Impact of Green Credit Policy on Debt Financing of Heavily Polluted Enterprise

Weidi Zhao

Department of Economics and Management, North China Electric Power University, Baoding, China

13147981921 @163.com

Abstract. The China Banking Regulatory Commission (CBRC) released in 2012 the Guidelines for Green Credit (Guidelines), which symbolizes the rapid development of green credit in China. The CBRC emphasizes the balance between environmental protection and economic development using credit in order to improve the ecology of China and control the pollution of heavily polluted enterprises. The realization of carbon peaking and carbon neutrality goals in China is inseparable from the green development of heavily polluting enterprises. Meanwhile, the low-carbon transformation of heavily polluting enterprises needs the promotion of green credit policies. Therefore, it is of great importance to explore and make full use of the effect of green credit policies on heavily polluting enterprises. Based on the data of all A-share no-ST enterprises in China from 2010 to 2022, this paper classifies the enterprises according to different environmental quality indicators. The control group and the control group are seriously polluted and non-polluted enterprises, respectively. Simultaneously analyzes enterprises with different equity natures and regions to explore the impact of green credit on debt financing of heavily polluting enterprises. The results indicate that the implementation of green credit policies has a significant restraining effect on the debt financing behavior of heavily polluting enterprises, leading to a significant increase in their financing costs. The article also conducted heterogeneity analysis and placebo testing. The results of heterogeneity analysis show that non-state-owned enterprises are more affected than state-owned enterprises. Because state-owned enterprises can obtain more support and information in debt financing, they are relatively easier to obtain funds. In addition, the debt financing costs of heavily polluting enterprises in the eastern region have increased less than those in the central and western regions. Perhaps it is because the operating policies of heavily polluting enterprises in the eastern region are more green and low-carbon. Moreover, the proportion of heavily polluting enterprises is higher in the central and western regions. All of these have motivated the local government to implement green credit policies to cope with the high pressure of environmental governance. Finally, this article proposes policy recommendations from five aspects. These suggestions include improving the government's policy system, increasing environmental awareness among enterprises, promoting green and sustainable development, reducing the gap between state-owned and non-state-owned enterprises, and strengthening coordinated development among different regions.

Keywords: Green credit policy; Heavy polluting enterprises; Debt financing costs; Double difference model.

1. Introduction

1.1 Research background

Nowadays, people are increasingly concerned about global environmental issues. It is particularly crucial to promote the concept of green development and build an ecological civilization. The Earth we rely on is experiencing unprecedented challenges: resource depletion, severe ecosystem damage, and frequent extreme weather caused by climate change. The emergence of these phenomena warns us of a grave problem. If we want to achieve harmonious coexistence between humans and nature, we must take immediate action and transform our development methods. The concept of sustainable development has shown us a feasible path. It emphasizes the coordination between economic development and environmental protection, rather than making them mutually opposed. This concept requires us to abandon the extensive growth model that sacrificed the environment in the past. Instead,

we should pursue coordinated development of the economy, society, and environment. Specifically, it means paying attention to resource conservation and ecological protection in the process of economic development to ensure that our actions do not cause irreversible damage to nature.

With the acceleration of China's industrialization and urbanization process, as well as the lack of corresponding environmental protection policies, combined with historical reasons and industry characteristics, heavily polluting enterprises have been able to consume a large amount of non-renewable resources and rapidly expand, producing a large amount of pollutants in the production process and causing serious damage to the environment. Heavy polluting enterprises not only face difficulties and high financing costs when seeking financing, but also have to cope with multiple pressures from the government and public opinion. These pressures force them to pay more attention to environmental protection and social responsibility while pursuing economic benefits. "Carbon peaking" and "carbon neutrality" are solemn commitments made by China to the international community, as well as our responsibility to actively respond to climate change and promote the construction of a community with a shared future for mankind. The report of the 20th National Congress of the Communist Party of China also pointed out the need to promote green development and harmonious coexistence between humans and nature. Therefore, the current important issue is to take the path of green development and fundamentally reverse the trend of ecological environment deterioration.

1.2 Research contents

Green finance, as the name suggests, is a new financing model that combines environmental protection with economic benefits. It has practical significance for China to achieve harmonious development between humans and nature, and promote high-quality social development. Green credit, as one of the important tools of green finance in China, has formed a relatively complete system. And it is also playing an increasingly important role. Practice has proven that green credit not only has a positive impact on economic and social development, but also has been widely recognized. Green credit has gradually become the main driving force for promoting economic and social development, as China's economy and society shift towards a "low-carbon" direction. Green credit refers to the strategy of commercial banks and other financial institutions providing preferential interest rate loans for environmentally friendly products or projects, while limiting loans to industries with negative environmental impacts by national policies. This policy enables enterprises committed to environmental protection and sustainable development to receive more financial support, thereby promoting the development of the entire society towards a more green, low-carbon, and sustainable direction. In 2007, China issued the "Opinions on Implementing Environmental Protection Policies and Regulations to Prevent Credit Risks" in order to improve China's ecological situation and limit non environmental production of heavily polluting enterprises. The aim is to optimize the allocation of credit resources and emphasize the use of credit means to balance environmental protection and economic development. This is a resounding voice made by China in the field of ecological environment after entering a new historical stage of economic and social development. The China Banking and Insurance Regulatory Commission issued the "Green Credit Guidelines" in 2012, enriching and improving the relevant regulations on green credit. Green credit has gradually been regarded by the domestic financial industry as the basic way to achieve green finance, symbolizing the rapid development of green credit in China. The development process of green credit policies fully demonstrates China's determination and efforts in promoting the development of green finance. In the future, green credit policies will continue to play an important role in promoting the development of green finance with the joint efforts of all parties. It will also make greater contributions to promoting green transformation and sustainable development of the economy.

