Study on the Influence of Green Credit Policies on the Investment Efficiency of Heavy Polluters

Zhihan Zhang

School of Honors, Tianjin Foreign Studies University, Tianjin 300000, China

Agar1145@163.com

Abstract. Green finance is an important driving force for green innovation as well as green development in China, and is also one of the important strategies for the current high-quality economic development. In the dual context of building a green financial system and a market-oriented green technological innovation system, this paper takes the implementation of the Green Credit Guidelines in 2012 as an entry point, and uses a two-way fixed double difference model to test and examine the specific effects of the implementation of the Green Credit Guidelines policy on the investment efficiency of heavily polluting enterprises based on panel data of Chinese listed companies in Shanghai and Shenzhen A-shares from 2009 to 2020, and analyze the mediating mechanism of financing cost and debt maturity. It is found that (1) the implementation of the Green Credit Guidelines significantly improves the corporate investment efficiency of heavy polluters; (2) the loan amount and debt maturity play a partially mediating role between the Green Credit Guidelines and the investment efficiency of heavy polluters; and (3) the implementation of the Green Credit Guidelines improves the investment efficiency of heavy polluters in state-owned and non-eastern regions more significantly. The results of the study further emphasize the necessity of implementing green financial policies and the importance of implementing the policies according to local conditions so as to contribute to the high-quality green development of China's economy.

Keywords: Green Credit Policy; Corporate Investment Efficiency; Heavy Polluters; Double Difference Model.

1. Introduction

General Secretary Xi Jinping pointed out in the report of the 20th Party Congress that "we must firmly establish and practice the concept of green water and green mountains is the silver mountain of gold, and plan development at the height of the harmonious coexistence of man and nature." Since the "14th Five-Year Plan" period, China has entered a new stage of development, which has put forward new and higher requirements for implementing the new development concept, building a new development pattern, promoting high-quality development, creating a high-quality life, strengthening the construction of ecological civilization, and accelerating the promotion of green and low-carbon development. In the process of high-quality development, China has realized that green finance can effectively reduce the negative external environmental effects of economic development and is an important policy tool to protect the environment.[1] In 2012, the CBRC issued the "Green Credit Guidelines" (hereinafter referred to as the "Guidelines"), aiming to implement the "Twelfth Five-Year Plan of the State Council" for energy conservation and emission reduction. In 2012, the CBRC issued the Green Credit Guidelines (hereinafter referred to as the Guidelines) to implement the State Council's 12th Five-Year Plan for Energy Conservation and Emission Reduction and other macro-control policies and actively adjust the credit structure. According to the China Local Green Gold Development Report (2022), by the end of 2021, the balance of China's domestic and foreign currency green loans was 15.9 trillion yuan, an increase of 33% year-on-year. The scale of issuance has ranked first in the world. However, whether the green credit policy has played the expected utility or not still needs to be further studied and explored.

Since the external financing of heavy polluting enterprises is mainly credit financing [2],[3]. This led to problems such as high liquidity and low industrial capacity of these enterprises, which in turn led to frequent inefficient investments. However, after the enactment of credit policies and under the restrictions of macro policies, banks will be more stringent in granting loans related to polluting

projects to heavy polluting enterprises, and the financing environment of enterprises and their investment behavior will be further affected. But in this case, will the investment efficiency of heavy polluting enterprises in China be improved due to the implementation of this policy? Therefore, heavy polluting enterprises are used as the research object to observe whether the investment efficiency of enterprises will be affected by the implementation of the Green Credit Guidelines in 2012.

At this point, this paper answers the following two main questions: first, whether the implementation of the Guidelines leads to an increase in the investment efficiency of heavily polluting firms compared to non-heavily polluting firms; second, what are the main ways in which the implementation of the Guidelines affects the investment efficiency of heavily polluting firms. This paper selects listed companies in China's Shanghai and Shenzhen A-shares from 2009 to 2020 as research objects, conducts quasi-natural tests based on the implementation of China's 2012 Guidelines, and uses a double-difference research method to explore the specific ways in which green financial policies work for heavily polluting enterprises.

The remainder of the paper is organized as follows: Part I conducts a review of the relevant literature and proposes research hypotheses; Part II presents the research design and descriptive analysis; Part III explores the impact of the promulgation of the Guidelines on the investment efficiency of enterprises and conducts a series of robustness tests. The fourth part provides an exploratory analysis of how the Guidelines can improve the investment efficiency of heavy polluting enterprises; the fifth part provides a heterogeneity analysis of the specific impacts of the implementation of the Guidelines. Finally, research conclusions and policy recommendations are presented.

