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Research on the Impact Mechanism of Green Credit Policy on Investment Efficiency of Heavily Polluting Enterprises: A Quasi-Natural Experiment Based on the "Green Credit Guidelines"

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Abstract. In the context of China's promotion of ecological civilization and its "dual-carbon" agenda, green credit has become a pivotal policy tool to guide financial resources toward environment-friendly usage, and its impact on firms' micro-level decisions has received increasing scholarly attention. This paper collects a panel data of Chinese A-share listed firms during 2004–2024, regards the 2012 Green Credit Guidelines as an exogenous policy shock, and applies DID estimation together with mediation analysis to test if green credit can improve investment efficiency of heavily polluting firms and through which channels. The empirical results show that the policy has a significant enhancement effect on the investment efficiency of targeted firms, mainly by curbing over-investment. Mechanism analysis demonstrates that debt maturity structure plays a partial mediating role between the policy and firms' investment efficiency; specifically, green credit policy improves investment efficiency by reducing the scale of long-term debt financing for heavily polluting enterprises, thus restricting funds for inefficient investment. Heterogeneity analyses find that the policy effect is stronger for heavily polluting firms with constrained commercial credit, while those with stronger commercial-credit ability can partially offset the tightening pressure via alternative financing, leading to a weaker marginal policy impact. A series of robustness checks, including placebo tests and propensity-score-matched DID estimations, confirm the stability of these findings. Overall, this study provides micro-level empirical evidence for evaluating green credit's effects and offers useful implications for perfecting policy design to jointly promote environmental objectives and firm-level efficiency.

Keywords: green credit policy, heavily polluting enterprises, investment efficiency, difference-in-differences model

1. Introduction

Amid the strategic context of China's advancing ecological civilization development and pursuit of the "dual carbon" goals, green credit—regarded as a pivotal environmental economic policy—bears a dual mandate: steering financial resources toward green and low-carbon initiatives while

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restricting investments in polluting sectors. In 2012, the former China Banking Regulatory Commission issued the Green Credit Guidelines, heralding the comprehensive institutionalization and rollout of this policy. By taking banks' credit allocation as a market-driven instrument, the guidelines aim to inherently restrict and steer the financing and investment behaviors of heavily polluting enterprises. A key question persists at the microeconomic level: what intricate "dual impacts" does this environment-focused policy exert on firms' economic activities? Does it merely "discipline" enterprises through financing constraints, or does it more actively "direct" them to enhance resource allocation efficiency? In-depth exploration of this issue is crucial for the scientific evaluation of green credit policies' microeconomic effects, as well as for optimizing the policy framework to achieve a win-win outcome between environmental protection and economic growth.

While prior research has documented the emissions-mitigation outcomes of green credit and its incentive effects on firms' green innovation [1], evidence on its influence over a central dimension of corporate financial behavior—investment efficiency—remains sparse and far from convergent. Existing discussions often stress that green credit tightens financing constraints, yet they typically understate a plausible countervailing mechanism: heightened credit discipline may push firms to refine project selection and reduce inefficient investment. Moreover, the pathways through which green credit translates into changes in investment efficiency are still not well specified, and firm responses may vary substantially across financing conditions. These unresolved issues mean that current knowledge of the policy's micro-level consequences is still relatively preliminary.

This study constructs a 2004–2024 panel of Chinese A-share listed companies, interprets the 2012 Green Credit Guidelines as an exogenous shock, and uses DID estimation to pin down the policy's causal effect on investment efficiency among heavily polluting enterprises. The study advances the literature in three respects. First, it directly tests whether green credit policy significantly promotes investment efficiency in heavily polluting firms and clarifies whether this effect primarily stems from curbing overinvestment or alleviating underinvestment. Second, by incorporating the share of long-term debt as a mediator, it evaluates the key channel whereby green credit policy raises efficiency through reducing long-term borrowing among heavily polluting firms, thus clarifying how debt-maturity adjustments shape investment decisions. Third, leveraging heterogeneity in commercial-credit financing capacity, the study investigates differential policy effects under varying degrees of financing constraints, offering micro-evidence to support more precise and tiered policy design.

2. Literature review and hypothesis development

Corporate investment efficiency has long been a central topic in corporate finance. Stein pointed out that information asymmetry and agency conflicts are important causes of inefficient investment [2]. Specifically, deviations from optimal investment decisions primarily manifest as overinvestment or underinvestment [3,4]. According to Jensen's free cash flow hypothesis, firms holding large free cash balances face a greater risk of managerial overinvestment in NPV-negative projects [5]. This phenomenon is particularly pronounced among heavily polluting enterprises. Such firms, often enjoying an advantage in asset scale, are more likely to obtain bank credit support; however, this financing convenience can exacerbate agency problems, leading to more severe inefficient investment. On the other hand, corporate managers tend to invest in areas with which they are relatively familiar, foregoing positive net present value projects to reduce risk. While this protects investors' in-situ value, it can harm the interests of creditors [6].

