

The Impact of Green Credit Policy on Corporate Risk Taking

Die Feng

School of Economics and Management, Southwest Jiaotong University, Chengdu, China

Email: Fendimm@163.com

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Abstract

In the context of ongoing efforts towards sustainable development, it has become an urgent and significant issue to explore how to better utilize green credit to guide enterprises in green innovation and promote the transition to a green economy. This study considers the original “Green Credit Guidelines” issued by the China Banking Regulatory Commission in 2012 as a quasi-natural experiment. It uses a sample of A-share listed companies in the Shanghai and Shenzhen stock markets from 2005 to 2021. Based on this, a difference-in-differences model is constructed to explore the relationship between green credit policies and corporate risk-taking. Parallel trend tests, propensity score matching, and lagged one-period treatment techniques are then employed to robustly test the empirical results. Furthermore, the study empirically examines the mechanisms through which green credit policies affect corporate risk-taking. Regression analyses are conducted by grouping companies based on ownership nature, scale, and life cycle to validate the differences in the impact of green credit policies on corporate risk-taking among different types of enterprises. Finally, two moderating variables, namely environmental regulations and heterogeneity in executive education, are introduced to empirically test the regulatory effects of green credit policies on corporate risk-taking.

Keywords

Green Credit Policy, Corporate Risk-Taking, Financing Constraints, Agency Costs

1. Introduction

With the rapid development of the Chinese economy, China is facing a series of problems such as excessive resource consumption and severe environmental

pollution. Although the government has issued various environmental regulations, it has not fundamentally changed the high energy consumption and pollution characteristics brought about by economic development. The country has explicitly proposed the construction of a market-oriented green technology innovation system as the foundation, while developing green finance to facilitate the scaled and intensified development of energy-saving and environmental protection industries, clean production industries, and clean energy industries. At the same time, specific requirements for accelerating green and low-carbon development have been outlined, with a goal of widespread adoption of green production and lifestyles before 2035. To achieve fundamental improvement in the ecological environment, besides relying on stronger end-of-pipe governance measures, it is also necessary to utilize financial tools to change the incentive mechanisms for resource allocation.

In the modern economic system, finance plays an indispensable role, and the green transformation of the economy relies on the support of the financial system. In recent years, China has made significant progress in the field of green finance. The government has introduced a series of policies and measures to support and guide the development of green lending, encouraging financial institutions to increase funding for sustainable development projects. According to statistics from China International Capital Corporation (CICC) in 2021, the scale of green financing in China has continued to grow. By the end of 2020, the total scale of green finance reached 13 trillion yuan, with green loans accounting for over 90% of the total scale of green financing (Wang et al., 2021b). Green loans, as the main policy tool of green finance, hold significant importance in achieving sustainable development and promoting green transformation. They are conducive to driving the economy towards environmental protection and low-carbon orientation, promoting the development of green industries, and ensuring economic sustainability.

On July 12, 2007, the government issued the Opinions on Implementing Environmental Protection Policies and Regulations to Prevent Credit Risks which required financial institutions to strengthen cooperation in environmental protection and credit management, strictly implement regulations, and effectively prevent risks. The release of these opinions marked the beginning of green lending policies. On February 24, 2012, the former China Banking Regulatory Commission issued the Green Credit Guidelines providing more reference for banks' green lending and offering specific and actionable guidelines for financial institutions to promote the green transformation of traditional industries and build a low-carbon circular industrial structure. Green finance, as an important policy tool for environmental governance, not only has the characteristics of environmental regulation but also enables resource allocation within the financial sector. Vigorous development of green finance can reduce credit allocation in industries and have a positive impact on the development of localities and enterprises. It accelerates the transformation of production methods and achieves

industrial structural upgrading (Wang et al., 2019; Dong et al., 2020). Green credit policies integrate financial institutions with the goals of the real economy, stimulating the promotion of green lending through incentive measures. This policy also effectively guides the allocation of bank credit funds, plays a role in environmental governance, and holds significant importance in promoting sustainable development (Wang & Wang, 2021).

Risk-taking, as a crucial aspect of corporate investment decisions, not only stimulates innovation but also promotes the effective accumulation of social capital, enhancing social productivity. In China, the development of green enterprises has been constrained by limitations in funding and market constraints. Their financing and investment needs have not been adequately met, and they struggle to access sufficient resources in the capital market. As a result, the risk-taking levels of green enterprises are generally low. For green credit policies, their objectives go beyond internalizing environmental costs to weaken the expansion capacity of highly polluting and energy-intensive industries. They aim to foster the flourishing development of green industries by guiding credit funds. However, there has been relatively little research conducted on whether green credit policies can promote the development of green enterprises and enhance their risk-taking levels. In light of this, this paper aims to explore whether green credit policies can contribute to the enhancement of enterprise risk-taking levels.

