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Research on the Impact of Green Credit on the Cost of Heavily Polluting Industries

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Abstract

This article uses non-financial listed companies in China from 2008 to 2021 as a sample, taking debt financing costs as the explained variable to explore the impact of green credit policies on heavy polluters in A-share listed companies. Through empirical research, it is found that green credit significantly restricts the financing availability of heavy polluters and limits their development. Long-term financing has the most significant impact, indicating that policy implementation has a long-term effect and can fundamentally guide companies to change their development direction to achieve the initial policy goal. Finally, this article conducts a robustness test and finds that the empirical conclusion is still reliable, and proposes policy recommendations based on relevant conclusions.

Keywords

Green Credit; Debt Financing; Difference-in-Differences; Policy Effectexplains and Demonstrates.

1. Introduction

Since the reform and opening-up, China's industrialization and socialization process has achieved remarkable results, with rapid economic development. However, the extensive development approach has inevitably led to high emissions and pollution, making ecological environment issues increasingly prominent. The green development approach, with efficiency, harmony, low carbon, and sustainability as goals, has become a consensus for modern economic and social development and a national development strategy.

General Secretary Xi Jinping proposed at the 75th United Nations General Assembly that China strive to achieve carbon peak before 2030 and carbon neutrality before 2060. The implementation of this goal will fundamentally transform China's economic development model. Correspondingly, the government has issued a number of policies to guide industrial reform, including financial tools such as green bonds, green credit, and green insurance. Among them, the role and importance of green credit are particularly significant.

In 2007, the State Environmental Protection Agency issued the "Opinions on Implementing Environmental Policy and Regulations to Prevent Credit Risks", proposing that financial institutions should fully consider the environmental effects of enterprises when issuing loans and actively promote the implementation of green credit policies. In 2012, the China Banking Regulatory Commission issued the "Green Credit Guidelines" requiring financial institutions to effectively and reasonably assess the environmental performance and risks of loan recipients, reasonably allocate economic resources, and improve the efficiency of financial resource allocation. Green finance is a useful supplement to traditional environmental regulation policies. Green finance policies have dual functions of capital allocation and environmental regulation. They are important market-oriented explorations of financial regulation in environmental governance. They play an important role in guiding social capital flows, improving the efficiency

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of financial resource allocation, and achieving "dual carbon" goals on schedule, promoting the green transformation of the economy.

In China, due to the developing stage of the financial market, enterprises rely mainly on bank loans for external financing. According to the statistics of the People's Bank of China, from 2004 to 2020, the proportion of bank loans in the total social financing scale was higher than 60%. Among them, the high-pollution industry, as a capital-intensive industry, has become a key industry for China's credit resource allocation through asset-heavy mortgage.

Green credit policy serves as an important financial tool to regulate the credit resource allocation of high-pollution enterprises. As of the end of 2022, the green credit balance of 21 major banks in China reached 2.06 trillion yuan, an increase of 33.8% year on year. However, the substantial incentive effect of green credit policy on banks is insufficient, so the enthusiasm for green credit is not strong. In addition, due to reasons such as weak supervision, insufficient environmental information disclosure by enterprises, and information asymmetry, the debt financing costs of highly polluting enterprises remain subject to the constraints of green credit policy and require further testing. At the same time, how to efficiently incorporate environmental risks into credit management through green credit and strictly prevent credit funds from flowing into heavily polluting industries to support enterprise green transformation is also one of the research hotspots in the theoretical circles.

2. Research Design

2.1. The Oretical Analysis

The "Green Credit Guidance" issued by the China Banking and Insurance Regulatory Commission mainly implements three important measures: first, requiring banking financial institutions to promote green credit from a strategic height, implement incentive and restraint measures to ensure the continuous and effective development of green credit; second, requiring banking financial institutions to fully consider the environmental and social risks involved in credit business, and refuse to extend credit to enterprises or projects that are not compliant with environmental and social regulations; third, clarifying the supervision responsibilities of the China Securities Regulatory Commission and banking regulatory agencies, and improving the supervision and management of green credit business and environmental and social risks management of banking financial institutions.

