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Environmental Information Disclosure, Environmental Inputs and the Cost of Debt Financing——Experience from Listed Companies in China's Heavily Polluting Industries

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Abstract: *This paper investigates the impact of corporate environmental information disclosure on the cost of debt financing and further explores the impact of environmental information disclosure on the cost of debt financing based on the moderating effect of environmental inputs and also based on the heterogeneity of firm attributes. The findings of this study show that: environmental information disclosure is negatively related to firms' debt financing costs; environmental protection inputs play an enhanced moderating role in the effect of environmental information disclosure on debt financing costs; and the moderating effect of environmental protection inputs on the negative relationship between environmental information disclosure and debt financing costs is more significant in non-state-owned firms compared to state-owned firms.*

Keywords: *Environmental Information Disclosure, Environmental Inputs, The Cost of Debt Financing, The heavy pollution industry*

1. Introduction

Since the reform and opening up, China's economy has gone through a phase of rapid development. However, the price of this achievement has been heavy pollution, high energy consumption and high carbon emissions. As China's environmental problems become increasingly serious, the issue of environmental information disclosure has received increasing attention, and environmental information disclosure has gradually become an important way for companies to communicate with their stakeholders. For the companies themselves, environmental information disclosure can also be used as an effective strategic tool to obtain long-term benefits for the company. While the transparency of environmental information of listed companies is increasing, there is also much concern about the impact of environmental information as non-financial information in the capital market, and investors and creditors increasingly expect companies to reasonably assess and honestly disclose corporate environmental information and their management of environmental issues. Debt financing, as an important form of external financing, plays a key role in the operation and future development of companies. However, against the backdrop of imperfect capital markets and tight credit facilities, the question of how to obtain adequate loans at a small financing cost has become a common problem for many enterprises.

In recent years, environmental information has received wide attention. As research and practice on environmental information disclosure continue to advance, the governance effect played by environmental information disclosure has received greater attention, for example, existing research indicates that environmental information disclosure has the role of coordinating the needs of stakeholders such as company managers, investors, and regulators, that companies that disclose more environmental information tend to have better social reputation and higher corporate value, and that voluntary disclosure of environmental information by companies is recognized by stakeholders as The voluntary disclosure of environmental information by companies is a positive ethical behavior recognized by stakeholders. However, some scholars believe that corporate management has a great deal of choice in environmental information management, and that corporate disclosure of environmental information may also be an opportunistic act of management to disguise and package[1] In addition, some scholars argue that the disclosure of environmental information may be an opportunistic act of management to disguise and package environmental information, and that the disclosure of environmental information

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may be an economically motivated effort to play the role of a "good actor" for image engineering.[2] Li et al. found a significant positive relationship between CSR and surplus management, suggesting that the motivation for CSR is more likely to be opportunistic speculation for management's self-interest, and is a sheltering tool for surplus management.[3] . It can be seen that the main disagreement among scholars lies in the motive of disclosing non-financial information; if the company voluntarily discloses more environmental information for the purpose of improving information transparency and is a sincere ethical act, it has positive economic consequences and can play a positive corporate governance role and improve the information asymmetry between the company and its stakeholders to some extent; on the contrary, if it is motivated by opportunistic motives, such as to cover up surplus management, there will be negative economic consequences. Therefore, when studying the impact of environmental information transparency on financing costs, considering the actual environmental protection input factors of enterprises can help us further judge the quality of environmental information disclosure and enrich the study of environmental information disclosure on debt financing costs.