Based on the above analysis, this study treats the Green Credit Guidelines issued by the China Banking Regulatory Commission in 2012 as a quasi-natural experiment. Using 2005-2021 data from listed companies on the Shanghai and Shenzhen stock exchanges in China, an econometric model is constructed to empirically examine the impact and mechanisms of green credit policies on enterprise risk-taking. The results demonstrate a significant promoting effect of green credit policies on enterprise risk-taking. Mitigating financing constraints and reducing agency costs are identified as important mechanism through which green credit policies influence the risk-taking of green enterprises. Heterogeneity tests indicate that this promoting effect is more pronounced in small-sized enterprises, firms in the growth and maturity stages, and private enterprises. The mechanism analysis shows that environmental regulations and managerial characteristics play a moderating role in the process of green credit policies influencing the risk-taking of green enterprises. Increasing environmental regulatory intensity and higher heterogeneity in managerial educational backgrounds significantly enhance the risk-taking incentive effects of green credit policies.

Compared to the existing literature, this study contributes in the following aspects.

To begin with, it offers a novel research perspective. Existing literature highlights the role of green credit policies in enhancing firm productivity, promoting innovation, and so on. However, there is a lack of detailed exploration on the relationship between green credit policies and enterprise risk-taking. This study fills this gap by focusing on examining the impact of green credit policies on en-

enterprise risk-taking.

Secondly, in terms of research design, this study overcomes the broadness issue in identifying green firms. The research design of this study incorporates criteria for identifying green firms at the operational and project levels, instead of solely relying on simple industry categorization. This improvement helps overcome the vagueness issue in the process of identifying green firms, thus enhancing the accuracy and credibility of the research.

Finally, this study combines macro- and micro-perspectives in its research content. Investigating the mechanisms through which green credit policies influence firm behavior contributes to a better understanding of this field. It provides empirical evidence for macro policymakers and facilitates the effective linkage between macro policies and micro entities. As a result, it enriches the research on the impact of green credit policies on microeconomic behavior.

2. Literature Review and Hypotheses Development

Green credit policy is implemented to encourage companies to invest in and engage in business activities in the environmental protection and sustainable development sectors. This paper will conduct a literature review from three perspectives: green credit policy, corporate risk-taking, and the impact of green credit policy on corporate risk-taking. The aim is to understand how green credit policy affects the level of risk for companies.

2.1. Green Credit Policies and Enterprise Risk-Taking Level

Enterprise risk-taking, as an important component of the investment decision-making process, plays a crucial role in driving innovation within companies and actively contributes to the accumulation of social capital and the enhancement of productivity. However, due to issues such as financing constraints and agency costs, businesses often struggle to access sufficient resources from the capital market. With the implementation of green credit policies, these constraints and costs are expected to be alleviated, thereby enhancing the level of risk-taking by enterprises.

In defining green credit policies, emphasis has been placed on the innovative use of financial tools by the government for environmental governance. By incentivizing companies to invest in green technologies and promoting the development of green finance by financial institutions, the goals of sustainable development and environmental protection are promoted (An et al., 2021). When companies excel in environmental information disclosure and environmental risk management, they are more likely to attract external financing (Sharfman & Femando, 2008).

Green credit policies aim to channel funds towards energy-saving and environmentally friendly enterprises engaged in green production activities. They encourage companies to take proactive actions in energy conservation, environmental protection, and sustainable development, thereby achieving the dual

objectives of environmental protection and economic development (Ding et al., 2020). In the investment decision-making process, companies need to consider the resources on which risk-taking behavior relies, which is essential for both start-ups and mature enterprises in their risk investment strategies. Green credit policies can leverage resource effects to meet the resource needs of companies, thereby promoting an increase in the level of enterprise risk-taking (Huang & Huang, 2018).

With the increasing willingness of banks to provide credit to green enterprises, the financing difficulties that green enterprises often faced in the past have been alleviated, and more credit resources are flowing into the green sector. The level of risk-taking by green enterprises has also correspondingly increased, prompting them to be more innovative and competitive in the green economy (Si & Cao, 2022). Green enterprises often worry about inadequate risk-bearing capacity in the event of project failure, but with the changing attitudes of financial institutions and the increasing tolerance for green investment behaviors, this issue has been greatly mitigated (Sun et al., 2019).

Based on the above analysis, the research hypothesis is proposed in this study as follows.

H1: Green credit policies significantly enhance the level of risk-taking by enterprises.

2.2. The Mechanism of Green Credit Policy to Enhance the Level of Corporate Risk Taking

On one hand, the implementation of green credit policies effectively alleviates the financing constraints faced by enterprises. The increased availability of resources enhances the willingness of businesses to undertake risks in investment activities. On the other hand, the implementation of green credit policies brings about a transformation in the internal governance model of companies. It achieves transparency of information and processes within the enterprises while strengthening external market supervision. This, in turn, mitigates internal agency conflicts and creates a favorable environment for enhancing the level of enterprise risk-taking.

The mechanism through which green credit policies enhance the level of risk-taking by enterprises is as follows. The contradiction between the profit-oriented nature of financial investments and the externalities of green development is difficult to balance under traditional credit mechanisms. Due to the long project cycles and high risk associated with green projects, financial institutions tend to avoid green projects when making investment decisions, leading to a prolonged lack of confidence in green credit concepts (Zhou et al., 2021). Green credit policies explicitly require banks to incorporate positive externalities in the allocation of credit resources and consider the performance of green credit business as an important aspect of bank evaluations. From the perspective of addressing financing constraints, credit resources are prioritized for allocation to

green enterprises (Guo & Fang, 2021).

