



Does green finance restrain corporate financialization?

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Abstract

Green financial policy is one of the important policy tools for China to implement the national carbon peak goal and carbon neutral vision through financial means. This policy has an important impact on the business strategy of corporates. Based on the data of listed corporates from 2013 to 2020, this study examines the impact mechanism of China's green financial reform and innovation pilot zones (GFRIPZ) on corporate financialization (CF) using the difference-in-difference method. The results show the following: (1) The implementation of GFRIPZ significantly restrains the CF. (2) GFRIPZ reversed the short-sighted behavior of firms and guided them to accelerate the green transformation and upgrading for long-term development. Firms' environmental capital expenditure and research and development expenditure increased significantly. (3) The restraining effect of GFRIPZ on CF is stronger in state-owned firms, firms with low-degree managerial myopia, and high-polluting firms. The research clearly identifies the causal relationship and mechanism between GFRIPZ and CF and reveals the formation mechanism and solution path of CF from the green finance perspective. In addition, this study has implications for guiding the green transformation of entity firms and stopping firms from deviating from their intended purpose.

Keywords Green finance · Corporate financialization · Green transformation · Difference-in-difference

Introduction

Finance is an important core competitiveness of a country and has a pivotal effect on rapid economic development. However, the development mode of high pollution, high emission, and high energy consumption associated with high-speed economic development has brought pressure on the environment. Particularly, the long-term mismatch of Chinese financial resources to high-polluting industries has aggravated environmental pollution (Wang et al. 2022). The existing economic structure urgently needs to be adjusted

and transformed. In 2021, the carbon peak and carbon neutral targets were written into the work report of the Chinese government. Taking a green development path is a way for countries to achieve the United Nations' 2030 sustainable development goal. A green economy will be the inevitable direction and trend of China's economic development (Li et al. 2022a, b; Zhou and Qi 2022). The finance and sustainable development began to combine in many ways, and green finance emerged as the times require and rapidly developed in countries worldwide (Carolyn 2017; Su et al. 2022). Green finance refers to the effective allocation of financial resources by the financial system in the form of green credit, green securities, green insurance, green investment, and carbon finance to guide the flow of funds to low-pollution and high-efficiency industries, so as to promote the optimization of industrial and energy structures and achieve win-win development of economic and environmental benefits (Ng 2018). In June 2017, China issued the *Overall Plan for Building Green Financial Reform and Innovation Pilot Zones* in five provinces. China decided to select Zhejiang, Jiangxi, Guangdong, Guizhou, and Xinjiang provinces to build GFRIPZ with different priorities and characteristics. This move is aimed at reducing the capital

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supply of polluting firms and providing financial support for firms carrying on cleaning items.

During the implementation of GFRIPZ, as rational economic people, firms will make corresponding adaptive behavioral responses. In view of the emission reduction and cost pressure brought by the GFRIPZ, firms will weigh the marginal cost of different strategies according to their own resource endowment and technological advantages. Then, they will adjust their own production, operation, investment, and financing decisions. The vigorous development of the financial market has provided a new investment direction for traditional entity firms. The profit model of entity firms has gradually shifted to financial channels, and the proportion of their financial assets has continued to increase. CF is a kind of resource allocation mode that enterprises take with emphasis on capital operation, which shows that enterprise assets are more used for investment than traditional production and operation activities (Zheng et al. 2019). The financial behavior of firms will crowd out the investment funds of firm entities, affect the development of their main businesses, promote the short-sighted operation of firms, and reduce innovation investment (Demir 2009; Davis 2016; Tang and Zhang 2019). Particularly for high-polluting firms, excessive financialization will make them pay more attention to short-term financial investment returns, hinder their green transformation, and thus produce strong externalities to the environment (Qi and Duan 2022). However, the existing research has not studied the relationship between the GFRIPZ and CF. As an important environmental regulation policy, the impact of the GFRIPZ on CF deserves further discussion.

The GFRIPZ actively develops green credit and green insurance, supports private equity funds to participate in green investment, and encourages small and medium-sized enterprises to issue green pooled bonds (Zhou et al. 2023a, b). The GFRIPZ also actively promotes the development of green businesses of various financial institutions, encourages microfinance companies to participate in the green finance business, and provides services for the green transformation of enterprises. In addition, the GFRIPZ has established a platform for enterprise pollution emission and environmental violation records. The platform effectively promotes environmental information disclosure and raises the cost of environmental pollution for enterprises. Theoretically, GFRIPZ can affect CF in two ways. On the one hand, the GFRIPZ urges firms to increase investment in environmental governance, increase their compliance costs, affect their profitability, increase their financing difficulties, and then restrain their financialization. On the other hand, the GFRIPZ has released a strong signal of strict environmental governance to firms, promoting firms to achieve transformation and upgrading by reducing long-term production costs, and restraining their speculative financial investment needs. We

will focus on the following questions: first, will the GFRIPZ strengthen the financial investment preference of firms or inhibit their financial behavior? Second, what is the impact mechanism of GFRIPZ on CF? Third, what are the differences in the role of GFRIPZ on CF in the firm dimension? A discussion on the above issues will help expand the theoretical understanding of the microeconomic effects of GFRIPZ, provide policy inspiration for promoting firms' long-term development through GFRIPZ, and guide the entity firms to avoid excessive financialization.