As the largest production unit, the business operations of enterprises directly or indirectly have a significant impact on the human living environment and stable development. For enterprises, sustainable development not only means profit growth, but also means a good social image, organizational structure, and long-term brand reputation. The implementation of the "carbon peak"

and "carbon neutrality" strategies cannot be separated from the "green development" of heavily polluting enterprises. Meanwhile, the low-carbon transformation of heavily polluting enterprises cannot be achieved without the support of green loans. Therefore, it is crucial to deeply explore and fully utilize the impact and effectiveness of green credit policies on heavily polluting enterprises. This article takes the data of all A-share no-ST enterprises in China from 2010 to 2022 as the sample, excluding all samples of banks and other financial institutions. Enterprises are classified based on different environmental quality indicators, and the heavily polluted and non-heavily polluted enterprises are respectively the experimental group and the control group. And analyze the equity nature and regional differences of enterprises, exploring the role of green credit in debt financing for heavily polluting enterprises. The results indicate that the implementation of green credit policies has a significant restraining effect on the debt financing behavior of heavily polluting enterprises, leading to a significant increase in their financing costs. Moreover, non-state-owned enterprises are more affected than state-owned enterprises. The reason is that state-owned enterprises have government support and social responsibility, which allows them to obtain more comprehensive information and more budget in debt financing, making it easier for them to obtain funds than non-state-owned enterprises. The debt financing costs of heavily polluting enterprises in the eastern region have increased less compared to those in the central and western regions. Because the proportion of heavily polluting enterprises in the central and western regions is relatively high, and the task of ecological environment governance is heavy. On the one hand, economic growth relies heavily on resources, leading to a continuous increase in environmental governance costs. On the other hand, the industrial transformation of heavily polluting enterprises often involves a large amount of equipment dismantling and relocation, which has a more serious impact on the environment. In this context, the governments of the central and western regions have a stronger drive to implement green credit policies.

2. Literature Review

The research question in this article mainly involves two aspects of the literature. The first is a review of the impact of green credit, and the second is an analysis of the influencing factors of corporate financing ability.

2.1 Research on Green Credit

2.1.1 Concept of Green Credit

In recent years, green finance has become a research focus for many scholars. Chen Guojin et al. (2021) believe that "green finance" is a concept that attracts more funds to invest in environmental protection through diversified financing channels. "Green credit", as a new type of sustainable development financial tool, has been widely used in China. Its core is to reasonably coordinate the relationship between the financial industry and sustainable development, and guide funds to flow to low-carbon industries through differentiated pricing (Li Xuefei, 2024). Compared to traditional credit, green credit places more emphasis on environmental benefits rather than solely pursuing economic benefits (Xu Xuefang and Qin Yubing, 2020).Dong Li (2012) believes that the connotation and extension of green credit mainly include the following three aspects: firstly, measuring a company's credit status through environmental protection and resource conservation; secondly, incorporating regulations to reduce pollution and energy consumption into credit allocation decisions; thirdly, strengthening supervision of enterprise business activities and guiding enterprises to enhance their concept of energy conservation and environmental protection. Lu Jing (2021) pointed out that green credit is a loan issued by China to promote industrial structure adjustment and ecological civilization construction. It is an important initiative that not only benefits the improvement of industrial structure but also promotes sustainable economic development. Fan Zhigang and Lu Xia (2012) believe that green credit, as a financial innovation, not only supplements and expands traditional credit methods, but also aims to save energy, reduce emissions, and promote green coexistence.

2.1.2 Analysis of the effectiveness of green credit policies

(1) Macro level

The research by Luo Yanzhi and Jiao Yue (2012) indicates that green credit has promoted active transformation of industrial structure, and their role in industrial restructuring has been deeply explored in China. Research has found that by creating a guidance system, China's cash flow can develop in a more reasonable direction, thereby achieving the goal of promoting economic development in our country.Hu Meimei et al. (2014) established a green finance support system that can promote the development of "dual gender" industries based on the financial needs of "dual type" industries. Li Yu (2020) examined the impact of green credit on industrial structure from the perspective of industrial structure. Research has found that green credit has played a positive role in promoting the all-round development of industrial structure, but its role is relatively limited for a specific industry. Niu Huan and Yan Chengliang (2021) empirically study the impact of green credit on China's economic growth by constructing an analytical framework that includes credit constraints, environmental taxes, and other policies. Research has found that strict credit limits can effectively promote economic development under the dual influence of credit constraints and environmental taxation. In addition, the increase in environmental taxation can also promote economic growth.

