The Impact of Carbon Information Disclosure Level on Enterprise Financing Cost in the New Economy: Research on the Mediating Effect of Organizational Reputation

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Abstract: Taking Chinese listed companies that issued social responsibility reports from 2010 to 2019 as research samples, this paper constructs a carbon information disclosure index system based on the connotation of the new economic background, and uses Python to mine relevant words to calculate the carbon disclosure score, empirically tests the impact of carbon information disclosure level on enterprise financing cost, and considers the impact mechanism of organizational reputation. The results show that the level of carbon information disclosure is negatively correlated with corporate financing costs, and organizational reputation plays a intermediary effect in the relationship between carbon information disclosure level and financing costs.

1 INTRODUCTION

At this stage, China's economic development conditions and environment are undergoing major changes. From the perspective of development conditions, China's past advantages in low-cost factors no longer exist. In order to enhance its international competitive advantage, in October 2020, the party proposed to speed up the construction of a new development pattern with domestic circulation as the main body and domestic and international double circulation promoting each other; From the perspective of development environment, the frequent occurrence of global extreme climate has caused huge losses to human production and life. In order to improve the environment, in March 2021, Premier Li Keqiang proposed to formulate an action plan for reaching the peak of carbon emissions by 2030 and do a solid job in carbon peaking, carbon neutralization and other work. Therefore, with the changes of China's economic development conditions and environment, the new economic background of the integration of double cycle background and green low-carbon background came into being. In the context of the new economy, in order to achieve the unity of economic and social benefits, enterprises, as the main participants in the internal and external economic cycle and the main "perpetrators" of carbon emissions, need to bear the responsibility of low-carbon development under the background of internal and external cycle. Voluntary carbon information disclosure just provides an opportunity for enterprises to implement the responsibility of low-carbon development.

Difficult and expensive financing has always been a difficult problem perplexing the development of China's real economy (Zhou, Han, 2020), and the disclosure of carbon information requires a lot of costs. With the continuous improvement of investors' awareness of environmental protection, it is worth exploring whether enterprises that take the initiative to disclose carbon can win the public's recognition and improve their reputation, so as to reduce financing costs and alleviate financing constraints. At present, the academic community has not reached a consensus conclusion on the impact of carbon information disclosure level on enterprise financing cost. Some scholars believe that a series of costs such as measurement, sorting and release will occur in the process of carbon disclosure, which is easy to lead to operational risks, so investors demand a higher rate of return. Moreover, carbon information disclosure will be understood as a means for enterprises to disguise as friends of the environment out of "green washing motivation", so that the financing cost does not

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decrease but increases (Lee, Park, Klassen, 2015). Other scholars believe that carbon information not only meets the needs of investors for non-financial information and solves the problem of information asymmetry, but also helps to show the enterprise's awareness of environmental responsibility, establish a good image and improve the recognition (Wen, Zhou, 2017), so as to obtain a lower financing cost. Other scholars believe that due to the influence of enterprise life cycle (Ma, Gai, 2019) and environmental regulatory pressure (Yang, Zhang, et al., 2020), there is an inverted "U" relationship between carbon information disclosure level and financing cost.

Therefore, this paper intends to explore the connotation of the new economy formed by the integration of internal and external circulation and green low-carbon, integrate this connotation into the carbon information disclosure index system, build a new evaluation system, study the relationship between enterprise carbon information disclosure and financing cost, and consider the intermediary role of organizational reputation, This paper studies whether enterprises can improve the awareness and level of carbon disclosure and realize the coordinated development of enterprises, society and environment by obtaining lower financing cost.