As a result of the implementation of green credit policies, investments and financing activities in high-pollution industries are restricted, diverting more funds to green enterprises (Su & Lian, 2018). The tolerance of banks towards investment risks in the green sector has increased, and they are willing to support green projects, leading to an increased flow of loans into the green industry. This shift enables green enterprises to better address risks and, consequently, enhances their risk-taking capacity (Qiu et al., 2018).

Based on the aforementioned analysis, the following hypothesis is proposed.

H2a: Green credit restrictions alleviate financing constraints in industries, thus increasing the level of risk-taking by enterprises.

Through increasing the transparency of information disclosure, the green credit policy can lower the costs of internal and external information exchange for enterprises, thereby reducing the moral risks associated with agency problems (Balsmeier et al., 2017). Additionally, the Green Credit policy can alleviate over-investment by reducing the agency costs of firms. This effect is particularly significant in state-owned enterprises (Ning et al., 2021).

From the perspective of debt contracts, Green Credit plays a crucial role in credit regulation. As banks have lower costs in obtaining borrower information, they can effectively supervise company managers and utilize agency costs that constrain free cash flows to fulfill their monitoring function (Diamond, 1984; Bai et al., 2019).

The green credit policy can enhance the focus of management on green transformation by establishing relevant laws and regulations, strengthening disclosure requirements for company information, improving information transparency, and reducing information asymmetry. This, in turn, reduces the agency costs borne by managers.

Therefore, the following hypothesis is proposed in this study.

H2b: Green Credit policies restrict industry and reduce agency costs, thus enhancing the level of risk-taking by enterprises.

2.3. The Regulatory Mechanism of the Green Credit Policy in Enhancing the Level of Risk-Taking by Enterprises

From the perspective of green finance, the effectiveness of green credit policies relies on the supportive measures of environmental policies and relevant laws and regulations. In other words, strengthening environmental regulations can effectively enhance the resource allocation efficiency of green credit. Green credit is a more advanced governance approach, and its implementation outcome largely depends on the understanding and compliance of micro-level entities with the policies. Therefore, the educational background or academic experience of corporate executives determines the outcomes of corporate decision-making.

The green credit policy not only has financial attributes but also includes environmental attributes. Therefore, this study focuses on environmental regula-

tion. To fully leverage the role of green finance, it is necessary to have corresponding environmental policies and legal frameworks. Thus, increasing environmental regulation can greatly enhance the resource allocation efficiency of green credit (Yu et al., 2019).

As the intensity of environmental regulation increases in a certain region, pollution-related enterprises will face more restrictions. At the same time, green enterprises, as they comply with environmental regulations and market demands, are expected to gain a larger share of resources and market opportunities. Therefore, environmental regulation and the Green Credit policy can mutually promote and drive the enhancement of green enterprise risk-taking (Li & Xiao, 2020). The Porter Hypothesis suggests that strengthening environmental regulation forces enterprises to seek more environmentally friendly and efficient production methods and technologies (Porter & Van Der Linde, 1995). By offsetting the costs associated with environmental regulation through innovative compensation effects, the competitiveness of enterprises can be improved.

H3a: The stronger the intensity of environmental regulation, the more significant the promoting effect of the Green Credit policy on enterprise risk-taking.

According to the higher-order theory, executives' decision-making behavior is influenced by their cognition. The educational background of executives shapes their knowledge structure, thinking style, and decision-making patterns, thereby affecting their strategic formulation and behavioral performance (Thomas & Simerly, 1995). Si and Cao (2022) suggest that the extent to which executives understand and comply with policies directly influences the implementation effectiveness of green credit. Green credit can only realize its potential when both the company and executives have a clear understanding of the green credit policy and are willing to take corresponding environmental measures and actions. The higher the heterogeneity in executives' educational backgrounds, the more diverse thinking they can provide, forming a broader perspective that fully reflects the advantages of decision-making.

H3b: The higher the heterogeneity in executives' educational backgrounds, the more significant the promoting effect of green credit policy on enterprise risk-taking.

3. Model and Data

3.1. Model and Variables

Based on the research objectives, we constructed the following Difference-in-Differences (DID) model to examine the effect of green credit policy on enterprise risk-taking.

$$\text{Risk}_{it} = \alpha_0 + \alpha_1 \text{Treat}_i \times \text{Policy}_t + \rho X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

where risk represents the level of risk-taking in green innovation by companies. $\text{Treat} \times \text{Policy}$ represents the double-difference variable capturing the impact of green credit policy on the risk-taking behavior of green enterprises. X represents

other control variables that may affect risk-taking behavior. μ and γ are fixed effects at the firm and time levels, respectively. ε represents the random error term. The variables i and t denote the sample companies and time periods, respectively.

1) Dependent variable: Enterprise risk-taking. The dependent variable in this study is the level of enterprise risk-taking. Previous literature has mostly measured risk-taking from the perspective of financial performance, such as measures like asset-liability ratio, stock return volatility, etc. Due to the significant volatility in the Chinese stock market, this study measures risk-taking level using the variability of Return on Assets (Roa). Following the studies by (John et al., 2008; Yu et al., 2013), Roa is calculated as earnings before interest and taxes (EBIT) divided by total assets (ASSET) at the end of the year.