(2) Microscopic level

① The Impact of Green Credit Policies on Enterprise Green Innovation

Wang Xin and Wang Ying (2021) found that green credit can effectively improve the environmental, social, and financial performance of enterprises by promoting green innovation. However, there is a significant difference in this effect between green credit restricted industries and non-restricted industries. Wang Yao et al. (2019) took the development of green loans in the Chinese banking industry as a starting point and empirically analyzed the impact of green loans on corporate innovation, growth, and sustainable development based on data from listed companies. Research has found that green loans have a significant positive impact on corporate innovation and growth. Lian Lili (2015) pointed out that green and low-carbon enterprises have more credit support, promoting the transformation of the entire industry towards cleanliness and low-carbon, proving the effectiveness of green credit policies after the implementation of green credit policies. However, some scholars have pointed out that due to the existence of green credit, heavily polluting enterprises are unable to utilize advanced green technologies to meet market demand, making it difficult for them to achieve higher levels of product innovation and technological upgrading (Cao Tingqiu et al., 2021). Previous studies have shown that green credit can increase the credit market between banks, thereby improving the profitability of enterprises. However, it can also pose challenges to the technological innovation of some enterprises (Yang Liuyong and Zhang Zeye, 2022). Currently, there is no consensus among domestic and foreign scholars on the mechanism of green credit in the digital transformation of enterprises. Therefore, to evaluate the effectiveness of green credit policies, the first step is to explore their operational mechanisms.

②The impact of green credit policies on corporate performance

Wang Wei et al. (2021) empirically tested, based on panel data from commercial banks in China, using a comprehensive evaluation of the internal and external environment of enterprises as a medium, that implementing green credit policies can significantly enhance the comprehensive strength of commercial banks in their credit allocation. Ma Ruowei and Zhai Tongtong (2021) studied the level of loan risk in commercial banks by analyzing the changes in customer trust and support for commercial banks after the implementation of green credit policies. It has been confirmed that in the process of economic development, due to inevitable environmental and social risks, the implementation of green credit has to some extent increased the non-performing loan ratio of banks. Meanwhile, the study also found that green credit plays an important regulatory role in customer trust in commercial banks.

2.2 Research on Corporate Debt Financing

Ye Kangtao et al. (2010) conducted a study on the solvency, profitability, and credit history of Chinese A-share listed companies. Research has shown that if a company has poor credit in its business activities, banks will reduce the amount of loans to the enterprise, leading to a decrease in its debt level.Shen Xianghua (2014) analyzed the financial situation of different companies. She believed that enterprises with good asset conditions, normal production and operation, and reliable credit are the main allocation of financial credit resources.From the perspective of the enterprise itself, factors such as operating environment and production costs can affect the level of profits, which in turn affects its judgment and evaluation of future development prospects and financial status. Therefore, the borrowing and lending interests between companies also vary. Li Chi et al. (2021) found that stock and bond financing of listed companies have a significant promoting effect on their operational performance. The better the performance of a company, the higher its debt level. Wei Yuanyuan et al. (2021) analyzed the financial situation of small and medium-sized technology enterprises in China. The results indicate a significant positive correlation between a company's technological level and its financial condition. Yao Lihan (2021) conducted an empirical analysis on loans for high-tech enterprises in Suzhou and obtained the same results. Others point out that as companies continue to develop, their ability to borrow externally may be limited (Gu Qun and Zhai Shuping, 2012). Ge Jing (2019) conducted an in-depth analysis of the interrelationships between carbon accounting and debt financing based on publicly available data from listed companies in China. On this basis, he incorporated the development of green modernization into the correlation analysis between the two. The following conclusion has been drawn: there is a clear reverse correlation between the quality of carbon accounting and the difficulty of debt borrowing for heavily polluting enterprises. Green modernization not only reduces the financial burden on companies, but also helps them save costs, improve efficiency, and promote the development of the environmental protection industry.

2.3 Literature Review and Review

There are currently two main perspectives on research related to green credit. One view is that from a macro perspective, green loans have a positive effect. It can to some extent promote the transformation and upgrading of economic structure, while also promoting sustainable environmental development. To a certain extent, it has a negative effect and may exacerbate the difficulty of economic structural transformation. Another perspective suggests that from a micro perspective, green credit policies have a particularly profound impact on micro entities such as banks and enterprises. It can guide financial resources to tilt towards the environmental protection industry, promote green transformation of the economy, and achieve the dual goals of economy and environment without green credit policies.

At present, Chinese and foreign scholars mainly explore the mechanism of the cost of debt financing from the perspectives of company reputation, financial indicators, operating performance, and green innovation capabilities. Existing research mostly examines the influencing factors of corporate debt financing costs from the perspectives of financial information and business operations. Further expansion of research perspectives is needed. It is to incorporate external institutional environmental factors into the research framework to comprehensively analyze the determining factors of a company's financing costs. However, there is currently a lack of research in the academic community on the economic effects of corporate debt. This poses many risks for enterprises when making green loan decisions, thereby affecting their financial condition and development prospects. Therefore, the academic community needs to further investigate the impact of green credit policies on corporate debt financing. Scholars should conduct more in-depth research on the effectiveness of green loan decisions to help enterprises better achieve sustainable development goals. According to the above research, this article intends to adopt the Double Difference Method (DID) method. Based on the financial indicators of listed companies from 2010 to 2022, this article explores the effect of green loan policies on the debt financing behavior of heavily polluting enterprises.