The research value of this paper lies in: (1) when constructing the carbon information disclosure system, innovatively excavate the relevant domestic and international carbon information disclosed by enterprises in the social responsibility report by integrating the connotation of the new economic background, so as to more comprehensively measure the level of carbon information disclosure. (2) When analyzing the relationship between carbon information disclosure level and financing cost, consider the intangible asset of organizational reputation, and enrich the research on the influence mechanism between carbon information disclosure level and financing cost from the perspective of resources

2 MATERIALS AND METHODS

2.1 Theoretical Analysis and Research Assumptions

2.1.1 Relationship between Carbon Information Disclosure Level and Enterprise Financing Cost

According to the stakeholder theory, the stakeholders of enterprises include shareholders, creditors, the public and so on. Shareholders, as equity holders, attach importance to the long-term development of enterprises. Carbon disclosure can prevent punishment for failing to comply with carbon emission requirements, which will affect long-term development. Therefore, shareholders expect to reduce risks and require lower return on investment. As the supplier of funds, creditors can evaluate the environmental legitimacy and measure the future repayment ability of enterprises through carbon information disclosure. When the creditor's loan collection risk is reduced, the required capital income also decreases. As product buyers, the public's low-carbon business information will increase their positive judgment on high-quality and environmental protection of products, so as to expand consumer demand, improve corporate cash flow, reduce external borrowing, and indirectly reduce financing costs (Zhou, Zhou, et al, 2018).

H1: the higher the level of carbon information disclosure, the lower the financing cost of enterprises.

2.1.2 The Relationship Between Carbon Information Disclosure Level and Organizational Reputation

Information asymmetry theory holds that there is information asymmetry between enterprises and investors. In order to reduce the adverse effects of information asymmetry before and after the event, enterprises actively transmit internal information to the outside world to improve their reputation. On the one hand, by disclosing relevant information such as carbon emission reduction strategy, carbon emission reduction measures and carbon emission reduction results, enterprises fill the gaps in investors' efforts and achievements for low-carbon environmental protection, so as to effectively alleviate information asymmetry(Mei, Ge, et al, 2020), avoid value discount and improve enterprise reputation; On the other hand, the higher the level of carbon information disclosure, which reflects the higher cultural conservation and moral standards of the enterprise. The interest motivation of the management to conceal bad news is relatively low, and the transparency level of corporate governance is high, so as to establish a good image of enterprise integrity and responsibility and improve the reputation of the enterprise. Accordingly, hypothesis 2 is put forward.

H2: the higher the level of carbon information disclosure, the better the reputation of the organization.

2.1.3 Mediating Role of Organizational Reputation

As a reflection of the interactive relationship between enterprises and investors, carbon information disclosure actively transmits internal information to the outside world, affects the enterprise reputation, and then affects the financing cost. Under the premise of information asymmetry, the adverse selection of investors and the moral hazard of managers are not conducive to the establishment of a good image of enterprises. The active disclosure of relevant information is conducive to avoiding value discount and improving the reputation of enterprises. According to reputation theory, reputation has asset attributes and information attributes (Guan, Zhang, 2019). On the one hand, reputation is an important intangible asset of enterprises, which can help enterprises obtain commodity premium and cushion the negative expectation of cost increase. On the other hand, reputation is the information carrier in the signal transmission mechanism. A good reputation can reduce uncertainty and enhance investor confidence (Li, Tong, et al 2020), reduce the necessary rate of return required by investors and reduce the financing cost of enterprises. Accordingly, this paper puts forward hypothesis 3.

H3: organizational reputation plays an intermediary role in the process of the impact of carbon information disclosure level on enterprise financing cost.

2.2 Research Design

2.2.1 Sample Selection and Data Source

This paper selects listed companies in all A-share industries in Shanghai and Shenzhen from 2010 to 2019 as the research sample, and further screens and arranges the samples: (1) eliminate financial listed companies; (2) Eliminate abnormal data or ST, * ST listed companies; (3) Excluding the listed companies with incomplete data, 3270 effective observations were finally obtained. The financial data of the company involved in this paper mainly comes from guotai'an database (CSMAR). The data in the carbon information disclosure index system mainly comes from the social responsibility report, and the scores are collected by text mining. In order to eliminate the influence of extreme values, this paper winsorize all variables at 1% and 99% quantiles.

2.2.2 Variable Design

a). Explained variable - financing cost. Equity financing and bond financing are the most common financing methods.

Therefore, this paper uses their weighted average capital cost to reflect the financing cost of listed companies, that is, financing cost = (debt / total capital) * debt cost * (1-corporate income tax rate) + (net asset value / total capital) * equity cost.

b). Explanatory variable - carbon information disclosure level.