First, we need to calculate the adjusted Roa for each company, which involves subtracting the industry-average Roa for the respective year. Then, we observe the adjusted Roa for three consecutive years and calculate its standard deviation (Risk 1) and range (Risk 2) to evaluate and compare the company's risk level over this period.

The specific calculation method is as follows:

$$\text{Adj_Roa}_{it} = \frac{\text{EBIT}_{it}}{\text{ASSET}_{it}} - \frac{1}{X} \sum_{k=1}^x \frac{\text{EBIT}_{it}}{\text{ASSET}_{it}} \quad (2)$$

$$\text{Risk1}_{it} = \sqrt{\frac{1}{T-1} \sum_{t=1}^T \left(\text{Adj_Roa}_{it} - \frac{1}{T} \sum_{t=1}^T \text{Adj_Roa}_{it} \right)^2} / T = 3 \quad (3)$$

$$\text{Risk2}_{it} = \text{MAX}(\text{Adj_Roa}_{it}) - \text{MIN}(\text{Adj_Roa}_{it}) \quad (4)$$

2) Key explanatory variable: Treat \times policy. The crucial explanatory variable in Model (1) is treat \times policy, which represents the interaction between industry attribute (treat) and green credit policy (policy). Since the Green Credit Guidelines were implemented on February 24, 2012, the policy dummy variable takes the value of 0 before 2012 and 1 in 2012 and onwards. According to the provisions of the Green Credit Guidelines, enterprises are classified into different levels of environmental and social risk, with class A indicating higher environmental and social risk. In this study, a comparison is made between companies in different industries and class A enterprises to determine whether they fall under the category of industries subjected to green credit restrictions.

3) Control variables. Based on previous research, this study incorporates the control variables as follows.

- a) Size: It is defined as the natural logarithm of the total asset size of the firm.
- b) Roa: It is defined as the ratio of net profit to total assets of the firm.
- c) Lev: It is defined as the ratio of total liabilities to total assets of the firm.
- d) Cashflow: It is defined as the ratio of net cash flow from operating activities to total assets of the firm.
- e) Top1: It is defined as the ownership percentage of the largest shareholder.
- f) Age: It is defined as the difference between the research year and the year of firm establishment.

3.2. Sample and Data

This study uses A-shares listed companies in the Shanghai and Shenzhen stock markets as the original sample from 2005 to 2021. The year 2021 is set as the cutoff point for the sample period. By analyzing the most recent and comprehensive data samples, this study aims to provide more favorable evidence for further optimizing green credit policies, thereby ensuring the smooth implementation of these policies. Based on this, an experimental group and a control group are constructed following the principles of the difference-in-differences model.

When selecting environmental protection companies, the study adheres to the “Guidance Catalog for Green Industries” jointly issued by seven ministries in 2019. Companies primarily engaged in energy conservation and environmental protection, clean production, clean energy, ecological environment, green infrastructure upgrades, and green services are included in the experimental group. For the selection of high-polluting companies, the study refers to the industry classification guidelines revised by the China Securities Regulatory Commission in 2012. Companies involved in 16 major polluting industries such as steel, thermal power, and cement are included in the control group.

Data on listed companies mainly come from the Wind database, Guotai An database, and companies’ disclosed annual reports. The following criteria are applied to process the research sample: 1) Exclusion of financial insurance industry; 2) Exclusion of samples with severe missing or abnormal data; 3) Exclusion of ST and PT companies during the sample period; 4) To eliminate the impact of extreme values, principal continuous variables are subjected to Winsorization at 1%. Ultimately, 37,891 observations are obtained.

4. Empirical Results

4.1. Testing the Parallel Trends Assumption

The validity of the difference-in-differences model depends on the parallel trends assumption between the treatment and control groups and the certainty of the policy timing. The underlying assumption is that in the absence of treatment (such as policy intervention), the trends of both groups would remain parallel before the treatment, and any observed differences can be attributed to the treatment effect. Only when this prerequisite is satisfied can the difference-in-differences model provide reliable results on the policy effect. Therefore, the parallel trends assumption requires that the treatment and control groups have similar trends in factors other than the policy intervention before the policy implementation. To ensure the validity of the parallel trends assumption and the uniqueness of the policy timing, this study conducted the following tests.

The model used for testing the parallel trends assumption is:

$$\text{Risk-taking}_{it} = \alpha_0 + \alpha_1 \sum_{k=-4}^4 \text{treat}_i \times \text{policy}_t + \beta X_{it} + \delta_i + \mu_t + \varepsilon_{it} \quad (5)$$

Based on the research by (Li & Li, 2020) and the practices of mainstream lite-

rature, this study selects the year before policy implementation as the baseline year. By analyzing the regression coefficients of the pre-policy years, we can determine whether the treatment group and control group meet the parallel trends assumption. Based on the observation of **Figure 1**, the following conclusions can be drawn. In the parallel trend test, it is observed that the coefficients of the before1 to before4 periods during the pre-implementation period fluctuate around 0, and the 95% confidence interval of these coefficients includes 0. This indicates that the coefficient is not statistically significant, which confirms the parallel trend inferences. This means that before policy implementation, the treatment group and control group had similar evolving trends in relevant factors without significant differences. However, in the years after policy implementation, the regression coefficient of the $treat \times policy$ is significantly greater than zero, indicating a significant difference in performance between the treatment and control groups after policy implementation. This further supports the validity of the parallel trends assumption in the difference-in-differences model. In other words, after policy implementation, the treatment group shows changes related to the treatment, while the control group's performance changes less. Therefore, based on the results of **Figure 1**, it can be concluded that the difference-in-differences model satisfies the parallel trends assumption.

