

# Will Green Development Increase the Cost of Debt Financing for Heavily Polluting Companies?

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## Abstract

In order to explore whether the growth of green development level increases the debt financing cost of heavily polluting companies, this paper takes the green development level index, corporate social responsibility performance (CSR) and corporate debt financing cost as the main research variables, and builds a fixed-effect regression model to get the results: For non-state-owned companies, there is a significant negative correlation between the level of green development and the cost of debt financing which means that the higher green development level of the government in the region where the heavily polluting industry is located, the lower the debt financing cost of the enterprise; CSR is negatively correlated with the cost of debt financing, indicating that improving CSR will help reduce the cost of corporate debt financing. At the same time, the intersection of green development level and CSR has a significant negative correlation with the debt financing cost of heavily polluting companies, but the correlation coefficient is not high, indicating that CSR plays a significant partial intermediary role in the relationship between green development levels and debt financing costs. Finally, this paper puts forward countermeasures and suggestions from the aspects of government environmental regulation and supervision and enterprise internal management.

## Keywords

Green Development, Corporate Social Responsibility Performance, Cost of Debt Financing for Heavily Polluting Companies

## 1. Introduction

On September 22, 2020, President Xi Jinping proposed at the 75th United Na-

tions General Assembly that China will increase its nationally determined contribution, adopt more powerful policies and measures, strive to peak carbon dioxide emissions by 2030, and strive to achieve carbon neutrality by 2060. Since the 18th CPC National Congress, the Central Committee has taken a tough attitude and strong measures to promote the construction of ecological civilization. China's green economy and finance have made great progress, and made great achievements in system construction, policy tools, safeguard measures, development results and other aspects. However, for heavily polluting companies, the green development policy will form environmental regulation, and has a great impact on the debt financing ability and cost of companies.

On the one hand, [Su and Lian \(2018\)](#) constructed a quasi-natural experiment to investigate the impact of green finance policy on the investment and financing behavior of heavily polluting companies by using the double-difference method, and found that green credit has significant financing punishment effect and investment inhibition effect. [Liu, Wang and Cai \(2019\)](#) empirically analyzed China's empirical data and found that since the promulgation of the green credit guidelines, the debt financing risk of heavily polluting companies has increased compared with before; In addition, compared with areas with good financial and ecological environment, poor areas cannot accurately and effectively identify the risks of heavily polluting companies. The reason is that commercial banks will inevitably reduce debt financing for companies in order to eliminate information asymmetry and reduce operational risks.

On the other hand, [Yao and Wang \(2016\)](#) found that under the environment of implementing the green credit policy, companies that disclose information obtain greater preferential treatment for debt financing costs. Further, [Wang and Sun \(2021\)](#) put forward the "Mystery of Porter Hypothesis" for green development and governance transformation. The empirical results show that there are two opposite effects of carbon risk on corporate financial leverage. Therefore, it can also be concluded that the more perfect the financial market, the more perfect the system and the better the environment, the smaller the risk faced by investors and the lower the external financing cost of the company. If we visualize green development and explore the relationship between green development level and debt financing of heavily polluting companies, what conclusion will we get?

China's provincial green development index system was established in 2010 and adjusted and improved according to the opinions of experts and society in 2011 and 2016 to fully reflect the new practices, changes and trends of China's social emergency bill station in the new era. At present, it has formed a relatively stable index system. [Li & Pan \(2011\)](#) first established the green development index, which is mainly divided into three dimensions: the greening degree of economic growth, the carrying potential of resources and environment and the degree of government policy expenditure. This paper makes an empirical study with the help of the green development index. Taking the heavily polluting com-

panies listed on A-share market from 2016 to 2019 as a sample, this paper discusses the relationship between green development level and debt financing cost, so as to put forward effective suggestions for heavily polluting companies to deal with the national green development policy in debt financing.

The innovation and contribution of this paper are mainly reflected in the following two aspects: 1) There are few literatures on the direct relationship between the level of green development and the financing cost of enterprises. Therefore, this paper is innovative in the research content and theme. Also, this paper conducts modeling analysis on the impact of the level of green development in different regions on the debt financing cost through empirical data, providing new research ideas for later researchers. 2) This paper conducts quantitative research on the implementation effect of green development policy so as to provide empirical evidence on how green development effectively affects the debt financing cost of heavily polluting enterprises.

## **2. Theoretical Analysis and Research Hypothesis**

### **2.1. Theoretical Basis**

#### **1) Stakeholder Theory**

The research subject of this paper is the heavy pollution industry, which causes many environmental problems. According to the stakeholder theory, shareholders and creditors in the heavy pollution industry pay different attention to environmental information. Shareholders pay attention to environmental protection investment, environmental governance cost and corporate reputation, and creditors pay attention to corporate solvency and social responsibility performance. The government and other regulatory agencies formulate environmental regulation policies, requiring companies to abide by environmental protection regulations and disclose environmental information. Enterprises with higher scores of environmental regulation also disclose more comprehensive relevant information, which can better realize the interests of stakeholders, enhance the confidence of stakeholders, improve the credit evaluation of investors, and then reduce the cost of debt financing. At the same time, there is a strong correlation between the contents of internal control disclosure and the interests of enterprise stakeholders. The information disclosure of internal control can better reflect the development prospects and future performance of companies. Information users can make relevant decisions with the help of this information. For investors, companies with high quality of internal control are more attractive, have more competitive advantages and reduce financing costs.