2. Literature Review and Research Hypothesis

2.1 The Guidelines and Corporate Investment Efficiency

The rapid development of green finance is an important signal for China to stimulate the development of green economy, indicating the greater demand for green economic growth in China. The government is actively promoting the implementation of the Guidelines, using banks to achieve restrictions on credit financing for enterprises with two high and one surplus, as well as encouraging and supporting green development of enterprises, with a view to promoting green transformation of enterprises and high-quality green development of the country. [4] The existence of financing restrictions makes heavy polluting enterprises have less available funds and are naturally more cautious when facing investment, forcing them to improve their investment efficiency. On the other hand, in order to respond to the national policy and improve the current pollution waste problem of enterprises, heavy polluters choose to reduce or postpone productive pollution investment and strictly manage productive pollution investment. At the same time, the cash flow available for investment by enterprises keeps decreasing, thus reducing the level of total investment and only reverse the efficiency of enterprise investment [5]. Based on the above analysis, hypothesis H1 is proposed that

H1: After the implementation of the Guidelines, the investment efficiency of heavy polluting enterprises has been significantly improved compared with non-heavy polluting enterprises.

2.2 Analysis of the Mediating Mechanism of Action

The promulgation of the Guidelines will implement incentive and constraint measures to ensure the sustainability and effectiveness of green credit. In this process, there is a significant financing penalty for the promulgation of green finance policies, which makes the cost of debt of heavy polluters rise significantly [6]. At the same time, compared with non-heavy polluters, heavy polluters are more likely to be subject to institutional regulation from the state and public opinion from society, which leads to more attention. [7] The excessive attention will lead to stricter constraints for banks to grant loans to heavily polluting enterprises, further reducing the total amount of loans offered to heavily polluting enterprises, resulting in a shrinkage of their available liquidity. In the face of

increased prudence of investment, the efficiency of enterprise investment will theoretically increase as well. Based on the above analysis, hypothesis H2 is proposed.

H2: The Guidelines improve the efficiency of investment in heavy polluters by reducing the amount of loans offered to them.

The Guidelines clearly state that the banking industry can reject credit requests from customers whose behavior is not compliant from an environmental perspective, while vigorously supporting the green and low-carbon economy by choosing to give less long-term credit to enterprises with high pollution, etc., thus achieving a change in the current corporate credit structure. As a result, the banking industry is no longer tilting its resources toward heavy polluters with traditionally high economic effects as in the past. Heavy polluters will be increasingly scrutinized for access to funds and the available funds will be gradually reduced. The agency cost theory emphasizes that the shortening of debt maturity will, to a certain extent, limit the management's abuse of the free cash flow available to the enterprise, prompting people to pay more attention to the efficiency of the use of corporate funds, emphasizing that the use of funds is not "quantity" but "quality", which is conducive to further optimizing corporate governance structures and related performance [8]. With the combination of the two perspectives, the access to credit is dominated by short-term borrowing, and long-term borrowing is decreasing due to the high risk and complexity of the review. This change in the proportion of long-term debt provides an incentive for companies to transform high-quality green development. The partial limitation of available funds brought by this will motivate enterprises to improve their investment efficiency. Based on the above analysis, hypothesis H3 is proposed.

H3: The implementation of the Guidelines has improved the efficiency of heavy polluters' investments by shortening their debt maturity.

2.3 Heterogeneity Analysis

The eastern region mainly includes Beijing, Shanghai, Jiangsu, etc. The level of economic development belongs to the first echelon of China's economic development, and the financial development is more prosperous. The regional financial development will have a specific impact on the implementation of the Guidelines [9], because the financial development in the eastern region is relatively prosperous, and the diversified financing channels for enterprises are not limited to credit financing, but can choose bond financing, etc. The diversification of channels means that the impact of the Guidelines on a single channel of bank credit is likely to be smaller in scope. In contrast, the financial development in the non-eastern part of the country is more backward, and enterprises have difficulty in obtaining other financing channels and have to rely too much on bank credit financing. In the context of the Guidelines, enterprises are bound to be subject to more stringent scrutiny and political constraints in the financing process, making it difficult to allocate financing and reducing the liquidity held by enterprises, which in turn forces them to improve their own corporate investment efficiency. Based on the above analysis, hypothesis H4 is proposed.

H4: Compared with the eastern region, the implementation of the Guidelines on the non-eastern region of the heavy polluters to improve the efficiency of investment more significantly.