3. Research Design

3.1 Sample Data

This project takes Chinese A-share listed companies as the research object, referring to the Guidelines issued in 2012, and adopts the Double Difference Method (DID) method to examine the impact of green credit policies on debt financing of heavily polluting enterprises from 2010 to 2022.

Given that the Guidelines include environmental risks in credit assessment requirements and have a significant impact on the credit of heavily polluting enterprises. This study used heavily polluting enterprises as the experimental group and other enterprises as the control group for research. In addition, the sample excluded the entire financial industry, as well as ST and *ST listed companies and listed companies delisted during the inspection period. In order to eliminate the bias of extreme values, 1% or lower tails were applied to all continuous variables. Finally, 3342 samples were obtained, including 689 experimental groups and 2726 control groups, totaling 38201 observation indicators. The sample enterprise data is taken from the CSMAR database.

3.2 Variable Definition

3.2.1 Dependent variable: Cost of debt financing (CDF)

Cost of Debt Financing (CDF), which measures a company's debt financing cost by the ratio of net financing to total loans.

3.2.2 Core explanatory variable: Green credit policy (Time * Treaded)

Green Credit Guidelines (Time). The Guidelines have been implemented since 2012. If the year of data selection is 2012 or later, Time=1; If before 2012, Time=0.

Heavy polluting industry enterprises (Treaded).Fifteen industries are selected as heavily polluting industries based on pollution emission intensity, including coal mining and washing industry, oil and gas extraction industry, ferrous metal mining and selection industry, non-ferrous metal mining and selection industry, textile industry, leather and feather products industry, papermaking and paper products industry, petroleum processing and coking and nuclear fuel processing industry, chemical raw material and chemical manufacturing industry, chemical fiber manufacturing industry, rubber and plastic products industry, non-metallic mineral products industry, black metal smelting and rolling processing industry, non-ferrous metal smelting and rolling processing industry, power and heat production and supply industry. When the sample is from a heavily polluted industry, Treat=1, and vice versa, Treat=0. The definition of heavy polluting industries is shown in Table 1.

Table 1 Definition of Heavy Pollution Industries

Industry code	Industry name	Industry code	Industry name
B06	coal mining and washing industry	C26	chemical raw material and chemical manufacturing industry
B07	oil and gas extraction industry	C28	chemical fiber manufacturing industry
B08	ferrous metal mining and selection industry	C29	rubber and plastic products industry
B09	non-ferrous metal mining and selection industry	C30	non-metallic mineral products industry
C17	textile industry	C31	black metal smelting and rolling processing industry
C19	leather and feather products industry	C32	non-ferrous metal smelting and rolling processing industry

C22	papermaking and paper products industry	D44	power and heat production and supply industry
C25	petroleum processing and coking and nuclear fuel processing industry	……	……

3.2.3 Control variables

This article controls for variables that may affect the cost of corporate debt financing, including company size (Asset), fixed asset ratio (Fix), corporate cash flow (Cfo), return on assets (Roa), company growth rate (Growth), debt ratio (Lev), Tobin Q value (Q), equity concentration (EC), stock return (Ret), and asset tangibility (PE).In addition, to better control inherent endogeneity issues, the effects of time and individual factors have been fixed. The specific variable definitions are shown in Table 2.

Table 2 Variable Description

Variable	Variable Definition
Time	After 2012, the value is 1. Before 2012, the value was 0
Treated	1 for heavily polluting enterprises.0 for non-heavily polluting enterprises
Asset	The natural logarithm of total assets
Fix	Net fixed assets/total assets
Cfo	Net cash flow generated from operating activities/total assets
Roa	Net profit/total assets
Growth	Operating income/total assets
Lev	Total liabilities/total assets
Q	(Stock market value + net debt)/Current value of tangible assets
EC	Shareholding ratio of the largest shareholder
Ret	Annual individual stock return rate
PE	(Inventory + Fixed Assets)/Total Assets

4. Empirical Process

4.1 Model Settings

This article uses a double difference model to divide China's A-share listed companies from 2010 to 2022 into two research groups. Heavy polluting and non-heavily polluting enterprises are used as experimental and control groups. On this basis, ST and *ST companies, as well as enterprises with a large amount of missing accounting information, were excluded from the sample to explore the impact of green credit policies on debt financing of heavily polluting enterprises. The formula is as follows:

$$Y_{it} = \beta_0 + \beta_1 time_t + \beta_2 treated_{ti} + \beta_3 time_t \times treated_i + \gamma X_{it} + \delta_i + \theta_t + \varepsilon_{it}$$

In the above formula, Y_{it} is the dependent variable, which is the debt financing indicator of the enterprise (debt financing cost); $time_t$ is a time dummy variable, that is, whether it is affected by policies or not; $treated_{ti}$ is a dummy variable for the group, with a value of 1 for heavily polluting enterprises and 0 for other enterprises; $time_t \times treated_i$ is the core explanatory variable of this article, which is the interaction term between the time dummy variable and the group dummy variable; X_{it} is a control variable (company size, return on assets, equity concentration, stock returns, etc.); ε_{it} is a random disturbance term; δ_i is an individual fixed effect; θ_t is a fixed time effect; β_3 is the coefficient of the interaction term, evaluating the degree of impact of the policy on the experimental group; β_0 is a constant term; i is the enterprise; t is time.