#### **2) Information asymmetry theory**

By solving the problem of information asymmetry between the two sides of funds, it can not only ensure that the debtor can obtain funds at a lower cost, but also enable the creditor to obtain stable and reasonable economic remuneration. Strengthen the internal control construction of companies, improve the quality of information disclosure, ensure the authenticity of accounting information,

reduce the agency cost of companies and reduce the occurrence of information asymmetry. At the same time, the government's environmental regulation policy is also an effective means to reduce information asymmetry. For heavily polluting industries, the government formulates environmental regulation policies, requiring companies to publish and disclose environmental information, reduce the investment risk of banks and other financial institutions, and ensure the stable return of funds. The more effective the enterprise environmental regulation policy is, the more it can meet the requirements of environmental information disclosure, reduce the risk premium, optimize the financing environment, enhance the financing ability and reduce the financing cost.

### **3) Signal transmission theory**

With the development of the times, the debt and dividends of companies play an important role in conveying the quality and value of companies. Enterprises with good quality have better solvency, and companies with poor quality may face the problem of defaulting on interest and dividends. Therefore, creditors decide their investment intention based on debt and dividends. When making investment choices, creditors and other stakeholders pay more attention not only to the financial information disclosed by the enterprise, but also to its social responsibility and the compliance and performance of environmental policies. Therefore, under the background of the rapid development of the Internet, the information dissemination is more convenient and rapid. It is very important for companies to seek more long-term development and maintain their own image and reputation, Enterprises can optimize their corporate image by strictly abiding by environmental regulation policies and improving their internal control quality, so as to transmit the information of economic operation and stable development to the outside world, and finally improve their financing ability.

### **4) Sustainable development theory**

The theory of sustainable development refers to meeting the needs of contemporary people without damaging the development of future generations. The three basic principles he adheres to are fairness, sustainability and identity. The theory specifically involves the following three aspects: 1) Economic sustainable development refers to that social and economic development should not only pursue the speed of development, but also pay attention to the quality of development. We should avoid sacrificing the environment for rapid development; 2) Ecological sustainable development refers to adhering to the harmonious coexistence with nature, not ignoring the carrying capacity of the ecological environment when seeking development, and requiring controlling and avoiding environmental pollution from the source; 3) In terms of social sustainability, more emphasis is placed on social equity, in which companies play an important role. Enterprises can not only consider whether they earn enough profits as in the past, but need to take responsibility for society and ecology under the call of the state, consciously practice environmental protection, and accept the supervision of the public and government departments.

## 2.2. Literature Review

### 1) Green development level and corporate debt financing cost

“Green development” is the guiding ideology and development concept of the 13th Five-Year Plan, its core is to achieve an organic balance between the environment and the economy, and promote high-quality economic development. The indicator system of China’s provincial green Development index was established in 2010, and was adjusted and improved in 2011 and 2016 according to the opinions of experts and the society, in order to fully reflect the new practice, new changes and new trends of China’s social emergency Response Law station in the new era. At present, a relatively stable indicator system has been formed. [Li & Pan \(2011\)](#) were the first to establish the green development index, which is mainly divided into three dimensions: “greening degree of economic growth”, “carrying potential of resources and environment” and “government policy expenditure”. The index was established to measure the level of green development in different regions. The impact of green development on heavily polluting enterprises lies not only in the environmental regulation of green development policies, but also in the great influence of green financial policies on debt financing capacity and cost of enterprises.

On the one hand, domestic and foreign scholars believe that the improvement of green development level will increase the debt financing cost of heavily polluting enterprises. From the perspective of environmental costs, heavily polluting enterprises need to bear additional environmental costs, such as pollution charges, pollution fines or punitive loans with high interest rates, in order to meet policy standards and obtain financial support ([Luo et al., 2021](#)), which indicates that green finance policies have significant financing punishment effects ([Su & Lian, 2018](#)). However, these increased expenditures will not generate additional income, but will lead to a decline in financial performance ([Deng & Li, 2020](#)), because additional environmental protection input will occupy the basic resources of production and operation, resulting in a decline in expected profits. In the short term, the production and operation structure of Chinese enterprises lacks flexibility, and the pollution situation cannot be fundamentally improved. Therefore, enterprises cannot obtain policy-based financing and are prone to the dilemma of increasing fund demand and shortage of fund sources. Capital constraints may also force heavy polluters to cut production, directly reducing environmental pollution. However, this will lead to a decline in firm productivity and industry competitiveness, as well as an increase in expected profits and liquidity risk ([Liu, Wang, & Cai, 2019](#)). In this case, creditors usually shorten the financing term and require higher risk compensation ([Xu & Li, 2020](#)), which increases the debt financing cost of heavily polluting enterprises. In addition, with the implementation of green credit policies, debt financing of heavily polluting enterprises has been restrained to a certain extent, and regional differences in the level of marketization and legalization in China will also have a further impact on the implementation effect of green credit policies ([Chen & Zhang, 2019](#)).