Green finance emphasizes the social responsibilities of financial institutions, requiring them to tilt capital toward green economic activities and restrict financing for non-green activities [7]. White

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defines green finance as a system in which varied financial instruments are leveraged to foster environmental protection, and environmental risk is incorporated as a pivotal factor in investment and lending decisions [8]. As an innovative tool integrating environmental and financial policy, green credit has become a focal point of academic discussion. Existing work on the green credit–investment efficiency nexus for heavily polluting firms can be reviewed from two key perspectives. On one hand, some scholars highlight the "financing constraint effect" of the policy, suggesting that green credit can influence investment efficiency by restricting financing, thereby reducing investment efficiency in heavily polluting firms. Some studies also find that green credit policies weaken the promoting effect of bank–firm relationships on fixed asset investment. On the other hand, other studies emphasize the "governance improvement effect," indicating that green credit policies can enhance investment efficiency in heavily polluting enterprises through multiple pathways.

From a governance perspective, green credit policy first strengthens bank-based creditor governance. Under the guidance of the Green Credit Guidelines, banks can enhance oversight of firms through control transfer mechanisms embedded in debt contracts, particularly when banks primarily extend short-term debt, which allows for more effective constraint of corporate investment behavior [9]. Fama and Jensen also noted that banks, as external stakeholders, can participate in corporate governance, exerting both supervisory and free cash flow effects [10]. Under agency theory, divergent objectives of shareholders and creditors may induce suboptimal investment behavior [11]. Relevant evidence demonstrates that subsequent to the implementation of green credit policies, the share of long-term debt in heavily polluting enterprises has experienced a decrease. The shortened debt maturity can effectively mitigate agency conflicts between shareholders and managers, diminish information asymmetry between creditors and debtors, thereby imposing an inhibitory impact on inefficient corporate investment [12]. Moreover, the policy generates a notable "compulsion effect." With the rollout of green credit policies, banks tend to tighten lending to heavily polluting firms through credit rationing. The resulting financing pressure, together with enhanced creditor monitoring, compels these firms to shoulder greater environmental and social responsibilities. Meanwhile, higher expenditures on environmental compliance and governance erode internal liquidity, leading to a decline in free cash flow [13]. Since free cash flow is typically positively correlated with overinvestment, reducing free cash flow helps restrain overinvestment behavior [14]. Volz found that the implementation of green finance-related policies effectively incentivizes firms to shift investment from high-pollution, high-energy-consumption industries toward green industries. This compulsion effect can optimize investment outcomes and improve investment efficiency [15]. In addition, through incentive effects, green credit policies encourage firms to improve information disclosure quality, enhancing financing availability and positively impacting investment efficiency. The policies may also promote better corporate governance, further contributing to improved investment efficiency.

Importantly, some studies confirm that green credit policies significantly suppress overinvestment in heavily polluting firms. Xin Wang and Ying Wang further found that high-cost environmental regulations can enhance the investment efficiency of regulated firms [1]. These findings suggest that, although short-term financing constraints may occur, governance improvement effects tend to dominate in the long run. By mitigating agency conflicts and optimizing resource allocation, the policy ultimately exerts a positive effect on corporate investment efficiency.

Based on the preceding arguments, we formulate Hypothesis H1 as follows:

H1: Green credit policy significantly promotes the investment efficiency of heavily polluting enterprises, with this effect primarily achieved through a reduction in the proportion of long-term

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debt, thereby enhancing investment efficiency.

3. Research design

Building on the foregoing theoretical discussion, we adopt a difference-in-differences (DID) framework to quantify how the Green Credit Guidelines affect the investment efficiency of heavily polluting firms, and to probe the channels through which the policy influence is realized.

3.1. Sample selection and data sources

The initial sample covers all Chinese A-share listed companies over the period 2004–2024. We then refine the dataset using the following filters: (1) firms with abnormal trading labels, such as ST, *ST, or PT, are removed; (2) observations from the financial and insurance industries are dropped; (3) firms with substantial missing values are excluded; (4) companies whose leverage ratios fall outside the [0,1] interval are eliminated; and (5) continuous variables are winsorized at the 1% and 99% levels. Following the above data-cleaning steps, the dataset comprises 4,836 firms. All accounting and market variables come from the CSMAR database.