4.2 Descriptive statistics

This article provides an overall description and analysis of the existing data, as shown in Table 3.

Table 3 Descriptive Statistical Analysis

Variable	Obs	Mean	Std. Dev.	Min	Max
CDF	38200	0.0029	0.0561	-2.4545	0.9466
Time	38200	0.9058	0.2922	0	1
Treated	38200	0.1958	0.3968	0	1
Time*Treated	38200	0.1941	0.3955	0	1
Asset	38200	22.2756	1.4931	14.9416	31.3101
Fix	38200	0.2012	0.1596	0	0.9709
Cfo	38200	0.0447	0.0777	-1.9377	0.8759
Roa	38200	0.0348	0.1133	-14.3018	0.7859
Growth	38200	0.6048	0.5224	-0.0502	13.9135
Lev	38200	0.4242	0.2161	0.0075	3.513
Q	38200	2.1225	4.5072	0.5093	719.757
EC	38200	34.3942	15.244	0	100
Ret	38200	0.0955	0.5297	-0.8498	15.2113
PE	38200	0.3376	0.1827	0	0.9709

According to the table, the statistical minimum value of corporate debt financing cost is -2.4545, the maximum value is 0.9466, the mean is 0.0029, and the standard deviation is 0.0561. The difference between the maximum and minimum values proves that the cost of debt financing varies greatly among different companies. The mean time is 0.9058, indicating that the sample size after policy implementation is 90.58%; The average treated value is 0.1958, indicating that there are 19.58% of heavily polluted enterprises in the entire sample.

On the basis of descriptive statistical analysis, the range of debt financing indicators for 4897 A-share listed companies changed significantly from 2010 to 2022, and the standard deviation of the vast majority of variables was less than 1. This indicates that the variable distribution selected in this article is stable and has low deviation, which provides reliable data support for the research in this paper.

4.3 Benchmark regression results

Table 4 Green Credit - Cost of Debt Financing for Heavy Polluting Enterprises

Variable	ESG
Time*Treated	0.0061***
	(0.0015)
Asset	-0.0008
	(0.0006)
Fix	-0.0475***
	(0.0052)
Cfo	0.0021
	(0.0038)
Roa	-0.0021
	(0.0024)
Growth	-0.0009***
	(0.0009)
Lev	-0.0849***
	(0.0024)
Q	-5.08e-06
	(0.0001)
EC	0.0002***
	(0.0000)
Ret	0.0001
	(0.0005)

PE	-0.0318***
	(0.0041)
Time fixed effect	Yes
Individual fixed effects	Yes
Observations	38200
Adj.R^2	0.1892

The Time * Treaded coefficient in Table 4 is 0.0061, indicating a significant positive effect of debt financing costs at the 1% level. This indicates that after implementing green credit policies, the debt and financing costs of heavily polluting enterprises have significantly increased. Due to the original intention of issuing green credit policies to avoid pollution emissions, the rising cost of debt financing for heavily polluting enterprises indicates that their operations are more difficult. Enterprises need to adjust their corporate structure to make the production process cleaner in order to achieve the goal of sustainable operation.

In terms of controlling variables, at the 1% level, there is an inverse relationship between fixed capital ratio (Fix) and corporate debt financing cost. The larger the fixed asset ratio of a heavy asset company, the stronger its competitiveness and productivity, the higher its repayment ability, and the lower its default risk. Therefore, the larger the fixed asset ratio of a company, the lower the cost of debt financing. The growth rate of a company (Growth) is significantly positively correlated with its debt cost, indicating a positive correlation between its growth rate and its development potential, credit rating, and debt cost. There is a significant negative correlation between equity concentration (EC) and the cost of corporate debt financing, indicating that high ownership concentration leads to greater investment errors. Their repayment ability is lower, and the likelihood of financial difficulties is higher. Banks often impose more restrictions on loans for such enterprises.