This paper's marginal contribution is as follows: first, the existing literature discusses the environmental effect of green finance policy and its impact on corporate financial performance, corporate debt cost, etc. In addition, few studies exist on the impact of environmental regulation on CF, and most of them started with command-control environmental regulation means. In terms of research perspective, we analyze the relationship between GFRIPZ and CF, which enriches the relevant research about green finance and micro-firm behavior, reveals the economic effectiveness of green finance, and provides policy guidance for optimizing China's green finance system. Second, in terms of research methodology, we construct quasi-natural experiments with the exogenous shock of GFRIPZ, evaluate the impact of green finance on CF using a DID method which can solve the endogenous problem effectively, and conduct a number of robustness tests. Third, GFRIPZ can not only play a restrictive role in promoting enterprises' investment in environmental protection but also play an incentive role in promoting enterprises' investment in research and development, thus restraining CF. This study verifies the inhibitory effect of environmental protection investment mechanism and R&D investment mechanism of GFRIPZ on CF, which helps to clarify the impact mechanism of green finance on CF and enrich the relevant literature on the influence factor of CF. Fourth, the study discusses the heterogeneity of the impact of GFRIPZ on CF, which provides a basis for proposing policy recommendations to promote firms' green transformation and stop firms from deviating from their inherent purpose.

Literature review and research hypothesis

Literature review

The motivation of CF mainly involves "reservoir" theory and "investment substitution" theory. The "reservoir" theory claims that entity firms hold more financial assets to reserve liquidity, which enables them to cope with liquidity risk by quickly realizing financial assets when facing financing constraints (Ding et al. 2013). Then, the "investment substitution" theory posits that the firm's financial behavior is the

result of the decline of traditional manufacturing industries' profit rate. The essence is the pursuit of profit maximization. Firms smooth the operational risk they encounter in industrial investment by transferring capital to financial investment (Tori and Onaran 2018). In terms of how to curb the financialization of entity firms, early studies mostly analyzed from the corporate governance perspective. These studies found that the increase in operating performance, the change in shareholder values, and the lack of financial background of executives can inhibit the financialization of entity firms (Hu et al. 2017a, b; Du et al. 2019). Micro field research has gradually enriched, and the academic community has begun to pay more attention to the macro policy level. Scholars then examined the impact of financial regulatory policies and social security funds on CF (Du et al. 2017; Peng et al. 2018; Li et al. 2022a, b; Tang et al. 2021).

In the relevant evaluation research of green finance policy, Shi et al. (2022), Muhammad et al. (2022), and Yan et al. (2022) took China's GFRIPZ launched in 2017 as a study target. They empirically studied the effect of GFRIPZ on corporate debt financing cost, investment efficiency, and innovation level using the DID method. They considered the limited time to implement China's GFRIPZ, and relevant research about GFRIPZ is limited. Meanwhile, other scholars evaluated the economic effect of green credit policy. Liu et al. (2019) constructed a quasi-natural experimental study on the green credit policy issued by China in 2012 and found that green credit policy restrains high-polluting firms' investment efficiency. Wang et al. (2022) and Yang (2022) studied the promotion effect of green credit policy on green innovation quality and export quality of listed firms using patent and export data.

To effectively promote the firms' green transformation, the government has constantly innovated the environmental supervision system and introduced a series of environmental regulations. The continuous introduction of environmental regulation will affect the investment decisions of firms through external pressure and internal incentives. In this regard, previous studies explored the impact of environmental regulation on the investment preference of firms, the choice of investment horizon, and environmental investment (Chiara and Carlo 2015; Liu and Xiong 2022). However, studies that have classified corporate investment into entity investment and financial investment and analyzed the impact of environmental regulation on corporate investment choice are rare. Given that the over-financialization of firms is not conducive to sustainable development, some studies started to investigate the relationship between environmental regulation and CF and obtained different conclusions. Cai et al. (2021) found that environmental regulation will reduce the profit margin of firm entity investment, induce the profit-seeking motive of firms, and encourage them to strengthen financial investment to pursue short-term profits

or deal with the risk of future cash flow fluctuations. The empirical analysis of Ding et al. (2021) shows that environmental regulation can improve the R&D investment of firms, accelerate their green transformation and upgrading, reverse the short-sighted behavior of firms, and restrain the financialization of firms. However, existing studies on the impact of environmental regulation on CF mostly started from command-and-control policy and did not study the effect of GFRIPZ on CF.