Chinese state-owned and private firms have long differed significantly in their access to credit from banks [10]. Since SOEs are underwritten by the government, their risk of collapse or debt default is smaller compared to non-SOEs. As a result, SOEs are subject to significantly better loan restrictions or receive a higher loan amount than non-SOEs under the same risk. Therefore, SOEs have more available liquidity than non-SOEs, which further leads to higher non-investment efficiency of SOEs. However, after the promulgation of the Guidelines, SOEs, as representatives of the government's will and interests, are more politically sensitive than non-SOEs and are subject to stricter regulation. The government's regulation and intervention will increase the difficulty for enterprises to obtain funds, thus achieving a significant disincentive for SOEs to invest in pollution-heavy inefficiency. Based on the above analysis, hypothesis H5 is proposed.

H5: Compared with non-state enterprises, the implementation of the Guidelines on state-owned heavy polluters to improve the efficiency of investment more significantly.

3. Study Design

3.1 Sample Selection and Data Sources

Chinese listed companies in Shanghai and Shenzhen A-shares from 2009 to 2020 are selected as the research sample, with heavy polluters as the experimental group and non-heavy polluters as the control group, and a two-way fixed-effects double difference model is used to explore the relationship between the specific effects of the introduction of the Guidelines on the investment efficiency of heavy polluters. The relevant data were mainly obtained from the Guotaian database.

3.2 Variable Definition

3.2.1 Explained Variables

This paper draws on the expected investment model of firms proposed by Richardson [11], Pan Yue et al.[12] , as follows.

$$Invest_{i,t} = \delta_0 + \delta_1 Growth_{i,t-1} + \delta_2 Cash_{i,t-1} + \delta_3 Age_{i,t-1} + \delta_4 Size_{i,t-1} + \delta_5 Return_{i,t-1} + \delta_6 Invest_{i,t-1} + \sum_t Year_t + \sum_j Indu_j + v_{i,t} \quad (1)$$

The formula for calculating the new investment is as follows

$$Invest_{i,t} = [CAPEX_{i,t} + Aquisition_{i,t} + RD_{i,t} - SalePPE_{i,t} - InvestMaintain_{i,t}]/A_{i,t-1} \quad (2)$$

Table 1. Definition of Corporate Investment Efficiency Variables

Variable Name	Variable Symbols	Variable Definition
Capital expenditure	$CAPEX_{i,t}$	Cash paid for construction of fixed assets, intangible assets and other long-term assets + Net cash paid for acquisition of subsidiaries and other business units
M&A expenses	$Aquisition_{i,t}$	
R&D Expenditure	$RD_{i,t}$	
Gain on liquidation of assets	$SalePPE_{i,t}$	Net cash recovered from disposal of fixed assets, intangible assets and other long-term assets + Net cash received from disposal of subsidiaries and other operating units
Reinvestment	$InvestMaintain_{i,t}$	Depreciation of fixed assets, depreciation of oil and gas assets, depreciation of productive biological assets + amortization of intangible assets + amortization of long-term amortization expenses
Total assets at the beginning of the period	$A_{i,t-1}$	
Growth rate of operating income in the previous period	$Growth_{i,t-1}$	Investment opportunities for representative companies
Cash assets of the previous period	$Cash_{i,t-1}$	
Age of companies in the last issue	$Age_{i,t-1}$	
Asset size in the previous period	$Size_{i,t-1}$	Ln(Total total assets of the previous period + 1)
Annual stock return for the previous period	$Return_{i,t-1}$	
New investments in the previous period	$Invest_{i,t-1}$	
Annual dummy variables	$Year_t$	
Industry dummy variables	$Indu_j$	

The variables of interest are defined as shown in Table 1 below. In this paper, we also follow the idea of Pan Yue et al. and run an OLS regression on the model, and then take the absolute value of the regression residuals, denoted as $ABSINV_{i,t}$, which is used to measure the degree of investment inefficiency of the firm. The larger the absolute value, the less efficient the firm's investment is.