3.2. Variable selection

3.2.1. Dependent variable

Corporate Investment Efficiency. Consistent with Richardson, we proxy firm-level investment efficiency via an expected-investment model:

$$Inv_{it} = \alpha_0 + \alpha_1 Growth_{it-1} + \alpha_2 Lev_{it-1} + \alpha_3 Cash_{it-1} + \alpha_4 Age_{it-1} + \alpha_5 Size_{it-1} + \alpha_6 Ret_{it-1} + \alpha_7 Inv_{it-1}$$

$$+ \sum Year + \sum Ind + \varepsilon_{it} \quad (1)$$

Here, Inv_{it} denotes firm i's realized new investment in year t. $Growth_{i,t-1}$ captures growth opportunities, measured by Tobin's Q. $Lev_{i,t-1}$ is leverage, proxied by the debt ratio. $Cash_{i,t-1}$ refers to operating cash flow scaled by beginning-of-year total assets (net cash from operating activities / initial total assets). $Age_{i,t-1}$ is firm age, calculated as years since listing. $Size_{i,t-1}$ is the natural log of total assets. $Ret_{i,t-1}$ represents annual stock returns including dividend reinvestment. $Inv_{i,t-1}$ is lagged investment. $\sum Ind$ and $\sum Year$ indicate industry and year fixed effects, respectively, and ε_{it} is the regression residual.

We estimate Eq. (1) using annual cross-sectional OLS to obtain residuals. Investment efficiency (IE) is then defined as the absolute value of ε_{it}. A larger $|\varepsilon_{it}|$ implies a greater deviation from expected investment and thus lower efficiency. To distinguish the direction of inefficiency, negative residuals are treated as underinvestment: $Uninv = |\varepsilon_{it}|$ if $\varepsilon_{it} < 0$, and $Uninv = 0$ otherwise. Positive residuals are interpreted as overinvestment: $Ovinv = |\varepsilon_{it}|$ if $\varepsilon_{it} > 0$, and $Ovinv = 0$ otherwise.

3.2.2. Key explanatory variable

The core explanatory variable in this study is the interaction term did, obtained by multiplying the treatment dummy variable (treatment) with the time dummy variable (post). The $post$ dummy

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captures policy enforcement. Using 2012—the year when the Green Credit Guidelines were released—as the cutoff, $post = 0$ for observations in 2012 and earlier, and $post = 1$ for years after 2012.

The $treatment$ dummy identifies whether a firm belongs to a heavily polluting sector. In line with the China Securities Regulatory Commission's 2012 revision of the Industry Classification Guidelines for Listed Companies, heavily polluting industries are determined at the two-digit (secondary) industry level. Firms operating in these sectors are assigned to the treatment group ($treatment = 1$), whereas the remaining firms serve as the control group ($treatment = 0$). Accordingly, the interaction term did equals one only for heavily polluting firms in the post-policy period, and zero otherwise.

3.2.3. Mediating variable

Debt Maturity Structure (Debt). We proxy long-term debt financing using long-term borrowings scaled by total assets, which reflects firms' long-term debt financing status.

3.2.4. Heterogeneity grouping variable

Commercial Credit Financing Capacity (Ccf). Measured by dividing the sum of accounts payable, notes payable, and advance receipts by total assets, this variable denotes a firm's capacity for alternative financing.

3.2.5. Control variables

Following existing studies, we include conventional firm-level and governance covariates that may influence investment efficiency—namely Roa, Growth, Size, Age, Top1, Lev, Cash, Board, and Indep.

Table 1. Variable definitions

Variable Type	Variable Name	Symbol	Measurement
Dependent	Investment Efficiency	IE	Expected investment model residuals
Explanatory	DID variable	did	Interaction of treatment and post-policy dummies
Mediating	Debt Maturity Structure	Debt	Long-term borrowings / total assets
Control	Firm Size	Size	Natural log of total assets
	Financial Leverage	Lev	Total debt / total assets
	Return on Assets	Roa	Net profit / average total assets
	Ownership Concentration	Top1	Shareholding of largest shareholder
	Independent Directors	Indep	Number of independent directors / board size
	Firm Growth	Growth	Tobin's Q
	Cash Flow	Cash	Net operating cash flow / beginning-of-year total assets
	Firm Age	Age	Natural log of years listed
	Board Size	Board	Natural log of board members
Heterogeneity	Commercial Credit Financing	Ccf	(Accounts payable + Notes payable + Advance receipts) / total assets