On the other hand, the improvement of green development level will reduce the debt financing cost of heavily polluting enterprises, which has also been supported by many scholars. Porter hypothesis holds that appropriate policy pressure can stimulate enterprise innovation, strengthen the effective use of resources and improve the production efficiency of enterprises (Jiang et al., 2020). The dividend brought by such green innovation can partially or even completely offset the cost caused by environmental protection, thus improving the competitiveness of enterprises (Du et al., 2018). For heavily polluting enterprises, environmental regulation also has a significant incentive effect on technological innovation (Cai et al., 2020), and plays an intermediary role in improving the profitability of enterprises (Rassier & Earnhart, 2015). When enterprises can obtain abundant profits through their own operations, internal capital can meet their regular operation needs, which reduces the demand for external debt financing, thus directly reducing the financing cost. Therefore, from the perspective of Porter's hypothesis, green finance policy can stimulate the innovative compensation effect of heavily polluting enterprises, improve profitability and competitiveness, reduce liquidity risk and expected uncertainty, and thus reduce debt financing costs.

In addition, according to signal transmission theory and corporate reputation theory, the green reputation effect of green financial policy will encourage heavily polluting enterprises to take the initiative to assume social responsibility, disclose environmental information, seek better environmental performance, and thus improve corporate performance (Benlemlih & Bitar, 2018; Liu, Xi, & Wang, 2021). In the context of more perfect green finance policies, creditors will use environmental disclosure information to judge the future operating uncertainty, cash flow and debt risk of enterprises. When an enterprise fulfils its social responsibility well, it will send a positive signal to the public that the enterprise attaches importance to its stakeholders. Therefore, stakeholders are willing to provide financial support for enterprises at a lower cost (Cheng et al., 2014). Empirical studies show that the improvement of the quality of carbon information disclosure can play a positive role in reducing the debt financing cost of enterprises (Liu, 2018). To be more specific, in the context of the implementation of green credit policies, enterprises that disclose information will get more favorable debt financing costs (Yao & Wang, 2016).

## **2) Green development level, corporate social responsibility disclosure and debt financing cost**

In recent years, various countries pay more attention to green environmental protection and social responsibility, and constantly relevant policies are introduced. The idea that we should not only pursue economic benefits but ignore environmental costs has been increasingly recognized by society and the public. At the same time, while the government is strengthening the development of green economy, it brings certain operational risks to banks, and banks must also formulate a series of green credit approval mechanisms. For example, the four

major state-owned banks have implemented the “one-vote veto system” to reject enterprises with unqualified environmental protection qualifications, while Industrial Bank became the first bank in China to adopt the “Equator principle”, and China Merchants Bank and Shanghai Pudong Development Bank have managed financing projects through the establishment of a classified management system. Commercial banks pay more and more attention to the approval of green credit. Banks are paying more and more attention to the achievements of enterprises in social responsibility and environmental protection. Therefore, enterprises' social responsibility indicators and debt financing are closely related to green policies (Wang, 2019). To be more precise, the higher the level of green development, the environmental information disclosure and environmental labeling emphasized by environmental regulations and other reputation mechanisms will motivate enterprises to take the initiative to assume social responsibilities, seek better environmental performance and obtain more environmental performance (Benlemlih & Bitar, 2018).

On the one hand, enterprises' active disclosure of environmental information can help reduce the degree of information asymmetry, send a positive signal that enterprises are willing to carry out environmental reform, improve the social image of enterprises, enhance investors' confidence in enterprises, and thus help enterprises obtain more favorable financing schemes. Empirical studies have shown that the quality of corporate social responsibility information disclosure can significantly affect the level of debt financing cost, especially for non-state-owned heavy pollution enterprises, and better environmental performance of enterprises can help obtain more long-term new loans (Shen & Ma, 2014; Xie & Zhu, 2018).

On the other hand, the creditor's preference for environmental information disclosure can be seen as a kind of reverse elimination. When heavy polluting enterprises disclose little or no environmental information, it is easy to be mistaken as unwilling to make environmental changes. Therefore, enterprises face higher risks of lawsuits and government fines, thus reducing enterprise value and thus being constrained by relatively high debt financing by creditors. In order to avoid such risks, heavily polluting enterprises are likely to take the initiative to assume social responsibilities and improve the quality of information disclosure so as to reduce debt financing costs (Shi et al., 2022).

To sum up, social responsibility information disclosure and green development level both influence the cost of debt financing.