3.2.2 Explanatory Variables

This paper draws on the methods of several scholars, including Yang Liuyong, Zhang, Zeye [13], Zhang Jinsong, Lu Shanshan [14], and Yu Bo. The selection of $Treat * Post$ as the explanatory variables. Where $Treat_i$ indicates whether the firm i is a heavy industry or not $Treat_i$. This paper sets heavy polluting enterprises according to the Notice on the Issuance of <List of Listed Industries for Environmental Verification and Management> issued in 2008, and takes the value of 1 if it is a green credit restricted enterprise, otherwise it takes the value of 0. $Post_t$ is a dummy variable for the implementation time of the Guidelines. This paper delineates the time range around the implementation of the policy based on the announcement of the Guidelines in February 2012. The period of 2012-2020, i.e., after the implementation of the policy, is chosen as the experimental group and $Post$ takes the value of 1. And when$t$ belongs to 2009-2011, i.e., before the implementation of the policy, as the control group, its value is 0.

3.2.3 Control Variables

Drawing on most of the literature research practices, the control variables as shown in Table 2, with specific symbols and definitions are shown below.

3.2.4 Mediating Variables

Referring to Chen, Xingxing. et al. [15] and Wang Kangshi.[16], the loan amount (Credit), debt maturity (Term) as mediating variables, which are defined as shown in Table 2.

Table 2. Variable Definition Table

Variable Type	Variable Name	Variable Symbols	Variable Definition
Explained variables	Corporate Investment Efficiency	ABSINV	The absolute value of the expected investment model regression residuals according to equation (1)
Explanatory variables	Whether it is a heavy polluter	Treat	Heavy pollution enterprises, take the value of 1, for the experimental group; otherwise take the value of 0, for the control group
	Green Credit Guidelines	Post	In 2012 and later, the value is 1; before 2012, the value is 0
Intermediate variables	Loan amount	Credit	(Short-term borrowings + long-term borrowings)/total assets
	Debt term	Term	Long-term debt/total debt
Control variables	Company Size	Size	Ln (total annual assets)
	Gearing ratio	Lev	Total liabilities at the end of the year / Total assets at the end of the year
	Net profit margin on total assets	ROA	Net income / average balance of total assets
	Return on Net Assets	ROE	Net income/average balance of shareholders' equity
	Cash Flow Ratio	Cashflow	Net cash flow from operating activities / operating income
	Operating income growth rate	Growth	Operating income for the year / Operating income for the previous year - 1
	Number of Directors	Board	Ln (number of directors board of directors)
	Two jobs in one	Dual	The chairman and general manager are the same as 1, otherwise 0
	Percentage of shareholding of the largest shareholder	Top1	Number of shares held by the largest shareholder / total number of shares
	Shareholding ratio of top ten shareholders	Top10	Number of shares held by the top ten shareholders/total number of shares

	Shareholding checks and balances	Balance	The sum of the shareholdings of the second to fifth largest shareholders / the shareholding of the first largest shareholder
	Tobin's Q value	TobinQ	(Market value of outstanding shares + number of non-marketable shares × net assets per share + book value of liabilities)/total assets
	Shareholding of institutional investors	INST	Total number of shares held by institutional investors / outstanding share capital
	Percentage of major shareholders' funds	Occupy	(Other receivables - other payables)/total assets

3.3 Model Setting

This paper is used to analyze the impact of the Guidelines on the investment efficiency of heavy polluters by constructing a two-way fixed double difference model to alleviate the problems of endogeneity and omitted variables. The details are as follows.

$$ABSINV_{i,t} = \alpha + \beta_1 Treat_{i,t} \times Post_{i,t} + \beta_2 \sum Controls_{i,t} + \gamma_i + \mu_t + \varepsilon_{i,t} \quad (3)$$

where the subscript $i$represents the enterprise, and $t$represents the year.The specific definitions of $ABSINV, Treat$ and $Post$ are shown in Table 2 above, the $Controls$ denotes a set of control variables, the γ denotes firm fixed effects, μ is the year fixed effect, and ε is the random disturbance term. When controlling for both individual firm fixed effects and year fixed effects, to avoid multicollinearity, the model no longer includes $Treat$ and $Post$.