4.2. Descriptive Statistics

Table 1 reports the descriptive statistics of the variables. According to **Table 1**, the average value of the variable "Risk1," which represents the level of risk undertaken by the firms, is 0.0375. The maximum value is 0.429, and the minimum value is 0.001. These results are consistent with the statistical findings in existing

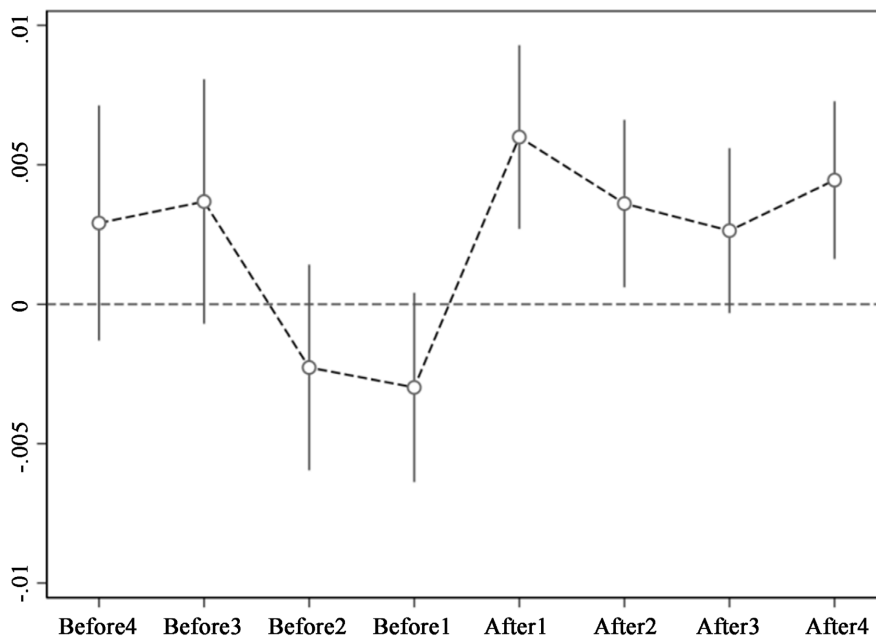


Figure 1. Parallel trend test results.

Table 1. Descriptive statistics for key variables.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Med.
<i>Risk1</i>	37,891	0.0331	0.0375	0.0001	0.429	0.0210
<i>Risk2</i>	37,891	0.0625	0.0698	0.0002	0.848	0.0400
<i>Treat</i>	37,891	0.7818	0.4129	0	1	1
<i>Policy</i>	37,891	0.7526	0.4314	0	1	1
<i>Insize</i>	37,891	7.632	1.253	4.564	11.06	7.566
<i>FirmAge</i>	37,891	2.808	0.381	1.609	3.497	2.833
<i>Lev</i>	37,891	0.427	0.205	0.0514	0.886	0.423
<i>ROA</i>	37,891	0.0441	0.0621	-0.209	0.221	0.0414
<i>Cashflow</i>	37,891	0.0490	0.0698	-0.158	0.246	0.0480
<i>Top1</i>	37,891	0.351	0.150	0.0881	0.745	0.331

literature, indicating that significant differences in the level of risk undertaken by different firms still exist.

4.3. Baseline Regression Results

To verify the impact of green credit policy on firm risk-taking, this study adopts the Difference-in-Differences (DID) method, starting from the quasi-natural experiment of the “Green Credit Guidelines,” and conducts a multiple regression analysis based on Model (1). The results in **Table 2** indicate that the coefficient of the core explanatory variable, $treat \times policy$, is significantly positive at the 1% level, with coefficients of 0.0019 for firm risk-taking (*Risk1*) and 0.0035 for firm risk-taking (*Risk2*). This suggests that the implementation of the green credit policy can significantly increase the level of risk-taking for green enterprises.

4.4. Robustness Tests

We conducted three types of robustness tests. To begin with, we included city fixed effects. Adding city fixed effects helps to more accurately identify the impact of other variables on the phenomenon under study and reduces endogeneity issues caused by city-specific unobservable factors.

Secondly, we implemented a lagged one-period treatment. Policy implementation takes time to generate effects, or the treatment group needs time to adapt and respond to the policy. Therefore, in this study, we lagged the explanatory variables by one period and regressed the lagged data.

Finally, we performed a Propensity Score Matching with Difference-in-Differences (PSM-DID) test. Following the matching approach of (Wang et al., 2021a), we used propensity scores and controlled variables as covariates to match individuals between the treatment and control groups in a 1:1 nearest neighbor manner, aiming to reduce bias caused by treatment selection (**Table 3**).

Table 2. Green credit policies and corporate risk-taking.