In the context of the new economy, green and low-carbon refers to a sustainable development concept to alleviate the greenhouse effect and reduce air pollution; The connotation of internal and external circulation is: a preliminary consensus has been reached on the connotation of internal circulation, that is, considering the national boundary of economic activities, internal circulation refers to the cycle formed by domestic production, distribution, circulation and consumption in reproduction activities and taking meeting domestic demand as the starting point and foothold (Liu 2020). The connotation of external circulation has been continuously improved with the development of the times. Under the suppression of current international trade, external circulation is no longer limited to the "export-oriented" of raw materials and markets in the past, but refers to the process in which one or more links in reproduction activities participate in international value creation (Lu 2020).

Based on the above connotation, this paper interprets the corporate social responsibility report and measures it according to the four dimensions of low-carbon awareness, emission reduction management, emission reduction performance and carbon emission verification. Considering that the internal and external circulation is mainly divided by the national boundary of reproduction activities, this paper uses the method of text analysis to mine the carbon information related to these four dimensions at home and abroad, So as to reflect the carbon information disclosure under the new economic background. The specific steps are as follows:

first, data acquisition. Crawl the PDF files of the social responsibility reports of Listed Companies in Shanghai and Shenzhen stock markets from 2010 to 2019 through Python software on hexun.com;

Secondly, basic keyword extraction. Since the format and content of the social responsibility report disclosed by the same enterprise in different years are basically the same, and the number of enterprises disclosing the social responsibility report is

increasing year by year, taking the 2019 social responsibility report as the sample, referring to the carbon information disclosure requirements of domestic and foreign authorities, the basic key phrases or phrases related to each secondary index are preliminarily extracted through manual reading;

Thirdly, word segmentation. Jieba library, an open source tool library of Python language, is used to segment Chinese words for the sorted basic keywords, and regular expressions are constructed to obtain training corpus. The basic keywords are used to match the corresponding sentences in txt. The matched sentences are segmented again, and the mood auxiliary words, connectives, punctuation marks, numbers and other stop words without clear meaning are removed, then we use word2vec algorithm to expand the most similar word, take top5 as the extension word, and add the word to the existing category, so as to expand the keyword.

Finally, summarize the scores. Use the expanded keywords to match the responsibility report to obtain the corresponding score: when the enterprise discloses domestic relevant carbon information, it is assigned 1 score, and when it discloses international relevant carbon information, it is assigned 2 score, otherwise it is 0 score, and then sum up all scores. The total score of the index system is 24 points. The carbon information disclosure level index can be obtained by dividing the score obtained by each company by the total score. At the same time, in order to ensure the reliability of the data results, this paper uses manual reading to score again to eliminate major errors.

Table 1: Carbon information disclosure indicator system in the context of the new economy.

First level indicator	Secondary indicators	Indicator meaning	Scoring
Low carbon awareness	Energy saving and emission reduction concept	Disclosure of green and low-carbon development in the corporate spirit and values, and the concept of becoming a first-class enterprise	1 point is assigned to carbon information related to the country, and 2 points are assigned to carbon information related to the world.
Emission reduction management	Functional organization	Set up energy-saving and emission-reduction leading groups, energy-saving committees and other functional organizations	
	Management System	Develop and implement management systems such as energy saving and emission reduction documents and manuals	
	Publicity and education	Adopt management measures such as publicity and education	
Emission reduction performance	Economic performance	Gain economic performance from selling low-carbon products and obtaining tax incentives	
	Environmental performance	Environmental performance such as reduction in COD emissions	
	Social performance	Obtained social performance such as the honorary title of energy saving and emission reduction	
Carbon Assurance	Energy-saving management system certification	Through environmental management system or energy management system	

c) Intermediary variable - organizational reputation. Referring to the practices of Zhen HX and Wang S (2021), according to the public's evaluation of corporate reputation, this paper selects 14 corporate reputation evaluation indexes, calculates the corporate reputation score by factor analysis method, and then sorts the scores from low to high, divides them into 10 groups, and assigns them l to 10 in turn.

d) Control variables. At the level of corporate governance, control the size and age of enterprises. At the level of company performance, control the asset liability ratio, return on assets, operating cash flow and operating income growth rate. Because the capital return rate and financing cost of enterprises are different in different industries and years, this paper introduces industry and year variables to control. The specific description of variables is shown in Table 2.