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3.3. Model specification

First, to test Hypothesis H1, a standard difference-in-differences model is employed as our baseline framework to capture the Guidelines' effect on the investment efficiency of heavily polluting enterprises:

$$Y_{it} = \beta_0 + \beta_1 did_{it} + \beta_2 Controls_{it} + \delta_i + \lambda_t + \varepsilon_{it}. \tag{2}$$

In Eq. (2), Y_{it} respectively denotes IE, $Ovinv$, and $Uninv$, capturing firm i's investment efficiency, overinvestment, and underinvestment in year t. The key regressor did_{it} is the interaction between the treatment indicator and the post-policy time dummy. $Controls_{it}$ is a vector of control variables. δ_i and λ_t represent firm and year fixed effects, respectively, and ε_{it} is the idiosyncratic disturbance term.

Second, to test whether debt maturity structure (Debt) mediates the policy effect on investment efficiency, we follow the mediation approach of Wen and Ye [16] and construct the following auxiliary equations derived from the baseline specification:

$$Debt_{it} = \chi_0 + \chi_1 did_{it} + \chi_2 Controls_{it} + \delta_i + \lambda_t + \varepsilon_{it}, \tag{3}$$

$$IE_{it} = \gamma_0 + \gamma_1 did_{it} + \gamma_2 Debt_{it} + \gamma_3 Controls_{it} + \delta_i + \lambda_t + \varepsilon_{it}. \tag{4}$$

Here, $Debt_{it}$ serves as the mediating variable measuring firms' debt maturity structure, while the remaining terms are defined identically to those in Eq. (2).

4. Empirical results and analysis

4.1. Descriptive statistics

Table 2 reports summary statistics for all variables. The final panel contains 45,585 firm-year observations. Investment efficiency (IE) has an average value of 0.039 and a median of 0.024, implying considerable cross-sectional dispersion in firms' investment efficiency. The DID indicator (did) exhibits a mean of 0.171, which indicates that treated firms account for roughly 17% of the sample—about one-fifth the size of the control group. The debt maturity structure variable (Debt) averages 0.068 with a standard deviation of 0.087, reflecting marked disparities in debt structures among firms. Other control variables show distributional patterns broadly consistent with those documented in related studies.

Table 2. Descriptive statistics

VarName	Obs	Mean	SD	Min	Median	Max
IE	45585	0.039	0.047	0.000	0.024	0.280
Ovinv	45585	0.018	0.041	0.000	0.000	0.237
Uninv	45585	0.020	0.030	0.000	0.006	0.166
treatment	45585	0.239	0.426	0.000	0.000	1.000
post	45585	0.767	0.423	0.000	1.000	1.000
did	45585	0.171	0.376	0.000	0.000	1.000

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Table 2. (continued)

Debt	34042	0.068	0.087	0.000	0.035	0.414
Roa	45584	0.035	0.063	-0.211	0.034	0.213
Growth	45065	1.954	1.223	0.833	1.554	7.969
Size	45585	22.267	1.294	19.870	22.080	26.320
Age	45583	2.148	0.762	0.693	2.303	3.367
Top1	45540	0.342	0.150	0.084	0.319	0.742
Lev	45585	0.444	0.200	0.063	0.443	0.891
Cash	45585	0.056	0.078	-0.177	0.052	0.303
Board	45574	2.133	0.204	1.609	2.197	2.708
Indep	45531	0.374	0.053	0.286	0.333	0.571

4.2. Parallel trend test

The DID model imposes a requirement for the parallel trend assumption—specifically, that no substantial disparities exist between the treatment and control groups prior to the policy's implementation. To validate this assumption, we construct the following model:

$$IE_{it} = \theta_0 + \sum_{k=2}^{4} \gamma_k treat\_pre\_k_{it} + \sum_{m=0}^{4} \gamma_{m+5} treat\_post\_m_{it} + \gamma_{10} Controls_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (5)$$

Figure 1 illustrates the dynamic trends in investment efficiency for the treatment and control groups from 2008 onwards. Prior to 2012's Green Credit Guidelines, the interaction term coefficients were insignificant, indicating no significant pre-policy group differences and validating the parallel trend assumption. After 2012 (2013–2016), the interaction term becomes significant, indicating a downward trend in inefficient investment among heavily polluting firms—that is, the green credit policy significantly improved their investment efficiency.