2. Theoretical basis and research hypothesis

2.1. Environmental information disclosure and the cost of debt financing

Based on social responsibility theory, more proactive external disclosure of environmental information means that listed firms are willing to take on more environmental responsibility, and such actions help firms improve their brand image and credibility with investors and partners, which in turn reduces financing costs.Dhaliwal et al. found that firms with higher capital costs in the previous year tend to initiate disclosure of CSR activities in the current year, while social The cost of capital is subsequently reduced after initiation by firms with superior responsibility performance[4] . According to the theory of information asymmetry, there is information asymmetry between the management of the firm with information advantage and external creditors. Enterprises should provide information useful for creditors' decision making such as solvency, profitability and default risk, as well as signal to creditors that they are green enterprises and show a good attitude to take environmental responsibility to obtain creditors' support. Corporate managers' choices about environmental issues affect corporate risk, and active environmental responsibility is usually associated with lower levels of corporate risk[5] The "communicative effect" of environmental information disclosure Environmental information disclosure has a "communication effect" and contributes to a significant increase in corporate value.[6] The quality of environmental information disclosure by listed companies in heavily polluting industries has a "communication effect" and contributes to a significant increase in corporate value. Improving the quality of environmental information disclosure of listed companies in heavy polluting industries can effectively enhance the transparency of corporate information and social responsibility, and thus reduce the cost of equity capital of companies.[7] . Listed companies with high transparency of environmental information can obtain more bank loans, and active disclosure of environmental information by listed companies can, to a certain extent, reduce the information asymmetry between banks and enterprises, thus helping enterprises to obtain more bank loans.[8] The active disclosure of environmental information by listed companies can reduce the information asymmetry between banks and enterprises to some extent, thus helping enterprises to obtain more bank loans. Improved environmental risk management indicates to financial markets that the company represents a lower risk investment and deserves a lower risk premium for debt and equity.[9] . Thus:

Hypothesis 1: The level of environmental information disclosure is negatively related to the cost of debt financing for firms.

2.2. Environmental inputs and the cost of debt financing

With the promulgation of government environmental regulations, the pressure on the legality of the environmental system has increased, so companies will actively invest in environmental protection to reduce their own environmental risks. Enterprises take the initiative to invest in environmental protection to truly reflect the efforts made by enterprises in the environmental protection level, which not only helps to send a "green" signal to stakeholders, more conducive to enterprises through green technology innovation and upgrading in all aspects of production and operation of enterprises to achieve energy saving and low-carbon environmental protection, and constantly improve the level of energy saving and environmental protection of enterprises. Improve production efficiency and production capacity, establish a good social image for the enterprise, improve the competitive advantage of the enterprise, increase the confidence of investors in the enterprise, reduce the risk return on investment requirements,

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and reduce the cost of capital. Through environmental protection investment, enterprises reflect their own sustainable development ability and sense of environmental responsibility, prompting investors to reasonably assess the risk of corporate default, thereby strengthening the market's interpretation of corporate environmental behavior and generating the corresponding market response[10] This will strengthen the market's interpretation of corporate environmental behavior and generate a corresponding market response. For example, when commercial banks in China make credit decisions, the information disclosed in the CSR report on environmental investment can reduce the environmental risks faced by banks, thereby reducing the return on investment required by banks and achieving the goal of reducing the cost of debt. Therefore, it can be argued that enterprises increase environmental protection investment can effectively enhance the negative impact of environmental information disclosure on the cost of debt financing.

Hypothesis 2: Environmental inputs play a moderating effect in the relationship between corporate environmental disclosure and the cost of debt financing.

3. Study design

3.1. Sample and data

This study intends to select A-share listed companies in the heavy pollution industry in Shenzhen and Shanghai from 2015-2021 as the initial sample. To mitigate the problem of endogeneity as much as possible, this paper lags the dependent variable by one period, i.e., the environmental information disclosure quality indicator in year t-1 corresponds to the financial data in year t[11] . To ensure the applicability and accuracy of the data, the following samples are further excluded from this study: (1) samples that are ST or PT in the current year; (2) samples with serious data deficiencies. All raw data in this study were obtained from the CSMAR database. In order to exclude the effect of abnormal extreme values on the empirical results, this study did a 1% Winsorize treatment on continuous variables.