4. Empirical Analysis Design

4.1 Descriptive Statistics

Table 3. Descriptive Analysis of Main Variables

Variable	N	Mean	p50	SD	Min	Max
ABSINV	13800	0.0390	0.0230	0.0590	0	1.087
Treat	13800	0.256	0	0.436	0	1
Post	13800	0.750	1	0.433	0	1
Treat*Post	13800	0.192	0	0.394	0	1
Size	13800	22.49	22.37	1.457	16.52	28.64
Lev	13800	0.519	0.513	0.301	0.00700	12.13
ROA	13800	0.0320	0.0300	0.0920	-1.683	3.589
ROE	13800	0.0460	0.0670	0.622	-60.15	8.715
Cashflow	13800	-0.0970	0.0740	15.26	-1757	17.00
Growth	13800	10.27	0.0790	1146	-1	134607
Board	13800	8.978	9	1.822	3	18
Dual	13800	0.158	0	0.365	-0.577	1.347
Top1	13800	34.88	32.80	15.03	3.620	89.99
Top10	13800	53.79	53.57	15.33	10.37	98.58
Balance	13800	0.579	0.405	0.542	-0.00400	3.695
TobinQ	13800	2.188	1.563	3.672	-97.21	127.0
INST	13800	51.36	51.99	19.32	-12.03	98.68
Occupy	13800	-0.0340	-0.0140	0.174	-9.984	0.702
Credit	13800	0.193	0.172	0.150	-0.273	3.539
Term	13800	0.191	0.149	0.186	-0.842	1.233

Table 3 shows the results of descriptive analysis of the main variables. Among them, the mean and standard deviation of enterprise investment efficiency ($ABSINV$) have means and standard deviations of 0.256 and 0.059, respectively, indicating that there are large differences in the investment efficiency of different enterprises. The mean value of green credit guidelines ($Post$) has a mean value of 0.750, indicating that 75% of the sample after the introduction of the Green Credit Guidelines; the mean value of whether or not they are heavily polluting enterprises is 0.256, indicating that 25.6% of the sample are heavily polluting enterprises (i.e., the treatment group). While the main variable of interest in this study $Treat * Post$ of this study has a mean value of 0.192, indicating that 19.2% of the heavily polluting enterprises will have affected their investment efficiency after the release of the guidelines. The intermediary variable loan amount ($Credit$) has a mean value of 0.193, a maximum value of 3.539, and a minimum value of -0.273, with a large difference between them, which indicates that the loan amount varies widely among enterprises (the negative number is due to the fact that some enterprises combine the accounts receivable account with the accounts payable account); the debt maturity ($Term$) means and standard deviations are 0.191 and 0.186, respectively, which indicates that the debt maturity varies widely across enterprises. The control variables are all within reasonable intervals.

4.2 Baseline Regression Analysis

Table 4. Baseline regression analysis

Variables	Corporate Investment Efficiency (ABSINV)			
	(1)	(2)	(3)	(4)
Treat*Post	-0.006***	-0.004***	-0.009***	-0.007***
	(0.001)	(0.001)	(0.003)	(0.002)
Constant	0.040***	0.079***	0.047***	-0.220***
	(0.001)	(0.014)	(0.002)	(0.023)
Controls	No	Yes	No	Yes
Firm FE	No	No	Yes	Yes
Year FE	No	No	Yes	Yes
N	13800	13800	13800	13800
R^2_adj				

Note: Robust standard errors for clustering to the industry are in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.01. Same below.

The results of the benchmark regression of the impact of the implementation of the Guidelines on the investment efficiency of heavily polluting firms are shown in Table 4 below. Columns (1)-(4) gradually control for firm and year fixed effects, columns (2) and (4) include control variables, while columns (1) and (3) do not include control variables. The core explanatory variables in the table. The $Treat * Post$ coefficients of the core explanatory variables in the table are significantly negative, and the stepwise controls do not cause significant changes in the coefficients, and the results are somewhat robust. This indicates that the implementation of the Guidelines can improve the investment efficiency of enterprises. The results are analyzed for column (4), and after adding control variables and firm and year fixed effects, the regression coefficient of $Treat * Post$ is significantly negative at 1% confidence level, indicating that the implementation of the policy leads to an increase in investment efficiency of heavily polluting enterprises compared to non-heavily polluting enterprises, with an average increase of 0.7%. The implementation of the policy has a significant impact on enhancing the investment efficiency of enterprises, which verifies the research hypothesis

H1. In the following tests of the mechanism of action, the specific mediating mechanism of action will be analyzed from two perspectives: loan amount and debt maturity.

4.3 Parallel Trend Test

The effective estimation of the double difference is based on the premise that the experimental and control groups satisfy the parallel trend assumption [17], i.e., the trends of the experimental and control groups are consistent when the policy is not implemented. To test this hypothesis, the annual dynamic impact of green credit policy on the investment efficiency of heavy polluters is analyzed by referring to the idea of Lu Shengfeng. et al [18]. The year 2012 was chosen as the base year and a dummy variable was created for each year of the sample interval [19]. The results show that before the implementation of the Guidelines in 2012, the regression results are close to 0 and insignificant, and after the implementation of the policy, the treatment groups all show a significant downward trend, which verifies the results of the base regression. In addition, the coefficient is significantly negative since 2015, indicating that the policy has a certain lag in improving the efficiency of corporate investment. The above results indicate that the trends of the experimental and control groups are consistent until 2012. The following figure reflects the results of the parallel trend test of the double difference model in this paper.