Table 2: Variable definition table.

Variable	Variable name	Variable definitions
Explained variable	Financing costs（$WACC$）	Financing cost = (debt/total capital) * cost of debt * (1- corporate income tax rate) + (net asset value/total capital) * cost of equity
Explanatory variable	Level of carbon information disclosure（$CIDL$）	Calculate the score from the carbon information disclosure indicator system
Intermediary variable	Organizational reputation (CR)	Build reputation system, calculate scores and assign values
Control variables	Enterprise size（$SIZE$）	Natural logarithm of total assets at the end of the period
	Enterprise age（AGE）	Years of listing
	The asset–liability ratio（LEV）	Total liabilities at the end of the period/Total assets at the end of the period
	Asset yield（ROA）	Net profit/average total assets
	Operating cash flow（CFO）	Net cash flow from operating activities/total assets at the end of the period
	Operating income growth rate（$OIGR$）	Business revenue growth this year/previous year business revenue
	Industry（IND）	virtual variable
	Year（$YEAR$）	virtual variable

2.2.3 Model Design

In order to test the relationship between carbon information disclosure and enterprise financing cost and the intermediary role of organizational reputation between carbon information disclosure and financing cost, this paper constructs the following three regression models with reference to the intermediary effect analysis method of Wen Zhonglin et al. (2005).

$$WACC_{i,t} = \alpha_0 + \alpha_1 CIDL_{i,t} + \alpha_2 SIZE_{i,t} + \alpha_3 AGE_{i,t} + \alpha_4 LEV_{i,t} + \alpha_5 ROA_{i,t} + \alpha_6 CFO_{i,t} + \alpha_7 OIGR_{i,t} + \sum IND + \sum YEAR + \alpha_{i,t} \quad (1)$$

$$CR_{i,t} = \beta_0 + \beta_1 CIDL_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 AGE_{i,t} + \beta_4 LEV_{i,t} + \beta_5 ROA_{i,t} + \beta_6 CFO_{i,t} + \beta_7 OIGR_{i,t} + \sum IND + \sum YEAR + \beta_{i,t} \quad (2)$$

$$WACC_{i,t} = \gamma_0 + \gamma_1 CIDL_{i,t} + \gamma_2 CR_{i,t} + \gamma_3 SIZE_{i,t} + \gamma_4 AGE_{i,t} + \gamma_5 LEV_{i,t} + \gamma_6 ROA_{i,t} + \gamma_7 CFO_{i,t} + \gamma_8 OIGR_{i,t} + \sum IND + \sum YEAR + \gamma_{i,t} \quad (3)$$

3 RESULTS& DISCUSSION

3.1 Descriptive Statistics

Table 3 shows the descriptive statistical results of the main variables. The average value of financing cost is 0.093, the minimum value is 0.018 and the maximum value is 0.640, indicating that there are great differences in financing costs among different sample enterprises. The average carbon information disclosure level is 0.227, indicating that the carbon information disclosure level of the sample enterprises is generally low, and the minimum value is 0 and the maximum value is 0.375, indicating that there are great differences in the carbon information disclosure level among the sample enterprises. The average values of domestic carbon information disclosure level and international carbon information disclosure level are 0.151 and 0.076 respectively, indicating that the domestic carbon information disclosure level of the sample enterprises is higher than the international carbon information disclosure level. The median of organizational reputation are 5, indicating that the sample enterprises have good reputation.

Table 3: Descriptive statistics of main variables.