Existing studies on green financial policies paid less attention to the impact of GFRIPZ on the green sustainable development of enterprises. The CF is of great significance for reducing carbon emissions and green transformation of China's economy. Therefore, the impact of GFRIPZ on the CF and its influencing mechanism should be investigated. Research on the relationship between GFRIPZ and CF can enrich the relevant research on green finance and micro-enterprise behavior.

Research hypothesis

The establishment of the GFRIPZ conveys a signal of the country's vigorous development of the green economy. People's awareness of environmental protection is also increasing, and the policy pressure faced by enterprises for pollution reduction is continuously strengthening. Reducing environmental pollution can better fulfill social responsibility for enterprises and bring more environmental recognition and other positive evaluations (Zhou et al. 2023a, b). In order to reduce pollution emissions that may occur during the production process, enterprises need to increase environmental protection investment. Environmental protection investment can help enterprises improve ecological efficiency, meet the requirements of green production, and then improve the environmental image of enterprises and gain recognition from stakeholders such as the government and consumers. In addition, enterprises' environmental protection investment can transmit a positive signal of the enterprises' environmental responsibility to the outside world, alleviate the information asymmetry between internal and external investors, and thus enable enterprises to obtain more external investment resources (Luo et al. 2019). However, financial asset investment is not conducive to the development of enterprises' core business, which is a negative signal for external investors (Cai et al. 2016). When faced with the constraint of green finance policies, enterprises will choose to increase environmental capital expenditure to reduce environmental risks and obtain more resources and will reduce investment in financial assets. Therefore, GFRIPZ can restrain CF by increasing the firm's environmental capital expenditure.

After the implementation of green finance policies, financial institutions such as the banking industry, driven

by environmental protection concepts and risk control objectives, will control funding for enterprises and projects that do not comply with industrial policies and environmental laws, thereby restricting the blind expansion of polluting enterprises (Shi et al. 2022). Under the pressure of environmental policies that impose hard constraints on energy conservation and emission reduction, GFRIPZ will create tremendous external pressure on enterprises, forcing them to upgrade existing technologies and engage in technological innovation (Yan et al. 2022). At the same time, GFRIPZ will also create a huge market demand for environmental protection technology, thereby stimulating enterprises to strengthen their efforts in environmental protection technology innovation. If enterprises continue to maintain their existing production methods, their profits will be affected and their market competitiveness will decline. Based on long-term development considerations, enterprises will actively research and develop advanced production equipment and technologies, use existing resources to ensure the smooth implementation of green transformation, and obtain compensation for green innovation and first-mover advantages, rather than investing in financial assets. After enterprises increase their research and development expenditure, their investment in financial assets will significantly decrease. Therefore, GFRIPZ can restrain CF by increasing the firm's research and development expenditure.

To sum up, this study further proposes the following hypothesis: GFRIPZ mainly restrains CF by increasing the firm's environmental capital expenditure and research and development expenditure.

Model and data

Model

Benchmark model

Following Muhammad et al. (2022), we employ the DID method to explore the relationship between GFRIPZ and CF. We also take five provinces, which have established GFRIPZ, as the treatment group. The specific model settings are as follows:

$$CF_{it} = \alpha_0 + \alpha_1 treat_i \times post_t + \alpha_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (1)$$

where i represents firm, t represents year, $treat \times post$ represents GFRIPZ, and $treat$ is a dummy variable of the pilot area. Firms in the pilot area take 1, and those in the nonpilot area take 0. $post$ refers to the dummy variable of the establishment time of GFRIPZ. We select 2017 as the implementation node of GFRIPZ. X represents control variables, μ

represents the firm fixed effect, and γ represents the year fixed effect.

Mediation effect model

We use the following model to test whether GFRIPZ can restrain CF through increasing the environmental capital expenditure and research and development expenditure of firms.

$$Med_{it} = \alpha_0 + \beta_1 treat_i \times post_t + \beta_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (2)$$

$$CF_{it} = \alpha_0 + \lambda_1 treat_i \times post_t + \lambda_2 Med_{it} + \lambda_3 X_{it} + \mu_i + \gamma_t + \varepsilon_{it}. \quad (3)$$

Explanatory variable Med refers to environmental capital expenditure and research and development expenditure in Eq. (2), respectively. Through the significance of β_1 , λ_1 , and λ_2 , we can test the mediating effects of environmental capital expenditure and research and development expenditure.

