raise its competitiveness. Secondly, enterprise managers should optimize the production process, increase R&D investment, and cultivate professional talents to enhance the management of corporates' environmental responsibility. Finally, enterprise managers should portray their identity to the public as being environmentally conscious by using the disclosure as one of the means.

Government should play a supervisory role in conjunction with the media and formulate an assessment, monitoring, and management mechanism for enterprises' carbon emission disclosure (Yuan et al. 2021). Firstly, the government should establish a unified and complete standard for carbon emission disclosure of heavily polluting corporations. Secondly, the government should play the role of external supervision, including formulating assessment and supervision mechanisms, employing monitoring and supporting management, introducing preferential policies, promoting corporations to increase investment in carbon emission reduction and auditing carbon emission disclosed by listed companies. Finally, the government should establish and improve the information channel between corporations and the public, promote corporations to actively disclose carbon emissions, reduce information asymmetry between corporations and investors, and ultimately achieve win-win results in economic development and environment protection (Yuan et al., 2020).

5.2 Influence of gatekeepers on state-owned enterprises

Government environmental regulation and media evaluation play a moderating role in the relationship between carbon emission disclosure and the short-term and long-term value of state-owned corporations. Corporate image management plays a moderating role in the short term. Firstly, the operation of state-owned heavily polluting corporations mostly depends on natural resources and market monopoly caused by institutional and policy advantages. These corporations not only have economic goals to obtain profits but also have social goals to protect the environment. Therefore, government environmental regulation plays a significant role in standardizing state-owned corporations' behavior. Secondly, state-owned corporations in charge of State-owned Assets Supervision and Administration Commission of the State Council (SASAC), and represent the image of the government. Compared with private corporates, state-owned corporations pay more attention to the negative evaluation of the media, so the media evaluation plays a significant role in regulating state-owned corporations. Finally, a good image of state-owned corporations helps to enhance the trust and reduce information asymmetry of the public and stakeholders. As a result, corporations pay attention to their image in the short term. However, the incomplete information in the Chinese market and the uneven quality of carbon emission disclosure causes it difficult for investors to make long-term decisions, so the moderating effect of corporate image management is not significant in the long term.

Chinese state-owned heavily polluting corporations should continue to actively disclose carbon emission levels and make use of the media to enhance their corporate image. Firstly, state-owned heavily polluting corporations should continue to follow government regulatory policies, actively implement carbon emission disclosure according to government requirements, and weaken the negative impact of carbon emissions on enterprise value while creating economic benefits. Secondly, state-owned heavily polluting corporations should continue to pay attention to public opinion on environmental protection, use the media to enhance stakeholders' understanding, reduce the information asymmetry between investors and corporations, and achieve the goal of low carbon and

sustainable development. Finally, state-owned corporations should invest in environmental protection technology, improve the efficient utilization of resources, maintain the momentum of green innovation, create an image of green, sustainable management, environmental friendliness, and enhance their competitiveness while ensuring a win-win situation for the environment and economy.

The government should promote the realization of “separation of government functions from those of corporations”. This helps to cut off the direct connection between state-owned corporations and the government forcing the corporations to reform and innovate to encourage the creation of an open and equal business environment. On the one hand, the government should continue to promote the implementation of environmental policies, set emission reduction targets through government legislation, and encourage state-owned enterprises through policy measures to protect the ecological environment. Furthermore, the government should revise pollutant emission standards, strengthen law enforcement and supervision, intensify investigation and punishment of illegal acts, and urge state-owned corporations to improve their internal management and disclosure levels. On the other hand, the government should increase the frequency and intensity of media and public supervision and force traditional high-risk polluting corporations to carry out structural changes, and encourage state-owned corporations to expand the scope of disclosure.

5.3 Influence of gatekeepers on private corporates

Government environmental regulation, corporate image management, and media evaluation have no significant moderating effects on private corporations. The instinct of private corporations is to pursue interests in China. They would predict the impact of policies on corporations in advance and adopt coping strategies to seek advantages and avoid disadvantages of environmental policies. Environmental regulation improves the frequency and quality of carbon emission disclosure of state-owned corporations, the state-owned corporations are more inclined to disclose carbon emission information for gaining more profit. As a result, the cost private corporations spend on the environmental protection investment is more than the profit from it, which means the market share of private corporations on environmental protection investment is squeezed out or replaced by state-owned corporations. Therefore, the consequences lead to a reduction of the willingness of private corporations to disclose carbon emission information, resulting in the moderating effect of government environmental regulation on private corporations not being significant. Secondly, because the carbon emission disclosure of corporations is the result of the decision-making of enterprise management, private corporations are committed to improving enterprise performance and increasing enterprise value. However, the media evaluation does not conform to the concept of enterprise shareholders seeking to maximize benefits, which leads to the leader of private corporations paying low attention to media evaluation and results in the media evaluation paying an insignificant role in regulating private corporations. Finally, the goal of private corporations is to maximize their interests, even at the expense of destroying the environment. Therefore, it does not focus on maintaining the positive image of corporations through carbon emission disclosure and the moderating effect of corporate image on private corporations is not significant.