4.4 Heterogeneity testing

Table 5 Heterogeneity of Enterprises

Variable	State-owned	Non-state-owned
Time*Treated	-0.0008	0.0091***
	(0.0009)	(0.0024)
Asset	-0.001**	-0.0002
	(0.0004)	(0.0009)
Fix	-0.0438***	-0.0465***
	(0.0033)	(0.0077)
Cfo	-0.0139***	0.0083
	(0.0027)	(0.0054)
Roa	0.009**	-0.0041
	(0.0038)	(0.003)
Growth	-0.0032***	-0.0108***
	(0.0006)	(0.0013)
Lev	-0.0449***	-0.0896***
	(0.0019)	0.0034
Q	-0.0000	0.0000
	(0.0001)	(0.0000)
EC	-0.0000	0.0002***
	0.0000	(0.0001)
Ret	-0.0004	0.0003
	0.0004	(0.0007)
PE	-0.0059**	-0.0443***
	(0.0027)	(0.0059)

Time fixed effect	Yes	Yes
Individual fixed effects	Yes	Yes
Observations	11213	25815
Adj.R^2	0.02785	0.1959

From Table 5, it can be seen that in two samples with different property rights, the coefficient of the Time*Treated differential term for non-state-owned enterprises is positive and significant, while the coefficient of the interaction term for state-owned enterprises is negative and not significant. It indicates that implementing a green credit system can reduce the debt of state-owned enterprises, but this effect is not significant. It is because state-owned enterprises, with government support and social responsibility, can obtain more comprehensive information and budget in debt financing, making it easier for non-state-owned enterprises to obtain funding.

However, at the 1% level, the coefficient of the interaction term for non-state-owned enterprises is significantly positive and has a positive relationship with the company's debt cost. This indicates that green credit plays a more important role in the improvement of China's economic development, and has a profound impact on the debt financing ability of heavily polluting non-state-owned enterprises. Non-state-owned companies need to adjust their operating policies reasonably to adapt to the overall environment of a green economy.

Table 6 Regional Heterogeneity

Variable	Eastern	Central	Western
Time*Treated	0.0063***	0.0077**	0.0078**
	(0.0011)	(0.0012)	(0.0013)
Asset	0.0000	-0.0009	-0.0061***
	(0.0008)	(0.0009)	(0.0015)
Fix	-0.06***	-0.026**	-0.0166
	(0.0065)	(0.0094)	(0.0131)
Cfo	0.0094*	-0.0115*	-0.0164*
	(0.0049)	(0.0061)	(0.0091)
Roa	-0.0046	0.0142**	0.0012
	(0.0046)	(0.0066)	(0.0028)
Growth	-0.0108***	-0.0042**	-0.0093***
	(0.0012)	(0.0014)	(0.0024)
Lev	-0.0931***	-0.0493***	-0.067***
	(0.0033)	(0.004)	(0.0055)
Q	-0.0008***	-0.0009***	0.0001
	(0.0002)	(0.0003)	(0.0001)
EC	0.0002***	0.0002***	0.0003***
	(0.0000)	(0.0001)	(0.0001)
Ret	-0.0000	-0.0002	-0.0005
	(0.0007)	(0.0009)	(0.0014)
PE	-0.0291***	-0.0263***	-0.0486***
	(0.005)	(0.0079)	(0.0111)
Time fixed effect	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes
Observations	27984	5242	4948
Adj.R^2	0.1881	0.2766	0.1597

According to Table 6, the interaction coefficient values for the eastern region are 0.0063, 0.0077 for the central region, and 0.0078 for the western region. At a significant level, the eastern region accounts for 1%, while the central and western regions both account for 5%. The research results indicate that the implementation effect of green loan policies varies in different regions. Although

policies have significant inhibitory effects on the cost of debt financing in the eastern, central, and western regions, the degree of inhibition varies. The absolute value of the interaction coefficient in the eastern region is lower than that in the central and western regions. This proves that after the implementation of green credit policies, the debt financing costs of heavily polluting enterprises in the eastern region have increased less, while those in the central and western regions have increased more. Probably because heavily polluting enterprises in the eastern region have shown a positive attitude and innovative ability when facing the dual challenges of environmental requirements and debt financing costs. They have implemented measures such as optimizing financing structure, improving credit rating, strengthening risk management, and increasing investment in technological innovation. And successfully minimized the impact of green credit policies on debt financing costs, achieving the transformation and upgrading of enterprises and green development.

Heavy polluting enterprises in the central and western regions often face more complex environmental governance issues when promoting green credit. This is not like the initial stage of building a green credit system, where environmental issues were relatively mild. Therefore, enterprises will face more difficulties in promoting green credit, which requires the joint efforts of the government, enterprises, and the public. Due to the strong dependence of these heavily polluting enterprises on local natural resources, especially on minerals, energy and other resources. In addition, the variety and intensity of pollutant emissions make their impact on ecology more severe, increasing the difficulty of industrial transformation and environmental protection work. In this context, in order to combat environmental pressure, both the central and western regions are vigorously promoting green credit systems.