3.2. Definition of variables

Table 1: Construction table of environmental information disclosure index

classify	targets	instructions
Environmental management disclosure by listed companies	Environmental Philosophy	Disclosure of environmental protection philosophy, policy, green development, etc., assigned a value of 1, otherwise 0
	Environmental objectives	Disclose the completion of past environmental targets and future environmental targets, assign a value of 1, otherwise 0
	Environmental management system system	Disclosure of environmental management systems, systems, regulations, responsibilities, etc., assigned a value of 1, otherwise 0
	Environmental Education and Training	Disclose the company's participation in environmental related education and training, assign a value of 1, otherwise 0
	Special Environmental Action	Disclosure of social welfare activities such as participation in environmental protection special activities is assigned a value of 1, otherwise 0
	Environmental incident response mechanism	Disclosure of emergency response mechanisms for major environment-related emergencies, etc., assigned a value of 1, otherwise 0
	Environmental honors or awards	Disclose the honors or awards the company has received for environmental protection, assign a value of 1, otherwise 0
	"Three simultaneous" system	Disclosure of the company's implementation of the "three simultaneous" system, assigned a value of 1, otherwise 0
	ISO14001 certification or not	Assign a value of 1 if the ISO14001 audit is passed, otherwise 0
	ISO9001 certification or not	Assign a value of 1 if you pass the ISO 9001 audit, otherwise 0
Information on environmental information disclosure carriers for listed companies	Annual Reports of Listed Companies	1=yes; 0=no; whether listed companies disclose environment-related information in their annual reports
	Social Responsibility Report	1=yes; 0=no; whether listed companies disclose environment-related information in their social responsibility reports
	Environmental reports	1=yes; 0=no; whether listed companies disclose separate environmental reports
Disclosure of environmental liabilities by listed companies	Wastewater emissions	0=no description; 1=qualitative description; 2=quantitative description
	COD emissions	0=no description; 1=qualitative description; 2=quantitative description
	SO2 emissions	0=no description; 1=qualitative description; 2=quantitative description
	CO2 emissions	0=no description; 1=qualitative description; 2=quantitative description
	Soot and dust emissions	0=no description; 1=qualitative description; 2=quantitative description
	Industrial solid waste generation	0=no description; 1=qualitative description; 2=quantitative description
Environmental performance and governance disclosure by listed companies	Exhaust emission reduction treatment	0=no description; 1=qualitative description; 2=quantitative description
	Treatment of wastewater abatement	0=no description; 1=qualitative description; 2=quantitative description
	Dust and fume control	0=no description; 1=qualitative description; 2=quantitative description
	Solid waste utilization and disposal	0=no description; 1=qualitative description; 2=quantitative description
	Treatment of noise, light pollution, radiation, etc.	0=no description; 1=qualitative description; 2=quantitative description
	Cleaner production implementation	0=no description; 1=qualitative description; 2=quantitative description

Environmental Information Disclosure (EID). At present, academics measure the quality of

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environmental information disclosure mainly by constructing environmental information disclosure index, and there are two main methods of construction, one is content analysis method, that is, designing a set of enterprise environmental information disclosure quality index system, and then going through to find the content of environmental information disclosure in enterprise annual report, social responsibility report or environmental responsibility report, for the corresponding number of sentences, sentence length and matching with the index score the content of[12,13] The second method is to use a professional rating agency. The second method is to construct an environmental information disclosure index through the ratings of professional rating agencies, such as Hexun.com and R&L Global Responsibility Rating.[14] The second method is to construct an index of environmental information disclosure through the ratings of professional rating agencies, such as Hexun and R&L Global Responsibility Rating. In this paper, we intend to use the data of environmental information disclosure section in the newly launched environmental research database of Guotaian to construct the index to calculate the environmental information disclosure score of listed companies as a measure of environmental information disclosure, which is shown in the table 1.

Cost of Debt Financing (Cost). In foreign studies, most scholars use the difference between the weighted average yield of corporate bonds issued by companies outside and the yield of similar treasury bonds as a proxy variable for the cost of debt financing. In China, on the other hand, because a complete bond market system has not yet been formed, most of them use the percentage of finance costs to express the cost of debt financing. Referring to the study of Kai-Tang Zhou et al, this paper uses interest expense divided by the average of total long and short-term debt as the measure of debt financing cost[15] .

Environmental protection input (EI). According to existing studies, environmental protection inputs can be defined as direct expenditures made by enterprises to carry out environmental protection[16] All the funds spent on environmental protection are environmental protection inputs. In this paper, we use the natural logarithm of the annual environmental protection input of an enterprise.

Control variables. Referring to existing studies, the following variables are selected as control variables in this paper. Listed company size, equity concentration, financial leverage, return on net assets, board size, dual-occupancy[17,18,19,20] . As shown in table 2.

Table 2: Variable definition table

Variable Name	Variable Description
Cost	Cost of debt financing. Average of interest expense/total long- and short-term debt.
EID	Environmental Information Disclosure Index. Calculated using the index construction method.
EI	Environmental Inputs. Natural logarithm of the amount of environmental inputs.
First	Shareholding concentration. Percentage of shares held by the largest shareholder.
SIZE	Company size. Natural logarithm of the closing balance of total assets.
LEV	Financial leverage. Ending balance of total liabilities/ending balance of total assets.
ROA	Return on net assets. Net profit/total average assets.
Board	Board size. The natural logarithm of the number of members of the board.
Dual	Double-hatted. Double-hatted is 1, split is 0.
State	Nature of ownership. The value is 1 if the sample firm is a state-owned enterprise in the year of observation and 0 otherwise.
Ind	Industry.
Year	Year.