Variable	N	Mean	SD	Min	Median	Max
WACC	3270	0.093	0.074	0.018	0.079	0.640
CIDL	3270	0.227	0.082	0	0.250	0.375
DCIDL	3270	0.151	0.061	0	0.167	0.250
NCIDL	3270	0.076	0.044	0	0.083	0.167
CR	3270	5.468	2.873	1	5.000	10
SIZE	3270	23.266	1.407	20.555	23.147	27.028
AGE	3270	13.069	6.359	1	14	26
LEV	3270	0.487	0.196	0.063	0.502	0.857
CFO	3270	0.058	0.068	-0.131	0.057	0.250
ROA	3270	0.059	0.048	0.002	0.046	0.236
OIGR	3270	0.182	0.289	-0.351	0.128	1.573

3.2 Correlation Analysis

Table 4 shows the Pearson correlation analysis results between the main variables. The level of carbon information disclosure is significantly negatively correlated with the financing cost at the level of 5%, and the correlation coefficient is -0.044, which preliminarily verifies the hypothesis H1. There is a significant correlation between organizational reputation and carbon information disclosure level, and there is also a significant correlation between most control variables and financing cost. The absolute values of correlation coefficients among variables are less than 0.8, indicating that there is no collinearity problem among variables.

Table 4: Correlation analysis results between variables.

	WACC	*CIDL*	*CR*	*SIZE*	*AGE*	*LEV*	*CFO*	*ROA*	*OIGR*
WACC	1								
CIDL	-0.044**	1							
CR	-0.032*	0.051*	1						
SIZE	-0.058***	0.037**	0.758***	1					
AGE	0.023	-0.008	0.102***	0.298***	1				
LEV	-0.141***	-0.022	0.333***	0.592***	0.242***	1			
CFO	0.100***	-0.000	0.172***	-0.044**	-0.021	-0.247***	1		
ROA	0.158***	-0.027	0.148***	-0.247***	-0.154***	-0.471***	0.465***	1	
OIGR	-0.028	-0.014	0.042**	0.005	-0.071***	0.095***	-0.018	0.155***	1

Note: ***, **, * indicate significant at the level of 1%, 5%, and 10%, respectively. The t value is in parentheses.

3.3 Multiple Linear Regression Analysis

Column 2 of table 5 reports the empirical results of the impact of carbon information disclosure level on corporate financing costs. It can be seen that the regression coefficient of carbon information disclosure level in model (1) is significantly negative at the level of 1%, which supports hypothesis 1, that is, the higher the carbon information disclosure level, the lower the financing cost, indicating that under the new economic background, the high-level carbon information disclosure formed by disclosing enterprises' participation in domestic and international carbon governance can reduce the financing cost of companies.

Column 3 of table 5 reports the empirical results of the impact of carbon information disclosure level on organizational reputation. It can be seen that the regression coefficient of carbon information disclosure level in model (2) is significantly positive at the level of 1%, which supports hypothesis 2, that is, the higher the level of carbon information disclosure, the better the organizational reputation, indicating that the active disclosure of enterprises' efforts for carbon emission reduction at home and abroad is conducive to improving the level of carbon information disclosure and winning a good organizational reputation.

Column 4 of table 5 reports the empirical results of the intermediary role of organizational reputation. It can be seen that in model (3), the regression coefficient of carbon information disclosure level CIDL is significantly negative at the level of 1%, and the regression coefficient of organizational reputation Cr is significantly negative at the level of 5%, indicating that organizational reputation plays an intermediary role in the relationship between carbon information disclosure level and financing cost.

Table 5: regression results of the relationship between carbon information disclosure level and financing cost.

Variable	Model (1) WACC	Model (2) CR	Model (3) WACC
CIDL	-0.052***	1.167***	-0.050***
	(-3.291)	(3.585)	(-3.126)
CR			-0.002**
			(-2.555)
SIZE	0.001	1.746***	0.005**
	(0.653)	(63.554)	(2.344)
AGE	0.001***	-0.046***	0.001***
	(3.339)	(-9.687)	(2.861)
LEV	-0.040***	0.451**	-0.039***
	(-3.859)	(2.123)	(-3.764)
CFO	0.042*	1.031**	0.044*
	(1.799)	(2.168)	(1.897)
ROA	0.135***	20.205***	0.180***
	(3.657)	(26.721)	(4.402)
OIGR	-0.000	-0.287***	-0.001
	(-0.055)	(-2.998)	(-0.190)
Constant	0.032	-36.400***	-0.049
	(0.916)	(-51.406)	(-1.042)
IND	Yes	Yes	Yes
YEAR	Yes	Yes	Yes
N	3270	3270	3270
R^2	0.072	0.742	0.073

Note: ***, **, * indicate significant at the level of 1%, 5%, and 10%, respectively. The t value is in parentheses.