### 2.3. Research Hypothesis

Based on the above analysis, green development level and social responsibility information disclosure have a significant impact on debt financing costs, and there is an interaction between green development level and social responsibility information disclosure. So below assumptions are put forward:

**H1a:** The improvement of green development level can significantly reduce

the debt financing cost of heavily polluting companies.

**H1b:** The improvement of green development level has a more significant effect on reducing the debt financing cost of heavily polluting companies in state-owned companies.

**H2a:** The improvement of the level of green development can significantly reduce the debt financing cost of heavily polluting companies, and the disclosure of social responsibility information can increase this effect.

**H2b:** The improvement of green development level can significantly increase the debt financing cost of heavily polluting companies, and the increasing effect of social responsibility information disclosure is more significant in non-state-owned companies.

### 3. Research Design

#### 3.1. Samples and Data

Referring to the sample selection methods of [Shen & Ma \(2014\)](#) and [Wang \(2019\)](#), and in accordance with the industry classification guidelines of listed companies issued by the CSRC in 2012, this paper combines the heavily polluting industries specified in the classified management directory of environmental protection verification industry of listed companies (HBH [2008] No. 373) published by the Ministry of environmental protection into eight categories: mining industry, textile and garment leather industry, metal and non-metal industry, petrochemical and plastic industry, food and beverage industry, Hydropower and gas industry, biomedicine industry and paper printing industry. This paper selects the heavily polluting companies listed in Shanghai and Shenzhen A shares from 2016 to 2019 as the research sample. Due to the epidemic, the acquisition of the latest data for 2020 and 2021 has been hindered, and the epidemic has a great impact on the operating conditions of companies, which cannot be studied together with the data of previous years. Among them, the data of green development index is from China green development index report—regional comparison. The data of social responsibility information disclosure is selected from the social responsibility score of listed companies by hexun.com; other enterprise financial information and basic information come from Guotai Minan database and enterprise annual report. In the empirical process, according to the differences of enterprise property rights, the whole sample is divided into two sub samples: state-owned companies and non-state-owned companies for empirical analysis. In the sample selection of listed companies, in order to ensure the objective authenticity of the selected samples, the sample companies are screened as follows: 1) delete ST\* companies; 2) Delete the listed companies that choose to delist during the sample study; 3) Delete listed companies with asset liability ratio equal to 0 and  $\geq 1$ ; 4) Delete listed companies with missing data of main variables. Based on the above screening requirements, 319 listed companies were finally selected as the research sample. In order to eliminate the influence of extreme values, the continuous variables of the selected samples are



treated with winsorize at the level of 1%.

### 3.2. Variable Design

#### 1) Explained variable

Cost of debt financing: the financial cost of an enterprise refers to the cost that the enterprise needs to pay to raise production and operation funds. However, when measuring the cost of debt financing, we should note that the amount of interest capitalization and exchange loss and profit included in the financial cost need to be eliminated. Based on the summary of previous studies, this paper refers to the practices of Li & Liu (2009), the numerator is measured by the total amount of interest expense, handling fee and other three secondary accounts in the detailed account of financial expenses, and the denominator is still measured by the average value of total debt.

#### 2) Explanatory variable

Green development level (Green): in the fourth quarter of 2010, Beijing Normal University, Southwest University of Finance and economics and China Prosperity Monitoring Center of the National Bureau of Statistics jointly developed and launched the 2010 China Green Development Index Annual Report—inter provincial comparison. In this paper, the green development index is used to measure the level of green development. The index is mainly divided into three dimensions: the greening degree of economic growth, the carrying potential of resources and environment and the degree of government policy expenditure. The three indicators include the following items (see Table 1).

Corporate social responsibility performance (CSR). Considering the integrity of evaluation data, this paper adopts the corporate social responsibility data published by He Xun. He Xun, as an authoritative third-party scoring organization in China, is committed to using a professional evaluation system, involving 13 secondary indicators and 37 tertiary indicators from the five levels of shareholders, employees, suppliers, customers and consumers' rights and interests, environment and society, to comprehensively investigate and score the social responsibility performance of companies. This evaluation system is relatively mature, and many scientific researchers have used this data for empirical research (Jia & Liu, 2014).

#### 3) Control variables

The main control variables are shown in Table 2.

### 3.3. Model Building

According to the assumptions and selected relevant variables, this paper constructs the following multiple regression model for research.