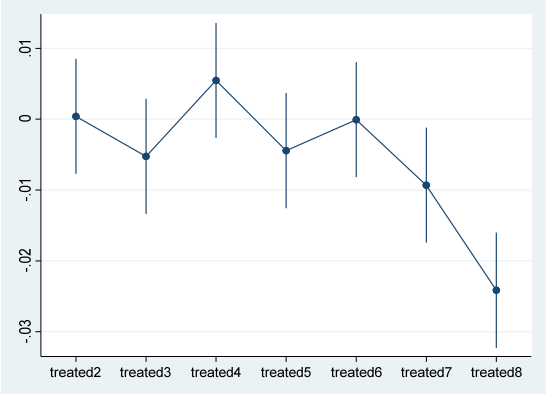


Fig 1. Parallel Trend Test

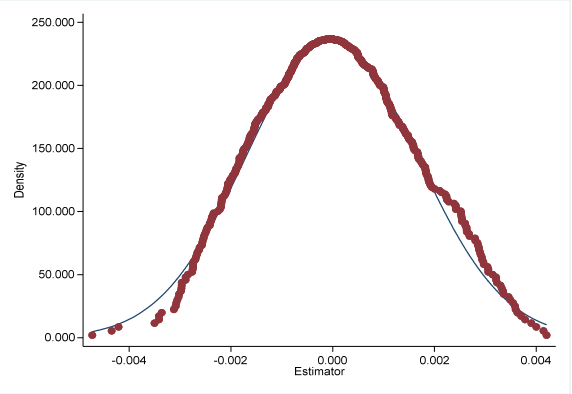


Fig 2. Placebo Test

4.4 Placebo Test

In order to exclude the interference of unobservable omitted variables on the study findings, this paper identifies the impact of the introduction of the Guidelines on the investment efficiency of the experimental group of heavily polluting firms through a placebo test. Specifically, this paper randomly assigns the experimental group in the full sample through self-help sampling and assumes that these firms are affected by the Guidelines, with the remaining firms treated as a control group, indicating that they are not affected by the policy. In this paper, the above process is repeated 500 times to plot the scatter distribution of the probability density of the coefficient estimates. The results of the placebo test show that the estimates of random assignment are concentrated around 0 and insignificant at the 1% confidence level. This indicates that there are no serious unobservable omitted variables in the model, further suggesting that the baseline regression results in the previous paper are reliable.

4.5 Robustness Tests

4.5.1 Propensity Score Matching Test

Referring to Yang Liuyong & Zhang Zeyo, Yu Lianchao et al. and others, in order to avoid the problems caused by sample selection bias, this paper chooses $PSM-DID$ method for robustness testing. Specifically, based on the nearest neighbor matching method using $Logit$ estimating propensity matching scores, the control variables which were $Lev, ROE, Cashflow, GrowthBoard, Top1, Top10, Balance, TobinQ, INST$ and $Occupy$ were selected as covariates

[20]. On this basis, the matched data were re-regressed, and Table 5 below shows the results of the re-regression of the matched samples. It can be seen from the$Treat$ with$Post$ The regression coefficient of the interaction term is significant at the 1% confidence level, which is consistent with the results of the benchmark regression above and verifies the robustness of the model.

4.5.2 Lagged One-period Regression

Referring to Chen Zhibin, Wang Shiyu [21], the data of the explanatory and control variables lagged one period were rerun with the above regression to eliminate endogeneity, and the coefficients and significance of the core explanatory variables did not change significantly, so the test model results were considered to remain robust. The specific regression results are reported as follows:

Table 5. Robustness Tests

Variables	Corporate Investment Efficiency	
	PSM-DID	One period behind
	(1)	(2)
Treated*Post	-0.007***	
	-0.002	
L.Treated*Post		-0.011***
		-0.003
Controls	Yes	Yes
L. Control variables	Yes	Yes
Firm FE	Yes	Yes
Year FE	Yes	Yes
N	12650	13774
R^2_adj	-0.04	-0.017

5. Mechanism of Action Test

The above benchmark regressions illustrate the role of green credit policies on firms' investment efficiency, but do not specifically discuss the mechanisms by which this impact works. Therefore, in this section, the mechanism of change of this impact is specifically explored.