3.3. Model construction

Based on the hypothesis proposed after the theoretical analysis, the following model is developed in this paper for validation.

For scenario 1.

$$Cost_{i,t} = a0 + a1\ EID_{i,t-1} + a2\ Controls_{i,t} + + \sum Industry + \sum Year + \varepsilon_{i,t}$$

For scenario 2.

$$Cost_{i,t} = a0 + a1\ EID_{i,t-1} + a2\ EI + a3\ EI*EID + a4\ Controls_{i,t} + \sum Industry + \sum Year + \varepsilon_{i,t}$$

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4. Empirical analysis

4.1. Descriptive statistics

Table 3: Descriptive statistics

Variable	N	Mean	Min	p50	Max	SD
Cost	3285	0.0560	0	0.0480	0.334	0.0460
EID	3285	8.777	1	7	37	7.190
EI	3285	15.72	-4.605	16.14	27.06	3.900
First	3285	33.38	2.870	30.98	89.99	14.37
Size	3285	22.19	19.73	22.01	26.39	1.242
Lev	3285	0.393	0.0550	0.385	0.990	0.191
ROA	3285	0.0450	-0.415	0.0440	0.244	0.0730
Board	3285	2.106	1.609	2.197	2.708	0.196
Dual	3285	0.328	0	0	1	0.469
state	3285	0.258	0	0	1	0.438

According to Table 3, it can be found that the minimum value of environmental information disclosure is 1 and the maximum value is 37, and the mean value is 8.777, which shows that there is a large difference in information transparency among companies, and the degree of disclosure is relatively low in all cases. The minimum value of environmental protection input is -4.605 and the maximum value is 27.06, which indicates that the environmental protection input of these listed companies in the heavy pollution industry is likewise widely disparate.

4.2. Correlation analysis

According to Table 4, the correlation coefficient between environmental accounting disclosure EID and debt financing cost Cost is -0.031, which is significant at 1% level, indicating that there is a significant negative relationship between environmental accounting disclosure and debt financing cost, the higher the quality of environmental accounting disclosure information, the lower the financing cost of the sample firms. Similarly, the correlation coefficient between environmental input EI and debt financing cost Cost is -0.044, significant at 1% level, and environmental input is significantly negatively related to debt financing cost. The correlation coefficient between the cross product term of corporate environmental information disclosure and environmental protection input and corporate debt financing cost is negative but not significantly correlated and needs to be further tested in multiple linear regression.

Table 4: Table of correlation coefficients

	Cost	eid	ei	A	First	Size	Lev	ROA	Board	Dual
Cost	1									
EID	-0.031***	1								
EI	-0.044***	0.134***	1							
EID*EI	-0.0190	0.966***	0.329***	1						
First	-0.040***	0.131***	0.066***	0.166***	1					
Size	-0.040***	0.423***	0.197***	0.372***	0.152***	1				
Lev	-0.032***	0.150***	0.065***	0.088***	-0.00900	0.490***	1			
ROA	-0.040***	0.074***	0.027*	0.110***	0.167***	-0.019**	-0.386***	1		
Board	-0.00900	0.203***	0.044***	0.185***	-0.0130	0.285***	0.147***	-0.001	1	
Dual	-0.00100	-0.118***	-0.0230	-0.052***	-0.00800	-0.210***	-0.136***	0.055***	-0.184***	1

4.3. Regression analysis

The results of the regressions in this paper are shown in table 5. For hypothesis 1, the main test regression results are shown in column (1), environmental information disclosure and debt financing costs are significantly negative at the 5% level. Environmental information disclosure by enterprises in the heavy pollution industry can signal to creditors that they are green enterprises, indicate a good attitude to take environmental responsibility, obtain support from creditors, and reduce financing costs. Hypothesis 1 proves that the degree of environmental information disclosure of enterprises in heavy pollution industry can affect the debt financing cost of enterprises, the more disclosure, the more transparent the information, the lower the financing cost. For hypothesis 2, the regression results after introducing the interaction term EI*EID of environmental protection input and environmental information disclosure are shown in column (2), and the interaction term is significantly negative at the 5% level, indicating that the moderating effect holds. For creditors, environmental protection investment can

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reflect the authenticity and validity of environmental information disclosed by enterprises, and enterprises' increased environmental protection investment can indicate that enterprises achieve green production through green technology innovation and show a good image of corporate social responsibility to the outside world, which can strengthen creditors and other stakeholders' awareness of environmental information disclosure. Hypothesis 2 proves that environmental protection investment can effectively enhance the effect of environmental information disclosure on the reduction of debt financing costs.