	(1) Risk1	(2) Risk1	(3) Risk2	(4) Risk2
Treat × policy	0.00187*** (3.3014)	0.00194*** (3.4375)	0.00343*** (3.2324)	0.00353*** (3.3471)
Insize		-0.00462*** (-24.4767)		-0.00865*** (-24.6613)
FirmAge		-0.00372*** (-6.3678)		-0.00688*** (-6.3084)
Lev		-0.0156*** (-10.3689)		-0.0288*** (-10.3122)
ROA		-0.171*** (-25.5490)		-0.315*** (-25.4503)
Cashflow		0.0383*** (10.6971)		0.0708*** (10.6665)
Top1		-0.00882*** (-7.0141)		-0.0162*** (-6.9269)
_cons	0.0320*** (86.0989)	0.0931*** (43.7873)	0.0604*** (87.0866)	0.174*** (44.0043)
N	37891	37891	37891	37891
R ²	0.0474	0.141	0.0480	0.141
idindustry	yes	yes	yes	yes
year	yes	yes	yes	yes
F	10.90	282.5	10.45	284.8

Note: *, **, *** represent statistical significance at the level of less than 10%, 5%, and 1%, respectively.

Table 3. Robustness check.

Variable	City fixed effects		One-period Lagged Processing		PSM + DID	
	Risk1	Risk2	Risk1	Risk2	Risk1	Risk2
Treat × policy	0.00201*** (3.4046)	0.00368*** (3.3489)			0.00348** (2.2540)	0.00638** (2.2258)
L.DID			0.00225*** (3.9327)	0.00406*** (3.8025)		
N	37840	37840	33649	33649	10964	10964
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & year	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.165	0.165	0.158	0.158	0.427	0.428

4.5. Heterogeneity Analysis

1) Firm size. According to research findings, the majority of studies have found that larger firms tend to have better credit accessibility (Zhang et al., 2013). This phenomenon can be explained by the fact that banks are more inclined to select larger firms when making decisions about credit supply. This is because larger firms often offer greater security and returns to banks. The outcome of this credit supply preference is that smaller firms face financial constraints and are more likely to forego high-risk investment projects when allocating their financial resources. Financial constraints can hinder the expansion and development of small firms, limiting their innovation and market competitiveness. In recent years, the introduction of green credit policies has provided certain opportunities for small green enterprises. These policies encourage banks to increase credit supply to green enterprises, providing more financing opportunities for small enterprises in the green sector.

Table 4 presents the results of the grouped regression. The regression coefficient of the green credit policy is significantly positive for small firms but not significant for large firms. Small firms have more stable resource support, and their risk decision-making capacity is enhanced, making them more influenced by the level of risk undertakings than large firms.

2) Ownership structure of enterprises. When there are differences in the ownership structure of enterprises, the impact of green credit policies on risk-taking behavior may exhibit heterogeneity. In this study, we group the sample firms based on their ownership structure and conduct regression analysis. **Table 5** presents the results of the regression analysis, indicating that the influence of green credit policies on risk-taking behavior is more significant for private enterprises.

Our study finds that state-owned enterprises, due to their special role in fulfilling government functions and maintaining social stability, tend to adopt relatively conservative investment strategies in their decision-making processes. They prioritize risk control and the pursuit of long-term stable returns. In contrast, among private enterprises, a positive correlation is observed between green credit policies and risk-taking behavior. These policies not only fulfill the funding

Table 4. Group regression results based on firm size.

Variable	Small firms		Large firms	
	Risk1	Risk2	Risk1	Risk2
<i>Treat × policy</i>	0.00360*** (3.9127)	0.00660*** (3.8472)	0.000714 (1.0720)	0.00127 (1.0149)
Controls	Yes	Yes	Yes	Yes
Industry & year	Yes	Yes	Yes	Yes
R-squared	0.148	0.147	0.0919	0.0922

and information needs of private enterprises but also provide better conditions and support for exploring high-risk, high-reward investments. The management of private enterprises is more willing to actively take on risks to maximize enterprise value and achieve long-term sustainable development. This relationship further emphasizes the importance and positive impact of green credit policies in private enterprises.

3) Enterprise life cycle. The level of risk-taking varies across the life cycle of an enterprise. For example, growth stage enterprises often require large amounts of capital for business expansion, and obtaining these funds is not easy. Due to the limitations and requirements of these financing sources, growth stage firms are often under financing pressure. In this case, the management prefers to choose relatively stable and low-risk investment projects, so the enterprise's risk-taking ability is weaker. And the green credit policy can broaden the financing channels of growth stage enterprises, which has a significant contributing effect on enhancing the risk-bearing capacity of enterprises.

Table 6 shows the group regression results for different life cycles of enterprises. The results show that green credit policy can significantly enhance the risk-taking level of enterprises in the growth and maturity periods. This is because the green credit policy provides enterprises in the growth and maturity periods with various opportunities, including diversified sources of funding, better risk management capabilities, and faster market response. These factors significantly

Table 5. Group regression results based on the nature of property rights.

Variable	Private-owned company		State-owned Company	
	Risk1	Risk2	Risk1	Risk2
<i>Treat × policy</i>	0.00352*** (4.6444)	0.00654*** (4.6287)	-0.00125 (-1.5170)	-0.00251 (-1.6183)
Controls	Yes	Yes	Yes	Yes
Industry & year	Yes	Yes	Yes	Yes
R-squared	0.148	0.147	0.132	0.133

Table 6. Group regression results based on firm life cycle.