These measures not only promote the standardization and institutionalization of green credit policies, but also convey the government's determination to control environmental pollution to the public. Therefore, this article believes that the "Guidance" can inhibit the financing behavior of heavily polluting enterprises through the following three ways: first, the supply-side factors of the financial market affect corporate financing decisions. If commercial banks strictly control credit thresholds and take environmental compliance as an important condition for granting loans, then the financing costs of heavily polluting enterprises will increase. The debt financing dominated by bank loans will necessarily decrease significantly, especially the long-term debt financing will be significantly reduced. Second, the sharing of enterprise environmental protection information between the government and financial departments will help achieve the linkage between environmental protection and financial credit. At the same time, it can transmit signals to the capital market about strengthening the management and supervision of enterprise environmental information disclosure, thereby reducing the willingness of external creditors to provide debt capital (Wu Chaopeng et al., 2012). Third, after the official implementation of the "Guidance", heavily polluting enterprises will inevitably suffer from greater public opinion pressure and moral criticism, and may even face environmental litigation risks, leading to external creditors withdrawing funds or refusing loan extensions. Therefore, the debt financing level of heavily polluting enterprises will decrease.

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2.2. Empirical Research

2.2.1. Sample Selection and Data Source

This article selects A-share listed companies from 2008 to 2021, including listed companies in the 16 industries specified in the "Industry Classification Guidelines for Listed Companies" issued by the China Securities Regulatory Commission, such as thermal power, steel, cement, electrolytic aluminum, coal, metallurgy, chemicals, petrochemicals, building materials, paper making, brewing, pharmaceuticals, fermentation, textiles, leather making, and mining. The listed companies in these industries are classified as heavy pollution industries, while other samples are classified as non-heavy pollution industries. The samples are screened as follows: (1) excluding listed companies in the financial industry; (2) excluding listed companies with delisting warnings such as *ST, SST, and ST; (3) excluding listed companies with missing key indicators. This article uses balanced panel data, and after data processing, a total of 4377 observations entered the research, including 139 heavy polluters and 698 non-heavy polluters. The required listed company data in this article comes from the Guotai Junan database, while the provincial-level pollutant emissions panel data comes from the "China Environmental Statistics Yearbook".

To mitigate the impact of extreme values on the empirical results, this article performs winsorization on continuous variables. For continuous variables with values below the 1% quantile (or above the 99% quantile), their values are set equal to the 1% quantile (or 99% quantile). To alleviate endogeneity issues, the control variables in the investment and financing equation in the regression analysis are all lagged by one period (except for firm age, equity concentration, and corporate social responsibility), and at the same time, the standard errors of the test results are adjusted by clustering at the firm level.

2.2.2. Variable Setting

Table 1. Definition of Variables and Names

	Variable name	Variable measure
Explained variables	Liquid liabilities	Liquid liabilities/Total assets at the beginning of the period,
	long-term liabilities	Long-term liabilities/Total assets at the beginning of the period
	Investment in physical capital	Cash paid for the acquisition and construction of fixed assets, intangible assets and other long-term assets in the current year divided by the explanatory variable of total assets at the beginning of the period
Explanatory variable	difference-in-difference variable	treated×after
Control variable	Size	Scale of enterprise assets (natural logarithm of total assets)
	Roa	Net profit/average total assets
	Tobin`s Q	(market value of tradable shares+face value of non-tradable shares)/(total assets-net intangible assets)

This article uses two methods to construct debt financing indicators: one is the debt financing of current liabilities, which is the proportion of current liabilities to the beginning of the total assets. The current liabilities include short-term borrowings, business credit (accounts payable, notes payable and accounts received in advance), non-current liabilities due within one year (or one operating cycle), including long-term debt financing, employee compensation payable,

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and taxes payable, etc. The other is the debt financing of long-term liabilities, which is the proportion of long-term liabilities to the beginning of the total assets. Long-term liabilities mainly include long-term loans, bonds payable, long-term accounts payable, and special accounts payable, etc. Table 1 provides the definitions and measurements of variables.

2.2.3. Model Design

The Difference-in-Differences (DiD) model is a commonly used design in econometrics for estimating the impact of policy changes or other types of interventions on specific targets. This model design aims to eliminate the influence of other factors, allowing a more accurate estimation of the intervention effect.