4.5 placebo test

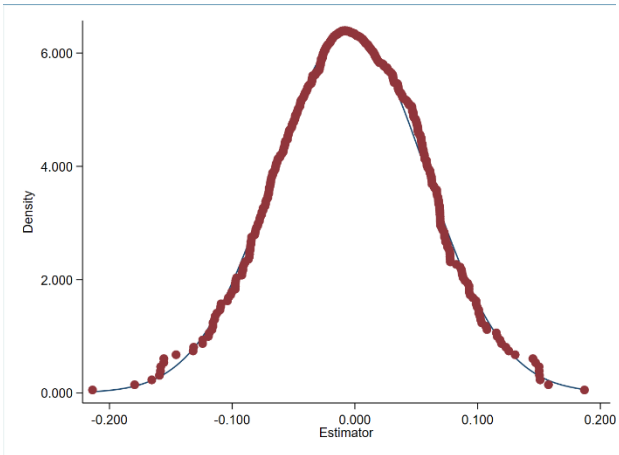

Figure 1 Placebo test

On this basis, the research results were validated through a placebo trial using random sampling from a large sample. This article takes 500 samples as the research object and uses the double difference method for regression analysis. If the DID value obtained by the random method is approximately 0, it indicates that the method has not ignored any key factors. That is to say, the impact effects considered in this study do indeed come from the implementation of green credit policies. Figure 1 shows that the estimated coefficients of the pseudo double difference part are close to 0, indicating that there will be no major data loss issues. Therefore, the main results of this study have a certain degree of robustness.

5. Conclusion and Suggestions

5.1 Research Conclusion

5.1.1 Basic research conclusions

This article discusses the effects of green credit policies and selects A-share listed companies from 2010 to 2022 as the research object. On the basis of considering both time and individual factors, this article adopts the double difference (DID) method to empirically study the debt financing costs of heavily polluting enterprises in China after the implementation of the Green Credit Guidelines, and analyzes them through a placebo test. Empirical evidence shows that China's green credit policy has a restraining effect on the debt financing of heavily polluting enterprises, leading to a significant increase in their debt financing costs.

Compared to non-heavily polluting companies, green loans have a more significant impact on the debt and financing costs of heavily polluting enterprises. This means that polluting companies need to bear higher interest expenses in the financing process, increasing the cost burden of loans. After implementing the green credit policy, the loan threshold for heavily polluting companies has significantly increased. Companies need to meet stricter environmental and sustainable development standards in order to obtain loan support from commercial banks. This has increased the difficulty for heavily polluting enterprises to apply for loans, and has a certain impact on the operation and development of heavily polluting enterprises.

In summary, the green credit policy has increased the financing costs of heavily polluting enterprises and raised the loan threshold. Green credit, as an economic means of exerting pressure on enterprises through debt financing, has indeed played a certain role in protecting the environment and reducing pollution.

5.1.2 Heterogeneity research conclusions

In terms of heterogeneity, this article studies and analyzes the debt financing costs of heavily polluting enterprises with different property rights and regions. The conclusion drawn is as follows.

In terms of property rights, this article finds that the implementation of green credit policies has reduced the cost of debt financing for state-owned enterprises, while increasing the cost of debt financing for non-state-owned enterprises. Because state-owned enterprises have government support and assume social responsibility, they can obtain more comprehensive information and more budget in debt financing, making it easier for them to obtain funds than non-state-owned enterprises. This indicates that for heavily polluting private enterprises, the effect of green loans is more significant. Non- state-owned companies need to adjust their business policies reasonably to adapt to the overall environment of a green economy.

In terms of regional differences, this article believes that green loan policies will have a significant negative impact on corporate debt financing in the eastern, central, and western environments of China, thereby increasing the cost of corporate debt financing. However, the absolute values of the interaction coefficient in the central and western regions are larger than those in the eastern region. This proves that the debt financing costs of heavily polluting enterprises in the eastern region have increased less, while those in the central and western regions have increased more. Maybe it's because the eastern region was earlier affected by green economic policies, emphasizing the green and low-carbon development of enterprises, and its production and business models are lower carbon and more complete than those in the central and western regions. From the perspective of industrial structure, most of the heavily polluting enterprises in the central and western regions are rooted in traditional manufacturing industries, such as chemical, steel, and paper industries. These industries have historically been important forces driving industrialization and economic growth. But with time, they have gradually exposed problems such as low technological level, high resource consumption, and serious environmental pollution, so they have more motivation to implement green credit policies.

5.2 Policy recommendations

5.2.1 The government improves policy system and strengthens supervision

The government needs to improve the legal, regulatory, and policy system for green finance, making green credit policies orderly, detailed, unified, and comprehensive. They should also strengthen constraints and encourage innovative development, clarify the legal responsibilities of heavily polluting enterprises and financial institutions in environmental pollution. In order to encourage more enterprises to participate in green projects, the government should provide more preferential policies. For example, providing interest rate subsidies, tax reductions, loan guarantees for green loans can reduce the financing costs of green projects and improve their economic feasibility.

To promote the implementation of the policy, it is necessary to improve the supervision and management of the policy. Firstly, the government needs to establish a dedicated regulatory agency to oversee and manage green credit policies. This institution should have professional knowledge and independence, be able to comprehensively grasp the implementation of green credit policies, and promptly identify and solve problems. Secondly, it is necessary to strengthen the information disclosure of green credit policies. The relevant information on policy implementation should be made public to society to increase transparency. Enterprises and investors should understand the specific content of policies and the procedures and conditions for applying for green loans. For the loan purpose of green credit, it is necessary to carry out comprehensive and rigorous control to ensure the reasonable and effective use of funds. Regular audits are also needed to check the implementation of green credit policies and encourage all sectors of society to participate in the supervision of green credit policies. The public, media, and environmental organizations can all play their respective roles in supervising and evaluating policy implementation.