3.4 Robustness Test

In order to test the robustness of the empirical results, this paper uses the practice of Wu XB et al. (Wu, et al, 2017) and adopts "debt financing cost * asset liability ratio + equity financing cost * (1-asset liability ratio)" (ACOC) as an alternative variable of financing cost (WACC). After testing, the empirical results are basically consistent with the previous text, indicating that it is robust.

Table 6: Robustness test.

Variable	Model (1) *ACOC*	Model (2) *CR*	Model (3) *ACOC*
CIDL	-0.050***	1.167***	-0.048***
	(-2.895)	(3.585)	(-2.749)
CR			-0.002**
			(-2.243)
SIZE	0.001	1.746***	0.005**
	(0.816)	(63.554)	(2.220)
AGE	0.001***	-0.046***	0.001***
	(4.056)	(-9.687)	(3.621)
LEV	-0.033***	0.451**	-0.032***
	(-2.872)	(2.123)	(-2.788)
CFO	0.062**	1.031**	0.064**
	(2.436)	(2.168)	(2.522)
ROA	0.129***	20.205***	0.171***
	(3.189)	(26.721)	(3.844)
OIGR	-0.003	-0.287***	-0.004
	(-0.665)	(-2.998)	(-0.783)
Constant	0.018	-36.400***	-0.059
	(0.478)	(-51.406)	(-1.157)
IND	Yes	Yes	Yes
YEAR	Yes	Yes	Yes
N	3270	3270	3270
R^2	0.059	0.742	0.060

Note: ***, **, * indicate significant at the level of 1%, 5%, and 10%, respectively. The t value is in parentheses.

4 CONCLUSIONS

In order to explore whether corporate carbon disclosure can reduce financing costs, this paper analyzes the mechanism based on stakeholder theory, information asymmetry theory, signal transmission theory and reputation theory, excavates domestic and international carbon information from the four dimensions of low-carbon awareness, emission reduction management, emission reduction performance and carbon emission assurance, and constructs the evaluation system of carbon information disclosure level, Taking the listed companies that issued social responsibility reports from 2010 to 2019 as a sample, this paper discusses the impact of carbon disclosure level on corporate financing cost, and studies the intermediary role of organizational reputation in the relationship between carbon information disclosure level and financing cost. Research findings:(1) The level of carbon information disclosure of listed companies needs to be improved. The disclosure content is not perfect. Most companies tend to disclose domestic carbon information and lack international carbon information; The disclosure methods are not unified, the disclosure process is not standardized, and the comparability of carbon information is poor. (2) Improving the level of carbon information disclosure is conducive to improving the reputation of the organization, so as to reduce the financing cost. A

high level of carbon information disclosure can reflect the environmental responsibility consciousness and environmental risk management level of listed companies, establish a good image, improve corporate social reputation and reduce corporate financing costs.

In order to improve the carbon information disclosure level of Chinese enterprises, we should pay attention to the following points:(1) The government should speed up the construction of carbon information disclosure regulations and enhance the level of carbon information disclosure of enterprises. Refine carbon information disclosure requirements or separately issue carbon information disclosure standards to clearly specify the content of carbon information disclosure; Establish an official platform for carbon information disclosure, conduct disclosure at a unified time and place, and standardize the disclosure process. (2) Listed companies should improve the level of carbon information disclosure and give full play to the financing cost advantage it brings to enterprises. In terms of disclosure content, we should seriously follow the relevant guidelines at home and abroad to achieve domestic and international standards; In terms of disclosure methods, a separate social responsibility report is published on the enterprise's official website to establish a good corporate image and enhance the organization's reputation, so as to reduce the financing cost.

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