1) The H1a design Model (1-1) is used to test the relationship between green development level and debt financing cost of heavily polluting companies.

$$\text{Cost}_{it} = \alpha_0 + \alpha_1 \text{Green}_{it} + \alpha_2 \text{Size}_{it} + \alpha_3 \text{ROA}_{it} + \alpha_4 \text{LEV}_{it} + \alpha_5 \text{Inver}_{it} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{it} \quad (1-1)$$

**Table 1.** Green development index system.

Primary index	Secondary index	Tertiary indicators
		1. Per capita GDP
		2. Energy consumption per unit of GDP
		3. Proportion of non-fossil energy consumption in energy consumption
		4. Carbon dioxide emissions per unit of GDP
	Green growth efficiency index	5. Carbon dioxide emission per unit of GDP sulfur dioxide emission per unit of GDP
		6. Chemical oxygen demand and emission per unit of regional GDP
		7. NOx emissions per unit of GDP
		8. Ammonia nitrogen emission per unit of GDP
		9. Discharge of industrial solid waste per unit of regional GDP
Greening degree of economic growth	Primary industry indicators	10. Primary industry indicators
		11. Land output rate
		12. Indicators of secondary industry labor productivity of secondary industry
		13. Water consumption per unit industrial added value
		14. Energy consumption of industrial added value above Designated Size
	Secondary industry indicators	15. Comprehensive utilization rate of industrial solid waste
		16. Reuse rate of industrial water
		17. Proportion of output value of high energy carrying industrial products in total industrial output value
		18. Coal consumption of thermal power supply
		19. Labor productivity of tertiary industry
	Tertiary industry indicators	20. Proportion of added value of tertiary industry
		21. Proportion of employees in tertiary industry
	Resource and ecological protection indicators	22. Per capita local water resources
		23. Per capita forest area
		24. Forest coverage
		25. Proportion of nature reserves in the area under jurisdiction
		26. Carbon dioxide emissions per unit land area
		27. Carbon dioxide emissions per capita
		28. Sulfur dioxide emission per unit land area
		29. Sulfur dioxide emissions per capita
Carrying potential of resources and environment	Environment and climate change indicators	30. Chemical oxygen demand and emission per unit land area
		31. Per capita COD emissions
		32. NOx emissions per unit land area
		33. Nitrogen oxide emissions per capita
		34. Ammonia nitrogen emission per unit land area
		35. Ammonia nitrogen emissions per capita
		36. Discharge of industrial solid waste per unit land area
		37. Per capita industrial solid waste emissions
		38. Application amount of chemical fertilizer per unit cultivated area
		39. Pesticide use per unit cultivated land area

## Continued

Government policy expenditure	Green investment index	40. Proportion of environmental protection expenditure in financial expenditure
		41. Proportion of investment in environmental pollution control in regional GDP
		42. Government investment in improving water and toilets per capita in rural areas
		43. Completed amount of investment in returning farmland to forest per unit cultivated land area
		44. Proportion of science, education, culture and health expenditure in financial expenditure
	Infrastructure and urban management indicators	45. Urban per capita green space area
		46. Urban water penetration
		47. Urban sewage treatment rate
		48. Harmless treatment rate of municipal solid waste
		49. Every 10,000 people in the city have public transport vehicles
	Environmental governance indicators	50. Recovery and treatment rate of ecological environment in mining area
		51. Per capita afforestation area
		52. Industrial sulfur dioxide removal rate
		53. Removal rate of industrial chemical oxygen demand
		54. Industrial NOx removal rate
		55. Industrial ammonia nitrogen removal rate

Source: Li & Pan (2011).

**Table 2.** Control variable definition and calculation.

Control variable	Variable symbol	Variable definition and calculation
Company size	Size	Ln(Total assets at the end of the year)
Enterprise profitability	ROA	Net profit/total assets
Financial risk	LEV	Total liabilities/total assets
Cash flow	CFO	Net operating cash flow/total assets at the end of the period
Realization rate of tangible assets	Inver	Net inventory and accounts receivable divided by total liabilities
Nature of enterprise property rights	Soe	If the largest shareholder of the enterprise is state-owned, it is assigned as 1, otherwise it is 0

Source: Manual sorting.

2) The H1B design Model (1-2) is used to test the relationship between green development level and debt financing cost of heavily polluting companies under the influence of property rights.

$$\text{Cost}_{it} = \beta_0 + \beta_1 \text{Green}_{it} + \beta_2 \text{Size}_{it} + \beta_3 \text{ROA}_{it} + \beta_4 \text{LEV}_{it} + \beta_5 \text{Inver}_{it} + \beta_6 \text{Soe}_{it} + \sum \text{Industry} + \sum \text{Year} + \varepsilon_{it} \quad (1-2)$$

3) The H2a design Model (2-1) is used to test the relationship between green development level, social responsibility information disclosure and debt financing cost of heavily polluting companies.

$$\text{Cost}_{it} = \alpha_0 + \alpha_1 \text{Green}_{it} + \alpha_2 \text{CSR}_{it} + \alpha_3 \text{Green}_{it} \times \text{CSR}_{it} + \alpha_4 \text{Size}_{it} + \alpha_5 \text{ROA}_{it} + \alpha_6 \text{LEV}_{it} + \alpha_7 \text{Inver}_{it} + \sum \text{Industry} + \sum \text{Year} + \varepsilon_{it} \quad (2-1)$$

4) The H2b design Model (2-2) is used to test the relationship between green

development level, social responsibility information disclosure and debt financing cost of heavily polluting companies under different property rights.