Variable	Growth stage		Maturity stage		Decline stage	
	Risk1	Risk2	Risk1	Risk2	Risk1	Risk2
<i>Treat × policy</i>	0.00323*** (3.7037)	0.00594*** (3.6502)	0.00200** (2.1257)	0.00358** (2.0421)	-0.000837 (-0.6255)	-0.000934 (1.0149)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry & year	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.238	0.239	0.186	0.193	0.0855	0.0944

increase the level of risk-taking by enterprises and enable them to better respond to competitive pressures.

5. Analysis of Moderation Mechanisms

The previous section characterized and interpreted the relationship between “green credit policies” and “enterprise risk-taking” in terms of overall relationship and heterogeneity. Therefore, how does green credit policy affect a firm’s risk-taking level? What are the underlying mechanisms? As mentioned earlier, green credit policies can alleviate firms’ financing constraints, thereby enhancing their risk-bearing capacity. By improving internal information transparency and external supervision, green credit policies can lower agency costs and enable firms to better control and manage risks, thus increasing their risk-taking capacity. Based on this, drawing insights from the approach of (Wen & Ye, 2014), we construct the following mediation model to empirically test the specific mechanisms through which green credit policies affect the risk-taking of enterprises.

$$\text{Risk}_{it} = \alpha_0 + \alpha_1 \text{treat}_i \times \text{policy}_t + \sum \alpha_k \text{Controls}_{it} + \Sigma \text{Year} + \Sigma \text{Industry} + \varepsilon_{it} \quad (6)$$

$$\text{Mediator}_{it} = \beta_0 + \beta_1 \text{treat}_i \times \text{policy}_t + \sum \beta_k \text{Controls}_{it} + \Sigma \text{Year} + \Sigma \text{Industry} + \varepsilon_{it} \quad (7)$$

$$\text{Risk}_{it} = \gamma_0 + \gamma_1 \text{treat}_i \times \text{policy}_t + \gamma_2 \text{Mediator}_{it} + \sum \gamma_k \text{Controls}_{it} + \Sigma \text{Year} + \Sigma \text{Industry} + \theta_{it} \quad (8)$$

According to the approach of Ju et al. (2013), this study measures the degree of firms’ financing constraints using the SA index. A higher value of the SA index indicates more severe financing constraints for the firms. Drawing insights from (Liu & Gao, 2015), the total asset turnover ratio is chosen as an indicator to measure agency costs, with higher values of total asset turnover ratio implying lower agency costs for the firms.

5.1. Financing Constraint Perspective

Green credit policy can broaden the financing channels of enterprises, thus alleviating their financing constraints. The results in columns (1) and (2) of **Table 7**

Table 7. Analysis of the mechanism from the perspective of financing constraints.

	Risk1	Risk2	SA	Risk1	Risk2
Treat × policy	0.00194*** (3.4375)	0.00353*** (3.3471)	-0.0185*** (-8.3024)		
SA				0.00153*** (2.6993)	0.00275** (2.6059)
Controls	Yes	Yes	Yes	Yes	Yes
Industry & year	Yes	Yes	Yes	Yes	Yes
R-squared	0.141	0.143	0.803	0.145	0.147

show that green credit policy can significantly promote the level of corporate risk-taking. The regression results in column (3) show that the regression coefficient of green credit policy on financing constraints is significantly negative at the 1% level, indicating that green credit reduces the financing constraints of enterprises.

The results in columns (4) and (5) show that the regression coefficient of the $\text{treat} \times \text{policy}$ is still significantly positive after adding the mediating variable of financing constraints, indicating the existence of the mediating effect of the green credit policy to enhance the risk-taking of green enterprises by reducing the financing constraints of enterprises.

5.2. Agency Cost Perspective

The implementation of green credit policy strengthens the regulation of the external market and makes the business process of enterprises more transparent, which can enhance the risk-taking level of enterprises by reducing the agency cost of enterprises and then enhance the risk-taking level of enterprises. The results in columns (1) and (2) of **Table 8** show that the regression coefficients of $\text{treat} \times \text{policy}$ are significantly positive, indicating that green credit policy enhances the level of corporate risk taking. Column (3) illustrates that the regression coefficient of green credit policy and firms' agency costs is significantly negative, indicating that the introduction of green credit policy significantly reduces firms' agency costs.

The results in columns (4) and (5) show that the regression coefficients are still significantly positive after adding the mediating variable of agency cost, indicating the existence of the mediating effect of the green credit policy to enhance the risk-taking of green enterprises by reducing the agency cost of enterprises.

6. Analysis of the Moderation Mechanism of Green Credit Policy in Enhancing Firm Risk-Taking

6.1. External Constraint: Environmental Regulations

In theory, stronger environmental regulations lead to a reduction in production

Table 8. Analysis of the mechanism from the perspective of agency costs.