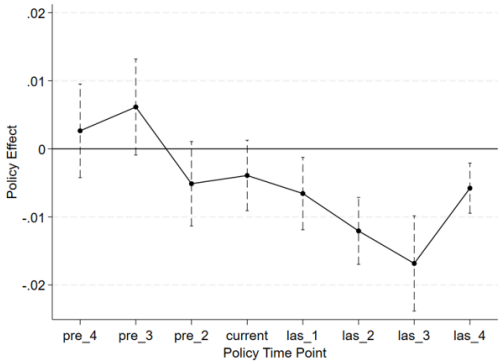

Figure 1. Dynamic effects of investment efficiency over multiple periods

4.3. Baseline regression results

Table 3 reports the baseline DID regression results. Column (1) shows that without control variables, the green credit policy significantly promotes investment efficiency in heavily polluting firms at the 1% significance level. Column (2) demonstrates that the statistical significance of the did coefficient remains unaltered even after incorporating a set of control variables. This confirms that green credit

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policies still exert a significant positive effect on improving investment efficiency at the 1% significance level, thereby offering preliminary empirical support for Hypothesis H1. Specifically, Columns (3) and (4) reveal that the policy significantly suppresses overinvestment among heavily polluting firms at the 1% level, thereby improving investment efficiency. Nevertheless, the policy exerts no significant impact on underinvestment, suggesting that the key mechanism through which green credit affects investment efficiency lies in the alleviation of overinvestment. Furthermore, robustness checks including placebo tests and propensity score matching (PSM-DID) verify the reliability of these findings (see Appendix).

Table 3. Baseline regression results

Variable	(1)	(2)	(3)	(4)
	IE	IE	Ovinv	Uninv
did	-0.00575***	-0.00463***	-0.00485***	0.000346
	(0.00162)	(0.00159)	(0.00137)	(0.000856)
Roa		0.0894***	0.0755***	0.00295
		(0.00614)	(0.00477)	(0.00426)
Growth		0.00440***	-0.000320	0.00382***
		(0.000385)	(0.000271)	(0.000271)
Size		0.00189**	0.00233***	-0.000448
		(0.000792)	(0.000590)	(0.000401)
Age		-0.0112***	-0.0125***	0.00155**
		(0.00120)	(0.00102)	(0.000650)
Top1		-0.00498	0.00128	-0.00574**
		(0.00466)	(0.00378)	(0.00226)
Lev		0.0160***	0.0201***	-0.00608***
		(0.00307)	(0.00247)	(0.00168)
Cash		0.00166	0.0250***	-0.0198***
		(0.00452)	(0.00390)	(0.00269)
Board		-0.00359	-0.00319	0.000412
		(0.00264)	(0.00220)	(0.00146)
Indep		-0.00990	-0.0200***	0.0101**
		(0.00800)	(0.00659)	(0.00469)
Constant	0.0400***	0.0157	-0.00412	0.0195**
	(0.000278)	(0.0181)	(0.0141)	(0.00925)
Observations	45158	44585	44585	44585
R-squared	0.248	0.267	0.180	0.182
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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5. Further analysis

5.1. Mechanism analysis

To investigate how the Green Credit Guidelines affect investment efficiency (IE) in heavily polluting firms, we treat debt maturity structure (Debt) as the mediating variable and test mediation using stepwise regressions. The analysis proceeds in three steps.

To gauge the net policy effect, we estimate the baseline DID regression. The did coefficient is negative and significant at the 1% level (-0.005), suggesting that green credit significantly raises investment efficiency among heavily polluting firms.

Second, we examine whether the policy influences the mediator. Results show that the Guidelines significantly lower the share of long-term debt in total assets, again at the 1% significance level, suggesting that green credit reshapes firms' debt-maturity structure.

Third, we include Debt in the IE regression to jointly assess the policy's direct effect and the mediator's role. After adding Debt, the coefficient on did remains -0.005 (1% level), while Debt enters positively with a coefficient of 0.087(also significant at 1%). These findings imply a meaningful partial mediation effect: the Green Credit Guidelines curtail inefficient investment by reducing the proportion of long-term debt in heavily polluting firms.

Table 4. Mediating effect of debt maturity structure

	(1)	(2)	(3)
	IE (Total Effect)	Debt	IE (Direct Effect)
did	-0.005***	-0.011***	-0.005***
	(0.002)	(0.004)	(0.002)
Debt			0.087***
			(0.008)
Roa	0.089***	0.031***	0.095***
	(0.006)	(0.011)	(0.008)
Growth	0.004***	0.000	0.005***
	(0.000)	(0.001)	(0.001)
Size	0.002**	0.017***	-0.000
	(0.001)	(0.002)	(0.001)
Age	-0.011***	-0.002	-0.013***
	(0.001)	(0.003)	(0.001)
Top1	-0.005	0.026**	-0.004
	(0.005)	(0.011)	(0.005)
Lev	0.016***	0.165***	0.001
	(0.003)	(0.007)	(0.004)
Cash	0.002	-0.055***	0.011**
	(0.005)	(0.007)	(0.005)
Board	-0.004	-0.012*	-0.004
	(0.003)	(0.006)	(0.003)
Indep	-0.010	-0.005	-0.014