$$\text{Cost}_{it} = \beta_0 + \beta_1 \text{Green}_{it} + \beta_2 \text{CSR}_{it} + \beta_3 \text{Green}_{it} \times \text{CSR}_{it} + \beta_4 \text{Size}_{it} + \beta_5 \text{ROA}_{it} + \beta_6 \text{LEV}_{it} + \beta_7 \text{Inver}_{it} + \beta_8 \text{Soe}_{it} + \sum \text{Industry} + \sum \text{Year} + \varepsilon_{it} \quad (2-2)$$

## 4. Empirical Results

### 4.1. Descriptive Statistical Analysis

The descriptive statistics of the main variables are shown in **Table 3**. The results show that the observed mean value of the debt financing cost of heavily polluting companies is 2.3%, the standard deviation is 0.013, the maximum value is 9.4%, and the minimum value is 0.0%, indicating that the debt financing cost of each heavily polluting enterprise is significantly different. The average green development level is 0.405, the standard deviation is 0.096, the maximum value is 0.722, and the minimum value is 0.279, indicating that although the level of green development varies greatly, the level of green development in most areas is similar and is around the average level. The full score of CSR is 100 points, but the average score of sample companies is only 30.922, the best performing company has a score of 87.02, the worst is negative, and the statistical standard deviation is 20.575, which is relatively large. As a result, it can be concluded that the social responsibility performance of listed companies in China's heavily polluting industries is generally poor, and there is a high degree of difference in responsibility performance among companies.

### 4.2. Correlation Analysis

The correlation test results of the main variables in this paper are shown in **Table 4**. It can be seen from the table that the correlation coefficient between Green and the cost of debt financing is  $-0.043$ , which is significant at the 5% level, indicating that the cost of debt financing does not increase with the improvement of Green, which shows that the restrictive impact of environmental regulation is less than the beneficial impact of environmental regulation. CSR and debt financing cost are significantly negatively correlated at the 1% level, indicating that the better the social performance of the company, the lower the debt financing cost. At the same time, CSR and the green development level are significantly positively correlated at the 1% level, indicating that the higher the green development level, the more companies pay attention to the quality of CSR. For the control variable, ROA is significantly negatively correlated with the cost of debt financing because companies with stronger profitability are more stable and reliable, with good performance and cash flow as debt support, which reduces the investment risk of creditors and thus reduces the cost of debt financing. In addition, ROA has a significant positive correlation with CSR, because the higher profitability of the company can bring sufficient income to the company, and only companies with abundant resources can have spare power in society. Invest funds in responsible projects to improve the level of responsibility performance.

**Table 3.** Descriptive statistics.

Variable	observation	mean	standard deviation	minimum	maximum
Cost	1276	0.023	0.013	0	0.094
Green	1276	0.405	0.095	0.279	0.722
CSR	1276	30.922	20.575	-4.86	87.02
Size	1276	23.38	1.421	20.523	28.52
LEV	1276	0.485	0.189	0.034	0.941
ROA	1276	0.037	0.059	-0.349	0.305
Inver	1276	0.526	0.21	0.036	1.708
Soe	1276	0.621	0.485	0	1

Source: calculation results by stata15.

**Table 4.** Correlation statistics.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Cost	1.000						
(2) Green	-0.043**	1.000					
(3) CSR	-0.145***	0.081***	1.000				
(4) Size	0.096***	0.139***	-0.016	1.000			
(5) LEV	0.338***	-0.059**	-0.197*	0.446***	1.000		
(6) ROA	-0.244***	0.001	0.357***	0.023	-0.378***	1.000	
(7) Inver	0.345***	-0.050*	-0.188***	0.419***	0.886***	-0.417***	1.000

Source: calculation results by stata15.

### 4.3. Multiple Regression Analysis

#### 1) Hypothesis test of green development level on debt financing cost

In order to test Hypothesis I, regression analysis was carried out on the collected sample data. After The Hausmann test (Table 5), the fixed effects model (controlling individual and time fixed effects) should be used since the  $p$  value is 0.0000. Model 1-1 is the regression analysis result of debt financing cost at the level of green development, Table 6 reflects the impact of various variables on the cost of debt financing. The F test of Model 1-1 is significant at the 1% significance level, indicating that the regression model established in this paper is acceptable. The standardized regression coefficient of the impact of Green development level on debt financing Cost is  $-0.007$ , which is significantly negatively correlated at the level of 10%, verifying Hypothesis I. The higher the level of green development, the lower the debt financing cost of heavily polluting companies, but the effect is not very obvious.

In order to continue to verify the impact of the nature of property rights on the relationship between green development level and debt financing cost, regression model 1-2 was carried out, which also used fixed effect model after Hausmann test, and the results are shown in Table 7 as follows. For state-owned companies, the effect of green development level on reducing the debt financing cost of heavily polluting companies is not obvious. Although the coefficient is

**Table 5.** Results of Hausmann test.

Variables	FE	RE
Constant	0.09	0.0265
Green	-0.007	-0.003
Size	-0.003	-0.0004
LEV	-0.003	0.0044
ROA	0.007	0.0018
Inver	0.013	0.0134
Chi-square test value		30.856
P-value		0.0000

Source: calculation results by stata15.