Referring to Baron, Kenny [22], Qian Xuesong. cted [23] to analyze the possible mediating effects in terms of both loan amount and debt maturity, and the model is set as follows.

$$ABSINV_{i,t} = \alpha + \beta_1 Treat_{i,t} \times Post_{i,t} + \beta_2 \sum Controls_{i,t} + \gamma_i + \mu_t + \varepsilon_{i,t} \quad (4)$$

$$Media_{i,t} = \gamma_0 + \gamma_1 Treat_{i,t} * Post_{i,t} + \gamma_2 \sum Controls_{i,t} + \gamma_i + \mu_t + \varepsilon_{i,t} \quad (5)$$

$$ABSINV_{i,t} = \zeta_0 + \zeta_1 Media_{i,t} + \zeta_2 Treat_{i,t} * Post_{i,t} + \zeta_3 \sum \text{Controls}_{i,t} + \gamma_i + \mu_t + \varepsilon_{i,t} \quad (6)$$

Where $Media$ are the mediating variables and the rest of the variables are the same as those defined in (3). If the regression coefficient β_1 is significant, the overall effect of green credit policy on firms' investment efficiency exists; if β_1 insignificant, there is no mediating effect. The regression of Eq. (5) explores the effect of the implementation of the Guidelines on the mediating variables. Eq. (6) regressions explore the mediating effect of the implementation of the Guidelines through the mediating variables ζ_1 and the direct effect on enterprise investment efficiency ζ_2. The regression explores the mediating effect of the implementation of the Guidelines through the mediating variables and the direct effect on the efficiency of corporate investment. If γ_1 and ζ_1 are significant and ζ_2 are insignificant, it indicates a full mediation effect ; if γ_1, ζ_1 andζ_2 are significant, then it indicates a partial mediation effect. If γ_1 and ζ_1 at least one is not significant, a secondary test using Bootstrap method should be performed to further investigate whether there is a mediating effect.

5.1 Green Credit Guidelines, Loan Amount and Corporate Investment Efficiency

Referring to Chen Xingxing et al, this paper includes the amount of corporate loans ($Credit$) as the mediating variable and the rest of the variables are consistent with the above. The empirical results are shown in columns (2) and (3) of Table 6. The coefficients of $Treat * Post$ are negative and significant, indicating that the implementation of the Guidelines reduces the amount of loans received by heavily polluting enterprises compared to non-heavily polluting enterprises. The results in Column (3) show that the effect of loan amount on investment efficiency of heavy polluting enterprises is significantly positive at the 1% confidence level, indicating that an increase in loan amount can significantly reduce the investment efficiency of enterprises. There is a significant partial mediation effect of loan amount between green credit and enterprise investment efficiency, and the percentage of mediation effect is 4.09%, which verifies the research hypothesis H2.

5.2 Green Credit Guidelines, Debt Maturity and Corporate Investment efficiency

Referring to the research methods of Xiao Zuoping, Liao Li [24] and Yang Xingquan, Mei Bo [25], this paper takes the maturity of corporate debt ($Term$) as the mediating variable, and the rest of the variables are consistent with the above. The empirical results are shown in columns (4) and (5) of Table 6. The coefficients of $Treat * Post$ are negative and significant. It indicates that the implementation of the Guidelines shortens the available debt maturity of heavily polluting firms compared to non-heavily polluting firms.The results in Column (5) show that the effect of loan amount on investment efficiency of heavy polluting enterprises is significantly positive at the 1% confidence level, indicating that an increase in debt maturity can significantly reduce the investment efficiency of enterprises. There is a significant partial mediation effect of loan amount between green credit and enterprise investment efficiency, and the percentage of mediation effect is 7.60%, which verifies the research hypothesis H3.

Table 6. Mechanism of action test

	(1)	(2)	(3)	(4)	(5)
	ABSINV	Credit	ABSINV	Term	ABSINV
Treat*Post	-0.007**	-0.013*	-0.006**	-0.019**	-0.006**
	(0.003)	(0.007)	(0.003)	(0.009)	(0.003)
Credit			0.022***		
			(0.007)		
Term					0.028***
					(0.005)
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
N	13800	13800	13800	13800	13800
R^2_adj	0.145	0.674	0.146	0.541	0.149

In summary, the credit policy represented by the Green Credit Guidelines will promote the increase of corporate investment efficiency mainly through the reduction of loan amount and the shortening of debt maturity.