Heavily polluting private corporations should strengthen the construction of corporate environmental governance mechanisms to raise their environmental consciousness. They should strictly abide by the requirements of ecological environment policies, take environmental protection and sustainable development as the basic principles of enterprise development, and establish a carbon emission reduction culture. Firstly, private corporations should promote innovative transformation and technological upgrade to speed up environmental management and pollution control. Secondly, private corporations should strengthen the construction of corporate environmental governance mechanism. This is a special low-carbon strategy set up for the formulation, implementation, and supervision of carbon emission reduction initiatives, and the carbon emission disclosure. Carbon emission disclosure should be part of the annual report or part of the social responsibility report. This is important for the coordinated development of production management and environmental protection of corporations. Finally, private corporations should strengthen cooperation with the media, jointly carry out corporate environmental protection publicity events, reduce information asymmetry between corporations and stakeholders, and enhance the image of corporations in the eyes of consumers and stakeholders (Degefu et al., 2016).

The government should comprehensively use various means such as the rule of law, market, science and technology to encourage private corporations to carry out carbon emission disclosure and help private corporations solve environmental governance difficulties. The government also should improve economic policies and measures for the sake of forming a long-term mechanism to support and serve the green development of private corporations. Firstly, the government should build an ecological environment governance system by collaborating with corporations, social organizations and the public. Secondly, make full use of mainstream media and social media platforms, strengthen the awareness and interpretation of environmental laws, regulations and standards, and major policy documents, promote advanced cases and expose negative cases in time, and promote corporations to fulfill their carbon emission disclosure obligations. Thirdly, support private corporations to participate in the implementation of major national environmental protection science and technology projects, national environmental protection investment projects, and promote the implementation of preferential policies such as enterprise income tax for environmental protection. Finally, more reputation mechanisms should be embedded in financing policies to increase the attention of private corporations to carbon emission disclosure, promote financial institutions to innovate green financial products, and develop green credit as a solution to difficult and expensive financing problems.

6. Conclusion

This paper explores the influence mechanism of carbon emission disclosure of heavily polluting corporations on enterprise value from the perspective of ownership difference through theoretical analysis and empirical research. In particular, it researches the moderating effect of gatekeepers corporate image management, government environmental regulation, and media evaluation on the impact of carbon emission disclosure on enterprise value. The following conclusions were obtained: Firstly, carbon emission disclosure has a “U-shaped” correlation with the value of corporations in the short term, and has a positive correlation with long-term enterprise value. Secondly, in the short term, corporate image management, government environmental regulation, and media evaluation have a significant moderating effect on state-owned corporations. In the long run, government environmental regulation and media evaluation have a significant moderating effect on state-owned corporations, while corporate image management has no significant regulatory effect. Furthermore, corporate

image management, government environmental regulation, and media evaluation have no significant moderating effect on private corporations. This paper puts forward some countermeasures and suggestions to strengthen corporations' implementation of taking responsibility for environmental protection and promote high-quality development of corporations from the perspective of government management and enterprise operation.

Declarations

7. Ethical approval

Not applicable.

8. Consent to participate

Not applicable.

9. Consent to publish

Not applicable.

10. Authors contributions

Liang Yuan: Conceptualization, Methodology, Software, Writing. Yuying Chen: Methodology, Software, Writing. Weijun He: Methodology, Software, Writing. Yang Kong: Methodology, Writing. Xia Wu: Methodology, Software, Writing-Reviewing. Dagmawi Mulugeta Degefu: Writing-Reviewing and Editing. Thomas Stephen Ramsey: Writing-Reviewing and Editing.

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12. Disclosure statement

No potential conflict of interest was reported by the authors.

13. Availability of data and materials

Data from this work is available upon request.

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Figures

Figure 1

The framework of the gatekeeper affects the influence of carbon emission disclosure on enterprise value