The model uses a fixed-effects difference-in-differences model to examine the impact of the green credit policy on investment and financing behavior of heavily polluting enterprises. The experimental group consists of listed companies in heavily polluting industries.

$$Y\,it = \beta 0 + \beta 1\ treatedi + \beta 2after + \beta 3treatedi \times aftert + \gamma Xit\text{-}1 + \delta i + \lambda t + \varepsilon it \quad (1)$$

The model includes the following variables:

Yit: an indicator of investment and financing behavior of enterprises;treatedi: a dummy variable indicating the treatment group, with a value of 1 for the experimental group and 0 for the control group;aftert: a dummy variable indicating the event, with a value of 1 starting from 2012 and before;treatedi×aftert: a dummy variable indicating the interaction between the treatment group and the event;Xit: a set of firm-level control variables;δi: individual fixed effects;λt: time fixed effects;εit: random disturbances.The coefficient β3 is the difference-in-differences coefficient, which measures the impact of the event on the experimental group.

3. Empirical Results

3.1. Analysis of Difference-in-Differences Regression Results

This article uses the 2012 green credit policy as an exogenous shock event to study its impact on the short- and long-term debt financing scale of heavily polluting enterprises. Table 2 is the benchmark regression result of the difference-in-differences method. Column 1 is the regression result of short-term debt financing, which is one of the dependent variables. Columns 2 and 3 are the regression results of long-term debt financing, which is another dependent variable. As the core explanatory variable, the policy impact effect of the interaction term of green credit policy is significant at the 1% level with a coefficient of 0.017 before adding control variables. After adding control variables, the regression coefficient of e_i_e is -0.0157, which is also significant at the 1% level. This indicates that the green credit policy effect is not significant in short-term debt, i.e., the implementation of the green credit policy is difficult to reduce the short-term debt financing scale of heavily polluting enterprises. The coefficient of net asset yield (ROA) is 0.352, passing the 0.1% significance test, indicating that in heavily polluting enterprises, short-term debt financing is still expanding. The coefficient of fixed asset ratio (fix) is -0.196, passing the 0.1% significance test, indicating that fixed asset ratio has a significant impact on short-term debt financing. The coefficients of enterprise growth and asset-liability ratio are 0.132 and 0.880, respectively, both passing the 1% significance test, indicating that short-term debt financing still depends on the level of enterprise development rather than policy influence. In summary, the green credit policy has no negative correlation with short-term debt financing for enterprises.

The regression results of long-term debt financing in columns 2 and 3 show that without selecting control variables, the regression coefficient of double difference is -0.016 and -0.013,

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passing the 1% significance test, indicating that the green credit policy has a significant constraint effect on long-term debt financing. The coefficient of enterprise size is 0.039, passing the 1% significance test, indicating that larger enterprise size is more favorable for long-term debt financing; the coefficients of growth are 0.027 and 0.059, passing the 1% significance test, indicating that operating profits have a significant impact on long-term debt financing; in summary, compared to non-heavily polluting industries, the green credit policy has no negative effect on short-term debt financing of heavily polluting enterprises but has a significant negative effect on long-term debt financing.

Table 2. The impact of green credit on financing behavior

	Liquid liabilities	Long-term liabilities	Investment in physical capital
Heavily polluted industries	-0.027*	0.028**	-0.001
	(0.017)	(0.002)	(0.911)
Green credit policy	-0.110	-0.015	-0.073
	(0.296)	(0.918)	(0.520)
Interactions	0.017**	-0.016**	-0.013**
	(0.003)	(0.001)	(0.007)
ROA	0.352***	0.025	0.094**
	(0.000)	(0.083)	(0.003)
Ratio of tangible assets	-0.027	-0.050**	0.038
	(0.207)	(0.003)	(0.204)
TobinQ	-0.003**	-0.004***	-0.000
	(0.002)	(0.000)	(0.824)
Debt-to-asset ratio	0.880***	0.262***	-0.035*
	(0.000)	(0.000)	(0.023)
Size	0.012***	0.039***	0.049***
	(0.000)	(0.000)	(0.000)
Proportion of fixed assets	-0.196***	-0.005	-0.060*
Proportion of fixed assets	(0.000)	(0.717)	(0.011)
Growth	0.132***	0.027***	0.059***
	(0.000)	(0.000)	(0.000)
The age of the business	0.001	-0.001	-0.007
	(0.877)	(0.903)	(0.597)
N	31404	27308	13933
adj. R2	0.501	0.234	0.148

1) p-values in parentheses.

2) * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

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3.2. Parallel Trend Test

In constructing a difference-in-differences model to study the impact of the green credit policy on the debt financing scale of heavily polluting enterprises, the parallel trend test is an indispensable prerequisite. Only when the parallel trend test is satisfied, can the difference-in-differences model continue to be used. Therefore, the experimental group and the control group should have the same trend characteristics until the policy shock. As can be seen from the figure, before the implementation of the policy, it is zero, and after the implementation of the policy, it is basically not zero, indicating that the policy effect is significant, and the control group and the experimental group have a parallel trend, passing the test.

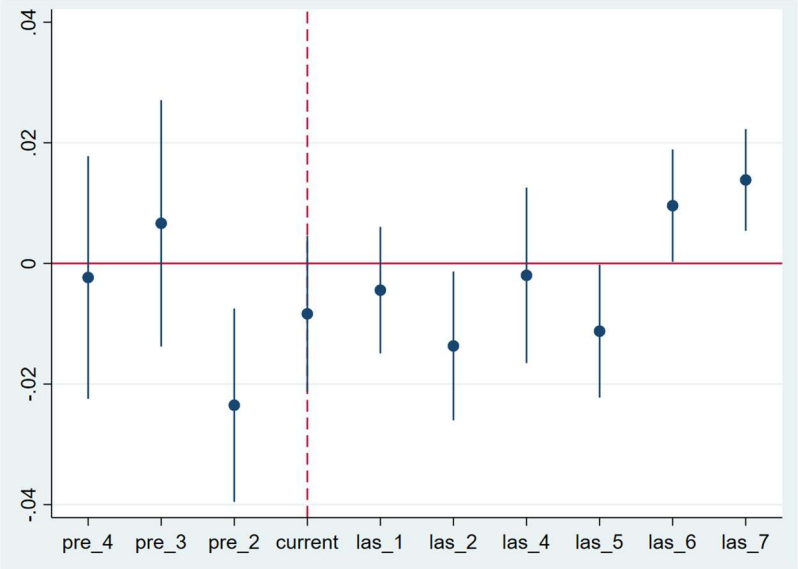

Figure 1. Parallel Trend Test

3.3. Robustness Test

It can be seen from the graph that the estimated coefficients of the interaction term "did" are mostly distributed around 0. This indicates that the model constructed in this article has not omitted important factors that are crucial to the regression results. Therefore, the conclusions drawn from the benchmark regression are indeed based on the assumption of the policy - the release of the "Green Credit Guidelines".

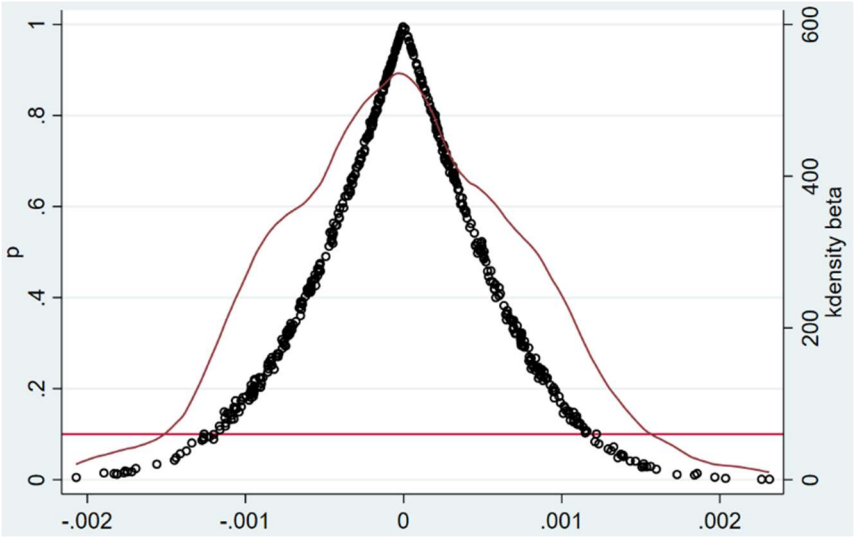

Figure 2. Robustness test

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4. Literature References

Green credit is often referred to as sustainable finance or environmental finance. For the purpose of this study, research on the implementation effect of green credit policies mainly focuses on two micro perspectives: loan institutions and financing enterprises.