	Risk1	Risk2	AC	Risk1	Risk2
Treat \times policy	0.00194*** (3.4375)	0.00353*** (3.3471)	-0.0426*** (-6.5797)		
AC				0.00184*** (3.2117)	0.00335*** (3.1286)
Controls	Yes	Yes	Yes	Yes	Yes
Industry & year	Yes	Yes	Yes	Yes	Yes
R-squared	0.141	0.143	0.289	0.138	0.136

scale for polluting firms, and more abundant resources are prioritized for allocation to green enterprises that meet environmental requirements, encouraging their sustainable development. Therefore, when environmental regulations and green credit policies are implemented simultaneously, they can synergistically promote the development of green enterprises and enhance their risk-taking level. Following the approach of (Liu et al., 2023), this study measures the stringency of regional environmental regulations by the proportion of the amount invested in air and water pollution control to the industrial output value in the same year for listed companies.

The regression results in columns (1) and (2) of **Table 9** show that the coefficient of the interaction term between environmental regulations and green credit policies is positive at a significance level of 5%. This indicates that as the stringency of environmental regulations strengthens, the effect of green credit policy in enhancing the risk-taking level of green enterprises becomes more pronounced.

6.2. Internal Focus: Corporate Managers

Green credit is an advanced governance approach, and its potential effectiveness can only be realized when micro-level entities fully understand the green credit policies. Generally, educational background can to some extent reflect a person's level of capability, and higher-order theories suggest that executives' decision-making processes are influenced by their cognition and values. The regression results in columns (3) and (4) of **Table 9** show that the coefficient of the interaction term between heterogeneity in executive education background and green credit policies is positive at a significance level of 1%. This indicates that

Table 9. Moderation effect testing.

	(1) Risk1	(2) Risk2	(3) Risk1	(4) Risk2
Treat × policy	0.00151** (2.3564)	0.00272** (2.2804)	0.00308*** (2.6152)	0.00592*** (2.6976)
Treat × policy × environmental regulation	0.342** (2.0329)	0.636** (2.0217)		
Treat × policy × educational background			0.00613*** (3.6037)	0.0117*** (3.7126)
Controls	Yes	Yes	Yes	Yes
Industry & year	Yes	Yes	Yes	Yes
Observations	37759	37759	33452	33452
R-squared	0.141	0.141	0.394	0.395

greater heterogeneity in educational background among executives, leading to diverse perspectives, enhances the effectiveness of green credit policy in enhancing the risk-taking level of green enterprises.

7. Conclusion and Policy Recommendations

7.1. Conclusion

This paper regards the Green Credit Guidelines issued in 2012 as a quasi-natural experiment, and constructs an econometric model to empirically test the effect and mechanism of green credit policy on corporate risk-taking with a sample of A-share listed companies in China's Shanghai and Shenzhen cities from 2005 to 2021. The results show that green credit policy has a significant role in promoting corporate risk-taking, and alleviating corporate financing constraints and reducing corporate agency costs are important mechanisms through which green credit policy affects green corporate risk-taking.

The heterogeneity test shows that the promotion effect is more significant in small enterprises, enterprises in the growth and maturity period, and private enterprises. The study of the mechanism of action shows that environmental regulation and executive characteristics have a moderating effect in the process of green credit policy affecting risk taking in green enterprises, and the increase in environmental regulation and the higher the heterogeneity of the educational background of executives, the incentive effect of green credit policy on risk taking will be significantly enhanced.

7.2. Policy Recommendations

1) Develop green credit. The government and financial institutions should further promote the development of green credit by providing favorable credit policies and incentives to attract more funds to the green economy. Green credit policies have been found to have a significant incentivizing effect on the development of green enterprises. Policymakers should leverage the guiding role of green credit policies to further stimulate the innovation vitality of green enterprises. Governments and financial institutions can explore and introduce risk control technologies that are suitable for the green industry to reduce the risks and costs of financing for green enterprises, and to enhance the willingness of banking and financial institutions to provide credit to green enterprises.

2) Coordinate environmental regulations with green credit policies. The incentivizing effect of green credit policies is closely tied to the important support of environmental regulations. When formulating environmental regulatory policies, the government should consider their coordination with green credit policies. This study found that the implementation effect of green credit policies is stronger in regions with stricter environmental regulations and higher heterogeneity in executive education levels. To promote green development and coordinated development, future development of green credit policies should further increase the stringency of command-based environmental regulations. This

means strengthening the supervision and punishment of poorly performing environmental companies, reducing their opportunities to access economic resources. By strengthening environmental regulations, it is possible to effectively restrain non-compliant behavior of companies and incentivize their transformation or exit from the market, thereby driving the entire industry towards green development.

3) Monitor enterprise risks in the implementation of green credit policies. During the execution of green credit policies, it is important to closely monitor the risk situation of enterprises. Especially in the process of economic green transformation, as green credit policies have significant differential effects on different types of enterprises, it is necessary to timely understand the transformation risks faced by enterprises in order to take appropriate measures for risk management and monitoring. In addition to supporting the development of green enterprises, green credit policies should also guide the provision of credit funds to facilitate the orderly transition of high-carbon enterprises. In the process of promoting the economic green transformation, high-carbon enterprises face risks and challenges in their transition and need to gradually reduce carbon emissions and adopt sustainable development strategies. Through reasonable credit support and guidance, high-carbon enterprises can gradually achieve a transition towards low-carbon, promoting sustainable economic development.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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