**Table 6.** The regression analysis result of Model 1-1.

Variables	Coef.	t-value
Constant	0.09	2.97 ***
Green	-0.007	-1.73 *
Size	-0.003	-2.35**
LEV	-0.003	-0.76
ROA	0.007	1.29
Inver	0.013	3.78***
F-value		3.508***
Adj- $R^2$		0.018
N		1276

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Source: calculation results by stata15.**Table 7.** The regression analysis result of Model 1-2.

Variables	State-Owned	Non-state
Constant	0.085 (2.28***)	0.169 (3.17***)
Green	-0.005 (-1.14)	-0.014 (-1.80*)
Size	-0.003 (-1.73**)	-0.007 (-2.89***)
LEV	-0.002 (-0.34*)	-0.005 (-0.62)
ROA	0.003 (0.42*)	0.017 (1.74*)
Inver	0.009 (2.18**)	0.025 (3.91***)
F-value	1.448***	3.837***
Adj- $R^2$	0.012	0.051
N	792	484

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Source: calculation results by stata15.

-0.005, it is still a negative number, but the test results are not significant. In contrast, for non-state-owned companies, the model results show that the level of green development is negatively correlated with the debt financing cost of heavily polluting companies at a significant level of 10%.

## 2) Hypothesis test of green development level and CSR on debt financing cost

In order to verify Hypothesis II, on the basis of Model 1-1, CSR and the intersection of CSR and the green development index was added, and regression analysis of fixed effects was carried out (passed the Hausmann test). The results of Model 2-1 are shown in **Table 8**. The level of green development and social responsibility information disclosure are both negatively correlated with the cost of debt financing at a significant level of 5%, and the cross items of the two are also negatively correlated at the level of 10%. It indicates that in the process of corporate financing, financial institutions can deeply understand the production, operation and management status of companies through the disclosure of corporate social responsibility, and CSR can reduce the degree of information asymmetry. From the perspective of risk control, financial institutions invest green credit resources to companies with controllable risks, thereby reducing the financing cost of companies.

According to Model 2-2, the samples of state-owned companies and non-state-owned companies are divided into fixed-effect regression models (passed the Hausmann test). The results are shown in **Table 9**. The study found that the level of green development, CSR and the cost of debt financing of heavily polluting companies are still negatively correlated, and their cross-terms are still negatively correlated. Although the F-tests are all significant, none of the main variable coefficient tests of state-owned companies are significant, and the main variable coefficient tests of non-state-owned companies are all significant. This shows that the improvement of the green development level has a more obvious effect on the reduction of the financing cost of non-state-owned heavily polluting companies.

**Table 8.** The regression analysis result of Model 2-1.

Variables	Coef.	t-value
Constant	0.111	3.57 ***
Green	-0.012	-2.36**
CSR	-0.001	-2.37**
Green* CSR	0.0019	-1.73*
Size	-0.004	-2.87***
LEV	-0.003	-0.88
ROA	0.01	1.82*
Inver	0.014	4.01***
F-value		4.139***
Adj- $R^2$		0.030
N		1276

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Source: calculation results by stata15.

**Table 9.** The regression analysis result of Model 2-2.

Variables	State-Owned	Non-state
Constant	0.095 (2.49**)	0.218 (3.95***)
Green	-0.007 (-1.30)	-0.027 (-2.61***)
CSR	-0.0006 (-1.15)	-0.0002 (-2.29**)
Green* CSR	0.0009 (0.80)	-0.0004 (1.79*)
Size	-0.003 (-1.91*)	-0.009 (-3.59***)
LEV	-0.002 (-0.41)	-0.005 (-0.73)
ROA	0.004 (0.65)	0.024 (2.37**)
Inver	0.009 (2.26**)	0.027 (4.17***)
F-value	1.423***	4.392***
Adj- $R^2$	0.017	0.080
N	792	484

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Source: calculation results by stata15.

## 5. Robustness Test

In order to make the regression results accurate, the sample data is first replaced by relevant replacements—the paper changes the measurement of the green development level. On the basis of the original data, a five-level scoring method was adopted, and the median of the green development index of the 30 provinces (autonomous regions and municipalities) was recorded as 0, the median to the upper quartile was recorded as 1, and the upper quartile was recorded as 1. The number above the number is recorded as 2, the median to the lower quartile is recorded as -1, and the lower quartile is recorded as -2. After the regression analysis of fixed effects (passed the Hausmann test) is also used, the results are shown in **Table 10**. It can be concluded that the regression analysis results are basically consistent with the research done in this paper, the green development level and the debt financing cost pass the negative correlation test at the 5% level, and the increase of the green development level reduces the debt financing cost of heavily polluting companies; CSR and debt cost pass the negative correlation test at the 1% level, which improves the degree of corporate social responsibility disclosure and reduces corporate debt financing costs; The intersection of corporate social responsibility information disclosure and green development level is significantly negatively correlated with debt cost only at the level of 5%, with a coefficient of -0.0001, indicating that social responsibility information disclosure improves the level of green development and reduces the debt financing cost of heavily polluting companies effect is not obvious.