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Table 4. (continued)

	(0.008)	(0.017)	(0.009)
_cons	0.016	-0.379***	0.073***
	(0.018)	(0.043)	(0.020)
N	44585	33169	33169

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

To further ascertain the robustness of the mediation effect, the Bootstrap method was employed. The observed indirect effect coefficient is -0.0011669, with a Bootstrap standard error of 0.0002768, a z-statistic of -4.22, and a $p < 0.001$. The 95% normal-distribution-based confidence interval excludes zero, thereby verifying the robustness of the mediating effect of debt maturity structure between the green credit policy and investment efficiency.

Table 5. Bootstrap test of mediating effect

Mediator	Fixed Effects Controls	Observed Coef	Bootstrap Std.Err.	z	P>|z|	Normal-based [95% conf. interval]
Debt	Yes	-0.0011669	0.0002768	-4.22	0.000	-0.0017094 -0.0006244

5.2. Heterogeneity analysis

To investigate whether the effectiveness of green credit varies with firms' commercial credit financing capability, we split the sample into two subsamples—low versus high commercial credit capacity—using the annual median of the commercial credit financing variable as the cutoff. We then conduct separate group regressions and interaction term tests respectively.

The results show that in the low commercial credit group, the coefficient of did is significantly negative at the 1% level (-0.0088), while the coefficient fails to reach statistical significance in the high commercial credit group. This finding demonstrates that the investment efficiency improvement effect of green credit policies is primarily concentrated in heavily polluting enterprises with weak commercial credit financing capacity. To further test this heterogeneity, an interaction term (did_lowccf) was included. The coefficient of the interaction term is -0.0052 and significant at the 1% level, suggesting that commercial credit financing ability is a heterogeneous factor: the policy has a stronger positive effect on investment efficiency in heavily polluting firms with lower commercial credit financing capacity.

Table 6. Heterogeneity analysis results

	(1)	(2)	(3)
	Low Ccf	High Ccf	Interaction Test
did	-0.0088***	-0.0024	-0.0027
	(0.0026)	(0.0022)	(0.0017)
Low_Ccf_group			0.0049***
			(0.0008)
did_lowccf			-0.0052***

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Table 6. (continued)

			(0.0017)
Roa	0.1046***	0.0876***	0.0902***
	(0.0137)	(0.0070)	(0.0061)
Growth	0.0039***	0.0045***	0.0044***
	(0.0008)	(0.0005)	(0.0004)
Size	0.0029	0.0021**	0.0017**
	(0.0020)	(0.0009)	(0.0008)
Age	-0.0056**	-0.0122***	-0.0109***
	(0.0026)	(0.0014)	(0.0012)
Top1	0.0017	-0.0090	-0.0052
	(0.0099)	(0.0057)	(0.0046)
Lev	0.0236***	0.0173***	0.0184***
	(0.0069)	(0.0037)	(0.0031)
Cash	-0.0025	0.0036	0.0027
	(0.0100)	(0.0050)	(0.0045)
Board	-0.0011	-0.0055*	-0.0033
	(0.0056)	(0.0031)	(0.0026)
Indep	-0.0006	-0.0205**	-0.0094
	(0.0170)	(0.0085)	(0.0080)
_cons	-0.0222	0.0185	0.0162
	(0.0442)	(0.0204)	(0.0180)
N	13366	30740	44585
r2_a	0.1903	0.2085	0.1871

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Research conclusions and policy recommendations

Drawing on the A-share sample for 2004–2024, this paper applies a difference-in-differences framework augmented by mediating-effect and heterogeneity analyses to identify the policy effect of green credit on investment efficiency among heavily polluting enterprises and to clarify its internal transmission channels. The main conclusions are as follows: (1) Effectiveness of the Green Credit Policy: The issuance of the Green Credit Guidelines is effective in significantly curbing inefficient investment behavior among heavily polluting firms. To be specific, this effect is primarily manifested in the inhibition of overinvestment, whereas the policy exerts no notable influence on underinvestment. This indicates that the green credit policy, by constraining the access and use of funds for heavily polluting firms, effectively curbs blind expansion and wasteful overinvestment, guiding capital toward more efficient uses. (2) Mediating Role of Debt Maturity Structure: Analysis of the mediating effect reveals that green credit policies are capable of curbing inefficient investment among heavily polluting enterprises by shortening their debt maturity structure. Implementation of the policy encourages banking institutions to adopt a more cautious lending