Table 5: Regression results of environmental information disclosure, environmental inputs and cost of debt financing

	(1)	(2)
	Cost	Cost
EID	**-0.0002****	0.0010*
	(0.0001)	(0.0006)
First	0.0000	0.0003
	(0.0001)	(0.0002)
Size	-0.0036**	-0.0081**
	(0.0017)	(0.0034)
Lev	0.0003	-0.0125
	(0.0066)	(0.0130)
ROA	-0.0306***	-0.0233
	(0.0085)	(0.0155)
Board	-0.0053	0.0018
	(0.0052)	(0.0088)
Dual	-0.0004	-0.0034
	(0.0017)	(0.0032)
EI		0.0072**
		(0.0029)
EI*EID		**-0.0004****
		(0.0002)
_cons	0.1505***	0.2150***
	(0.0379)	(0.0775)
industry	control	control
year	control	control
N	3285	3285
r2	0.0043	0.0108

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.4. Regressions grouped according to the nature of ownership

Table 6: Regression results for grouping according to the nature of property rights

	non-state	state-run	non-state	state-run
	Cost	Cost	Cost	Cost
EID	**-0.0001**	**-0.0004****	0.0016*	0.0005
	(0.0001)	(0.0002)	(0.0009)	(0.0009)
First	-0.0004***	0.0007***	0.0003	0.0003
	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Size	-0.0069***	-0.0031	-0.0108**	-0.0031
	(0.0021)	(0.0031)	(0.0047)	(0.0058)
Lev	0.0004	-0.0041	-0.0163	0.0028
	(0.0077)	(0.0137)	(0.0166)	(0.0230)
ROA	-0.0335***	0.0337	-0.0322*	0.0246
	(0.0096)	(0.0232)	(0.0189)	(0.0316)
Board	-0.0041	-0.0103	0.0200	-0.0219*
	(0.0065)	(0.0095)	(0.0132)	(0.0123)
Dual	0.0011	-0.0048	-0.0037	-0.0017
	(0.0020)	(0.0036)	(0.0043)	(0.0051)
EI			0.0090**	0.0044
			(0.0038)	(0.0049)
EI*EID			**-0.0007****	**-0.0002**
			(0.0003)	(0.0003)
_cons	0.2334***	0.1262*	0.2367**	0.1445
	(0.0479)	(0.0714)	(0.1051)	(0.1325)
year	control	control	control	control
N	1986	1299	1986	1299
r2	0.0082	0.0126	0.0198	0.0081

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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The sample enterprises were divided into state-owned and non-state-owned groups according to the nature of enterprise ownership, and after group testing according to the nature of ownership, it was found from table 6 that the quality of environmental information disclosure of both state-owned and non-state-owned enterprises in the main test reduces the cost of debt financing, and this negative relationship is more significant in state-owned enterprises, which may be due to the influence of the political attributes of enterprises reinforces the interpretation of environmental information by creditors that environmental information disclosed by state-owned enterprises is more reliable. After adding the interaction term between environmental investment and environmental information disclosure, it is found that environmental investment significantly contributes to the negative relationship between environmental information disclosure and debt financing cost in non-state owned enterprises, which suggests that environmental investment does strengthen creditors' reliance on environmental information disclosed by enterprises, which is particularly evident in non-state owned enterprises without political attributes.

5. Conclusion

By empirically analyzing the environmental information disclosure, environmental protection input and debt financing cost of listed companies in the heavy pollution industry from 2015-2021, this paper draws the following conclusions: first, environmental information disclosure is negatively related to debt financing cost, and the higher the transparency of environmental information, the lower the debt financing cost; second, environmental protection input plays a positive moderating role in the negative relationship between environmental information disclosure and debt financing cost , environmental protection input strengthens creditors' interpretation of disclosed environmental information; third, compared to state-owned enterprises, the moderating effect of environmental protection input on the negative relationship between environmental information disclosure and debt financing cost is more significant in non-state-owned enterprises. In conclusion, heavily polluting industries should pay more attention to disclosing environmental information and improving environmental protection inputs so as to establish a good social image, convey favorable information, and help reduce financing costs.

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