6. Heterogeneity Analysis

6.1 Geographically based Heterogeneity Analysis

China is a vast country with uneven regional socio-economic development and is affected by green credit policies to varying degrees. Referring to Yu, Bo and the National Bureau of Statistics' division of geography, the 30 Chinese provinces and cities are divided into two categories: eastern and non-eastern. This subsection will analyze the heterogeneity of the data grouping based on geography. As shown in columns (1) and (2) of Table 7 below, the improvement of investment efficiency of the guidelines on heavy pollution is significant at the 5% confidence level in the non-eastern region, but not in the eastern region. The coefficient of the cross product term in the non-eastern region is -0.008, and the investment efficiency of heavy polluters in the non-eastern region is significantly lower compared to the non-heavy polluters. The coefficient of the cross product term in the eastern region is -0.004, but it is not significant. This result supports the study H4 in this paper.

6.2 Heterogeneity Analysis based on the Nature of Enterprise Property Rights

Considering the actual situation, credit discrimination does exist in China due to the different nature of enterprise ownership, which may lead to the difference in the level of impact on enterprise investment efficiency under the green credit policy due to the different nature of enterprises. Considering such differences, this paper performs group regressions based on the nature of enterprise ownership. As shown in columns (3) and (4) of Table 7 below, the promotion effect of the guidelines on the investment efficiency of heavy polluters is significant at the 5% confidence level in state-owned enterprises and insignificant in non-state-owned enterprises. The coefficient of the cross product term in state-owned enterprises is -0.006, and the investment efficiency of heavy polluting enterprises in state-owned enterprises is significantly lower compared to that of non-heavy polluting enterprises. The coefficient of the cross product term in non-SOEs is 0.002, but it is not significant. This result supports the study H5 of this paper.

Table 7. Analysis of heterogeneity

	Corporate Investment Efficiency (ABSINV)			
	East	Non-Eastern	State-owned	Non-State
	(1)	(2)	(3)	(4)
Treat*Post	-0.004	-0.008**	-0.006**	0.002
	(0.004)	(0.004)	(0.003)	(0.007)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	8028	5472	7020	3408
R^2_adj				

7. Conclusion and Insights

Green finance policy, as an important financial control instrument to stimulate the green development of enterprises, is gradually influencing the investment efficiency of relevant enterprises. This paper finds that (1) after the implementation of the Guidelines, the investment efficiency of heavily polluting enterprises significantly increases compared with non-heavily polluting enterprises. (2) The improvement of investment efficiency of heavy polluters by the Guidelines works through

both loan amount and debt maturity. (3) The implementation of the Guidelines improves the investment efficiency of heavy polluters in state-owned and non-eastern regions more significantly.

The marginal contributions of this paper are as follows (1) Most scholars currently analyze the specific utility of the promulgation of the Guidelines in terms of corporate innovation, and few analyze it from the perspective of corporate investment efficiency. To a certain extent, this paper fills the gap in the relevant field of research. (2) We explore the channels through which the promulgation of the Guidelines affects the efficiency of enterprise investment through the loan amount and the debt maturity, and uncover the deep relationship between the two variables. (3) To explore the specific regulation process of the promulgation of the Guidelines from a microscopic perspective and to analyze the heterogeneity in terms of geography and nature of enterprise property rights.

This paper combines theoretical and empirical research, the following two aspects of decision-making insights are proposed (1) vigorously implement measures related to green finance. Green finance as an important strategy for national development at present, every enterprise should actively participate in making contributions. The government and the market work together to continuously improve the development of existing policies in conjunction with the current market situation and ensure the effective implementation of policies on the ground. At the same time, it encourages financial institutions to develop green financial products and mobilizes the enthusiasm and ability of market green innovation, so as to improve the development and progress of green financial industry. (2) Implement green credit policies according to local conditions. The implementation of the policy will have different degrees of impact on the nature of property rights of different enterprises as well as heavy polluters in the region. Adopting a one-size-fits-all strategy and policy management does not effectively help heavy polluters improve their investment efficiency. For non-nationalized enterprises, the government and the CBRC must also strictly approve financing for polluting projects. In the eastern region, the implementation of green credit policies alone is not enough to limit highly polluting enterprises. The government and the CBRC should propose more appropriate and specific laws and regulations for various financing channels of green finance to effectively restrict the financing revenue of heavy polluting enterprises nationwide, and achieve the purpose of promoting the improvement of investment efficiency of enterprises through the restriction of their own funds .

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