The implementation of green credit policies by banks leads to an increase in the debt costs of heavily polluting enterprises, a continuous reduction in new investments, a sharp decline in the interest-bearing debt and long-term debt of polluting enterprises, and a subsequent decline in investment levels and operating performance. Cai Haijing et al. (2019) [1] empirically analyzed the impact of green credit policies on bank loans to "two high" enterprises and the improvement of ecological benefits of these enterprises. It was found that green credit policies resulted in a negative annual growth rate of bank loans to "two high" industry enterprises, and also significantly reduced sulfur dioxide and industrial wastewater emissions in cities covered by the policy. Li Wanchao et al. (2022) [2] found that green credit reduces the financing of non-liquidity liabilities of heavily polluting enterprises, while the scale of alternative financing such as commercial credit increases.

The factors that affect the cost of corporate debt financing can be divided into two categories: internal factors and external factors. Internal factors mainly refer to the company's own conditions, including corporate financial conditions, property rights, and corporate size. Hu Yiming and Xie Shili (2005) [3] found that corporate loan interest rates are positively correlated with asset-liability ratios and negatively correlated with corporate size, operating cash flow, net asset yield, current ratio, and total asset turnover. Dai Guoqiang and Wu Xujun (2006) [4] also found that corporate loan interest rates are significantly affected by debt-paying ability, profitability, management ability, cash flow and other relevant financial indicators. In addition, most scholars use financial indicators such as profitability, asset status, and debt level as control variables when studying the cost of debt financing, and empirical results show that better company performance usually leads to lower financing costs (Jiang Fuxiu and Lu Zhengfei, 2006; Jiang Yan, 2009, etc.) [5,6]. In terms of company size, it is generally believed that large-scale companies have more perfect internal institutional systems and management processes. Therefore, correspondingly, their operational efficiency and capital utilization efficiency are relatively high, and the funds raised from creditors are safer. Therefore, the cost of debt financing is also relatively low.

Existing research has basically confirmed that green credit policies can reduce the cost of corporate debt financing. The impact on short-term debt is greater than on long-term debt, and it inhibits the debt financing scale of high-pollution enterprises. Therefore, this article examines the impact of green credit policies on heavily polluting enterprises from the perspective of corporate debt financing costs. Furthermore, it further examines the asymmetry of green credit policy effects from the perspective of firm heterogeneity, as well as whether corporate social responsibility moderates the implementation of green credit policies. This will improve research in related fields.

5. Conclusion

Firstly, when commercial banks implement green credit policies, they consider a company's green performance as one of the loan approval conditions. For green companies, their loan rates are relatively low, so these companies can raise funds at a lower cost. This indicates that green credit policies can reduce the debt costs of green companies. Secondly, green credit and green bonds have environmental information disclosure requirements for companies. Disclosure of a company's information can reduce information asymmetry between borrowers and lenders, thus helping to reduce the cost of financing. Therefore, green credit policies further affect a

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company's debt cost by requiring environmental information disclosure. In addition, for heavily polluting enterprises, green credit policies may affect their debt financing scale and loan term. For example, the debt financing scale of heavily polluting enterprises may significantly decrease due to the implementation of green credit policies, and the loan term may be shortened. This means that heavily polluting enterprises may need to pay higher debt costs to obtain loans.

Policy Proposal

This article concludes through theoretical and empirical analysis that the green credit policy has played a positive role in heavily polluting enterprises, but there are still shortcomings in its implementation. Therefore, suggestions are made from the perspectives of the policy implementation body, the policymakers and regulators, and the policy target groups:

Banks and other financial institutions should continue to comply with the requirements of the green credit policy, strengthen the constraints on debt financing for heavily polluting enterprises, provide credit support for the renovation and pollution control of heavily polluting enterprises, formulate reasonable pricing strategies, and increase credit support for energy-saving and environmental protection enterprises and new green enterprises.

Government departments should strengthen the supervision of green credit policies and improve them. For high-emission areas, environmental supervision should be strengthened, and credit resources should be directed towards green industries, gradually phasing out the "two high" industries to achieve industrial structure optimization and upgrading.

Enterprises in heavily polluting industries should fully understand the concept of policy implementation, namely the concept of green and sustainable development. Enterprises should implement green concepts, enhance their initiative in environmental governance, strengthen their innovation capabilities, stimulate their own innovative environmental protection technologies, and actively carry out transformation and upgrading. For enterprises with weak policy constraints, namely non-state-owned enterprises, small-scale enterprises, and enterprises in high-emission areas, they should adjust their current development direction, actively adapt to the trend of the times, shoulder social responsibilities, and achieve a "win-win" development of environmental benefits and profitability growth.

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