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approach toward these firms, reducing the proportion of long-term debt. This limits the funds available for inefficient investment and, in turn, promotes improvements in investment efficiency. (3) Heterogeneous Effects: The heterogeneity analysis shows that there are significant differences in the inhibitory effect of green credit policies on the inefficient investment of heavily polluting enterprises. Compared with heavily polluting firms with high commercial credit financing capacity, the policy has a stronger inhibitory effect on firms with low commercial credit financing capacity. This is because firms with lower commercial credit financing ability rely more heavily on bank loans, so the policy's constraints on fund access are more direct and effective, thereby more effectively suppressing inefficient investment. In contrast, firms with high commercial credit financing ability can partially mitigate the policy's impact through alternative financing channels, weakening the policy's effect on their inefficient investment.

On the basis of the above research conclusions, to better leverage the function of green credit policies and facilitate the enhancement of investment efficiency and green transformation of high-polluting enterprises, the following policy recommendations are proposed:

Firstly, refine regulatory evaluation of green credit performance: Regulatory authorities should further detail the performance evaluation system for banking institutions, incorporating both "environmental benefits" and "capital efficiency" into the assessment of credit allocation. This encourages financial institutions not only to "lend green" but also to "lend wisely," achieving dual benefits in resource allocation. Considering the heterogeneity of policy effects across firms, differentiated regulation is recommended. For heavily polluting firms with low commercial credit capacity but strong willingness to transform, a "green transformation whitelist" system could be established, supported by incentives such as interest subsidies or guarantees. This would help firms navigate the transition period and avoid blanket policies that inadvertently harm promising firms, ensuring policy goals of "survival of the fittest" rather than indiscriminate suppression.

Second, enhance financial institutions' role in corporate governance: Banks should move beyond merely controlling loan size and play a more active role in corporate governance. Loan contracts should include clauses linked to environmental performance and social responsibility, and debt maturity structure should be used as a dynamic management tool. By regularly evaluating environmental risk and investment efficiency, financial institutions can adjust lending conditions flexibly, channeling funds to firms committed to green transformation and high investment efficiency, achieving a win-win of risk control and efficiency improvement.

Third, encourage firms to internalize environmental constraints: Firms should recognize that green credit policy presents both challenges and opportunities. They should proactively align with policy directions by adjusting investment structures, reducing high-pollution and low-efficiency projects, and increasing investment in energy-saving, emission-reduction, and green technology innovation. By improving environmental performance and building a strong green reputation, firms can expand green financing channels and gain access to a more favorable financial environment.

References

[1] Wang, X., & Wang, Y. (2021). Research on the promotion of green innovation by green credit policy. Management World, 37(6), 173–188+11. https: //doi.org/10.19744/j.cnki.11-1235/f.2021.0085

[2] Stein, J. C. (2003). Agency, information and corporate investment. In G. M. Constantinides, M. Harris, & R. M. Stulz (Eds.), Handbook of the Economics of Finance, Volume 1, Part A (pp. 111–165). Elsevier. https: //doi.org/10.1016/S1574-0102(03)01006-9

[3] Richardson, S. (2006). Over-investment of free cash flow. Review of Accounting Studies, 11, 159–189. https: //doi.org/10.1007/s11142-006-9012-1