5.2.2 Enterprises take responsibility and allocate resources reasonably

Enterprises should start from within and strengthen the promotion and education of environmental awareness among employees. Through regular training, lectures, or internal publications, employees can gain a deeper understanding of the importance of environmental protection and develop habits of green office and production. We should actively promote green production and management models to reduce environmental pollution during the production process. This includes using environmentally friendly materials, optimizing production processes, and improving resource utilization efficiency. At the same time, enterprises should pay attention to every aspect of the product lifecycle, ensuring that everything from raw material procurement to product design, production, sales, and recycling meets environmental standards. Pay close attention to the changes and trends in green credit policies, and understand the direction of financial institutions' support for green projects. This can not only help companies obtain low-cost financing, but also promote their green transformation through cooperation with financial institutions.

For potential green projects, enterprises should establish a project library and track and manage it. Once there are new developments in green credit policies or financial institutions provide funding support, enterprises can quickly seize opportunities and promote the implementation of projects. Enterprises should regard environmental protection as an important social responsibility, actively participate in various environmental public welfare activities, and demonstrate their environmental determination and achievements. This not only helps to establish a good image of the enterprise, but also earns more social trust and support for the enterprise. Simultaneously establish an environmental monitoring and evaluation mechanism, and regularly evaluate and summarize one's own environmental protection work. This helps to identify problems promptly manner and take improvement measures to ensure that the environmental protection work of the enterprise is always on the right path.

5.2.3 Promoting green and sustainable development

With the increasing awareness of environmental protection, enterprises should actively adjust their energy structure, reduce their dependence on traditional fossil fuels, and increase the use of clean

energy. This includes introducing renewable energy sources such as solar and wind energy, optimizing energy allocation, and reducing carbon emissions. Enterprises should increase investment in green industries and develop a low-carbon economy. At the same time, attention should be paid to the coordinated development between industries, forming a green industry chain, and improving overall environmental performance. Environmental governance is the foundation of green transformation for enterprises. For heavy pollution, a sound environmental management system should be established, environmental regulations should be strictly followed, and pollution prevention and control measures should be strengthened. By technological transformation and upgrading, the emission of pollutants in the production process is reduced, and the level of environmental governance is improved.

Improving resource utilization efficiency is an important means to achieve sustainable development. In the production process, attention should be paid to the recycling of resources, and the principles of reduction, reuse, and resource utilization should be promoted. By improving production processes and management models, reducing the consumption of raw materials and energy, and improving resource utilization efficiency. Green technology innovation is a key driving force for enterprises to accelerate their green transformation. Investment in green technology research and development should be increased, and advanced energy-saving and emission reduction technologies should be actively introduced and promoted. Cultivating employees' awareness of green development is an important part of achieving green transformation in enterprises. Enhance employee awareness and participation in environmental protection through training and educational activities. Advocate for the concepts of green office and low-carbon living, and create a good atmosphere of green corporate culture. Encourage employees to participate in green innovation activities and cultivate the company's green innovation capabilities.

5.2.4 Reducing the gap between state-owned and non-state-owned firms

Through research and analysis, it has been found that under traditional financing models, state-owned enterprises have more favorable debt financing conditions compared to non-state-owned enterprises. To reduce the gap between state-owned and non-state-owned enterprises, the first step is to improve the financial market and establish a sound multi-level financial market system. We need to increase financing channels and methods, so that both state-owned and non-state-owned enterprises can have more fair and transparent financing opportunities. Secondly, we need to increase the reform efforts of state-owned enterprises, while guiding non-state-owned enterprises to strengthen their own management and internal control, improve their operational efficiency and credit rating, and thus make it easier to obtain financing. The government can also introduce relevant policies to provide more financing support and guarantees for non-state-owned enterprises, reducing their financing costs and difficulties.

5.2.5 Strengthen coordinated development among different regions

The heterogeneity analysis results indicate that after the implementation of green credit policies, the increase in debt financing costs of heavily polluting enterprises in the eastern, central, and western regions is different. The possible reason is that the financing environment varies in different regions, which affects the speed and quality of economic development. The financing environment in the eastern region is relatively favorable, attracting a large number of domestic and foreign enterprises. However, the central and western regions face problems such as poor financing environment and immature market development, as well as factors such as history, natural conditions, policy measures, industrial structure, and human capital.

To strengthen coordinated development among different regions, the first step is to encourage local governments to adopt diversified financing methods. For example, reducing debt risk through equity financing and asset securitization, strengthening supervision of fund utilization, and ensuring that funds are used in necessary areas such as infrastructure construction. The central government should also regulate and guide local government debt, establish a sound debt risk warning mechanism, control the scale of debt in various regions, and prevent debt risks. In addition, it is necessary to

strengthen cooperation and communication among regions, promote coordinated economic development between regions, and reduce debt risks caused by lagging economic development in some regions. Finally, a sound legal and institutional system should be established to regulate the financing behavior of governments in various regions and prevent the occurrence of illegal and irregular behaviors.

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