**Table 10.** Results of Robustness test.

Variables	Model 1-1	Model 2-1
Constant	0.064 (2.51**)	0.084 (3.16***)
Green	-0.0003 (-1.21*)	-0.001 (-1.97**)
CSR		-0.0003 (-2.83***)
Green* CSR		-0.0001 (2.16**)
Size	-0.002 (-1.80*)	-0.003 (-2.45**)
LEV	-.003 (-0.75)	-0.003 (-0.90)
ROA	.007 (1.32)	0.011 (1.95*)
Inver	0.012 (3.62***)	0.013 (3.88***)
F-value	3.199***	4.145***
Adj- $R^2$	0.017	0.030
N	1276	1276

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Source: calculation results by stata15.

## 6. Conclusion and Implications

### 6.1. Research Conclusion

This paper takes the cost of debt financing as the foothold of the research, takes the heavily polluting companies listed company in Chinese A stock market from 2016 to 2019 as the research sample, and uses the fixed effect model to construct four empirical models, mainly discussing the relationship between the level of green development, CSR and debt financing costs. Through empirical research and theoretical research, the conclusions are as follows:

1) For non-state-owned companies, the level of green development has a significant negative correlation with the cost of debt financing, that is, the higher the level of green development of the government in the region where the heavily polluting industry is located, the lower the cost of debt financing for companies. The level of green development is the embodiment of local environmental regulation. Strict environmental regulation policies make companies pay more attention to the performance of their environmental responsibilities, and actively disclose environmental information to the outside world, improve their own reputation and image, and enhance the investment confidence of relevant financial institutions, thereby significantly reducing the cost of debt financing for companies. Since this conclusion rejects Hypothesis I, it also shows that the implementation of environmental regulation policies is still insufficient, and its negative impact is not large.

2) For non-state-owned companies, the intersection of green development level and CSR has a significant negative correlation with the debt financing cost of heavily polluting companies, but the correlation coefficient is not high, indicating that corporate social responsibility information disclosure is in green development. The relationship between the level of debt financing and the cost of debt financing plays a significant partial mediating role. On the one hand, the improvement of green development level plays a positive role in promoting companies to improve the disclosure of social responsibility information, reducing the information asymmetry between banks and financing companies, thereby enabling companies to achieve the goal of reducing debt financing costs more quickly. On the other hand, it also shows that China's green finance and other policies, measures, supervision, and assessment still need to be improved, and they have not yet played a full role in financial institutions.

3) For state-owned companies, the improvement of green development level also reduces the debt financing cost of heavily polluting companies, but it is not significant, because state-owned companies themselves have fewer financing constraints, so the impact of green development on them is not high.

## **6.2. Research Implications**

### **1) Strictly formulating environmental regulation policies and giving full play to the government's regulatory functions.**

The government should strengthen the construction of relevant laws, regulations, policies and systems, expand the implementation scope of environmental regulation policies, strictly regulate the method and content of environmental information disclosure, strengthen the implementation of environmental regulations, and impose severe penalties on companies that do not meet environmental protection requirements. Also, the government should earnestly implement green credit and green finance policies, guide companies to fulfill their environmental responsibility, and enhance their awareness of social responsibility such as consciously disclosing environmental information. What's more, the government should accelerate the establishment of an environmental information audit system, supervise the authenticity of environmental information, and avoid misleading third-party information users to create a good debt financing environment for enterprise development.

### **2) Enriching and improving the enterprise management system.**

Enterprises are the demanders and final destination of green credit, and they are also the main body of social responsibility. We should focus on strengthening and guiding companies to develop their awareness of social responsibility. On the premise of improving fair market competition, the influence of green and quality factors in enterprise operation and management should be reflected in business results, with emphasis on operating costs or benefits, so as to further promote the initiative of companies to change their business philosophy to green and environmental protection. Heavy polluting companies should raise their

awareness of fulfilling their environmental protection obligations, consciously fulfill their environmental protection responsibilities, and actively disclose their fulfillment of social responsibilities. In addition, the enterprise itself should also formulate a feasible internal control standard system according to its own development characteristics and long-term interests, establish a risk prevention mechanism, systematically collect relevant environmental information, regularly disclose the true internal control report, improve the management level and financial performance of the enterprise, ensure Enterprises earnestly fulfill their environmental protection responsibilities and optimize the structure of debt financing.

### 6.3. Research Limitations

- 1) The heterogeneity of debt is not considered, and further research should be carried out from the financing cost of long-term and short-term debt or financial operating debt.
- 2) There can be more attempts to measure the level of green development, and the green development index itself has many deficiencies and limitations.
- 3) The model construction is relatively simple, and an unbalanced panel can be considered to accommodate more data and a model that can further eliminate endogeneity.

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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