DOI: 10.54254/2754-1169/2026.NJ31185

[4] Shen, Y., & Zhao, J. (2016). The “gains” and “losses” of entertainment expenses: Evidence from the investment efficiency of listed companies. Financial Research, (03), 140–156. https: //doi.org/CNKI: SUN: JRYJ.0.2016-03-010
[5] Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. The American Economic Review, 76(2), 323–329. http: //www.jstor.org/stable/1818789
[6] Shleifer, A., & Vishny, R. W. (1994). Politicians and firms. The Quarterly Journal of Economics, 109(4), 995–1025. https: //doi.org/10.2307/2118354
[7] Soundarrajan, P., & Vivek, N. (2016). Green finance for sustainable green economic growth in India. Agricultural Economics, 62(1), 35–44. https: //doi.org/10.17221/174/2014-AGRICECON
[8] White, M. A. (1996). Environmental finance: Value and risk in an age of ecology. Business Strategy and the Environment, 5(3), 198–210. https: //doi.org/10.1002/(SICI)1099-0836(199609)5: 3< 198: : AID-BSE66> 3.0.CO; 2-4
[9] Yuan, W. (2005). Debt maturity structure of listed companies in China: An empirical study based on the trade-off theory. Accounting Research, (12), 53–58+96. https: //doi.org/CNKI: SUN: KJYJ.0.2005-12-010
[10] Fama, E. F., & Jensen, M. C. (1985). Organizational forms and investment decisions. Journal of Financial Economics, 14(1), 101–119. https: //doi.org/10.1016/0304-405X(85)90045-5
[11] Myers, S. C. (1977). Determinants of corporate borrowing. Journal of Financial Economics, 5(2), 147–175. https: //doi.org/10.1016/0304-405X(77)90015-0
[12] D’Mello, R., & Miranda, M. (2010). Long-term debt and overinvestment agency problem. Journal of Banking & Finance, 34(2), 324–335. https: //doi.org/10.1016/j.jbankfin.2009.07.021
[13] Si, L., & Cao, H. (2022). Can green credit policy improve corporate environmental social responsibility? From the perspectives of external constraints and internal attention. China Industrial Economics, (04), 137–155. https: //doi.org/10.19581/j.cnki.ciejournal.2022.04.009
[14] Su, D., & Lian, L. (2018). Does green credit affect the investment behavior of heavily polluting firms? Financial Research, (12), 123–137. https: //doi.org/CNKI: SUN: JRYJ.0.2018-12-008
[15] Volz, U. (2018). Fostering green finance for sustainable development in Asia. ADBI Working Papers.
[16] Wen, Z., & Ye, B. (2014). Analysis of mediating effects: Methodological and model development. Advances in Psychological Science, 22(5), 731–745. https: //doi.org/CNKI: SUN: XLXD.0.2014-05-001

Appendix: robustness checks

Placebo test

To verify the robustness of the baseline regression results, this study conducts a placebo test to rule out interference from other unobservable factors. Specifically, the coefficient of the policy dummy variable (did) was randomly shuffled 500 times to simulate a distribution of false policy effect estimates, which was then compared with the actual estimated coefficient.

As shown in Appendix Figure 1, the kernel density distribution of the placebo estimates is symmetric around zero, whereas the actual estimated coefficient of the policy effect (indicated by the vertical dashed line) clearly deviates from the center of this distribution. This indicates that the observed policy effect is not driven by random factors or unobservable disturbances, supporting the reliability of the baseline regression results.

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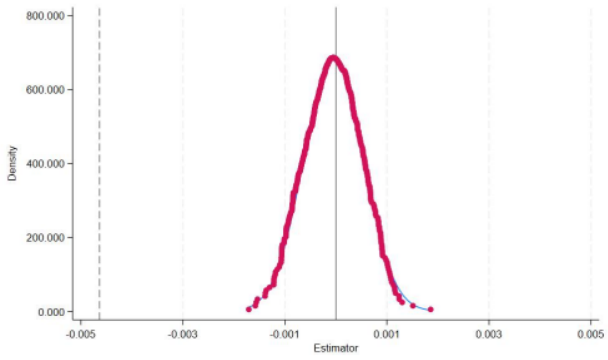

Appendix Figure 1. Kernel density distribution of placebo test coefficients

Propensity score matching (PSM-DID)

To further mitigate potential sample selection bias in the baseline regression, this study applies the propensity score matching combined with difference-in-differences method (PSM-DID) as a robustness check. The procedure is as follows: First, using data from 2011 (one year prior to policy implementation) as the baseline, control variables were included as covariates. One-to-one nearest-neighbor matching was performed using a caliper of 0.03 via the psmatch2 command. Then, a balance test was conducted on the matched sample to ensure no significant differences in covariates between the treatment and control groups. Lastly, DID regression analysis was then conducted on the matched sample.

As shown in Appendix Table 1, the coefficient of the policy variable did is -0.0059 and remains significant at the 1% level, consistent with the baseline regression results. This confirms that, even after controlling for sample selection bias, the core conclusion of this study—namely, that the green credit policy significantly enhances the investment efficiency of heavily polluting firms—remains robust.

Appendix Table 1. PSM-DID regression results

Variable	IE
did	-0.0059***
	(0.0018)
Size	0.0022**
	(0.0010)
Lev	0.0098**
	(0.0038)
Growth	0.0052***
	(0.0006)
Cash	0.0089
	(0.0055)
Age	-0.0099***
	(0.0020)
Roa	0.0910***
	(0.0082)

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Appendix Table 1. (continued)

Indep	-0.0127
	(0.0096)
Top1	-0.0026
	(0.0058)
Board	-0.0035
	(0.0031)
_cons	0.0106
	(0.0220)
N	24320
r2_a	0.1691

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01