Parallel trend test model

A parallel trend is where no systematic difference exists in the CF level trend before GFRIPZ implementation between pilot and nonpilot firms. Alternatively, if a difference exists, then the difference is fixed. We employ the following model to test the parallel trend.

$$CF_{it} = \beta_0 + \sum_{t=2014}^{2019} \beta_t treat_i \times d_t + \beta_1 X_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (4)$$

where d_t is a dummy variable of the year. If the year is 2014, then $d_{2014} = 1$. The condition of parallel trend test, that is, from β_{2014} to β_{2016} , is insignificant, whereas that from β_{2017} to β_{2019} is significant.

Sample and variable definition

Sample

This study selected Chinese A-share listed firms from 2013 to 2020 as the research object and processed the data as follows: (1) excluding firms with abnormal status; (2) excluding firms in banking, securities, insurance, and other financial industries; (3) excluding firms that have been listed for less than 1 year; (4) excluding firms with serious lack of control variables; (5) winsorizing main continuous variables at the 1% level for avoiding extreme values' interference. The final unbalanced panel data of 18,834 sample observations were obtained. The firm data come from the CSMAR database.

Variable definition

CF We select the ratio of financial assets to total assets to measure the CF according to the practice of Tang et al. (2021). To be specific, this study divides six items into financial assets: transactional financial assets, net financial assets available for sale, derivative financial assets, net held to maturity investment, net long-term equity investment, and net investment real estate. The total amount of financial assets held by firms can be obtained by adding the above items.

Mediation variables The mediation variables include environmental capital expenditure (ECE) and research and development expenditure (RDE). ECE mainly involves the expenditure of firms on environmental governance, environmental protection design and energy conservation, and the recovery of three wastes. We manually collected data on ECE from the annual reports of listed firms of Hu et al. (2017a, b). The RDE is measured by the ratio of R&D expenditure to main business income of firms.

Control variables Some enterprise-level variables that may affect CF should be controlled to observe the net policy effect of green finance on CF and try to avoid the self-selection error of the sample. This study’s control variables selected are as follows according to Peng et al. (2018) and Tang et al. (2021): *Size* (the logarithm of total assets of the firm); *Lev* (the ratio of total liabilities to total assets); *Roa* (the ratio of net profit to total assets); *Age* (the logarithm of firms’ listing time); *Board* (the logarithm of the total number of directors); *Top1* (the shareholding ratio of the largest shareholder); *Inta* (the ratio of net intangible assets to total assets); *Tobin Q* (the ratio of firm market value to total

Table 2 Descriptive statistics

	Observation	Mean	Standard deviation	Minimum	Maximum
CF	18,834	0.071	0.104	0	0.594
Treat	18,834	0.212	0.432	0	1
Post	18,834	0.521	0.5	0	1
ECE	18,834	2.924	4.665	0	18.677
RDE	18,834	0.041	0.022	0	0.085
Size	18,834	22.334	1.265	19.882	25.873
Roa	18,834	0.041	0.063	-0.214	0.215
Lev	18,834	0.521	0.163	0.051	0.958
Age	18,834	2.506	0.762	0	3.578
Board	18,834	2.156	0.199	1.732	2.954
Top1	18,834	0.355	0.154	0.09	0.799
Inta	18,834	0.046	0.064	0	0.348
Tobin Q	18,834	2.157	1.443	0.911	8.956
Insr	18,834	0.256	0.167	0	0.853

assets); and *Insr* (the proportion of the shares held by institutional investors in the total shares of listed companies). Table 1 presents the definition and measures of main variables, and Table 2 presents the descriptive statistics.

Empirical results

Benchmark results

We estimate the impact of GFRIPZ on CF through Model 1. Table 3 reports the results of GFRIPZ effect on CF. The first column shows the raw data without controlling the control variables and the fixed effects of firm and year, and

Table 1 Definition and measures of main variables

Variable	Definition	Measure
CF	Financialization degree of enterprise	The ratio of financial assets to total assets
ECE	Environmental capital expenditure of enterprise	The expenditure of firms on environmental governance, environmental protection design and energy conservation, and the recovery of three wastes
RDE	Research and development expenditure of enterprise	The ratio of R&D expenditure to main business income of enterprise
Size	Enterprise size	The logarithm of total assets of the enterprise
Roa	Return on assets	The ratio of net profit to total assets
Lev	Financial leverage	The ratio of total liabilities to total assets
Age	Enterprise age	The logarithm of enterprises’ listing time
Board	Board size	The logarithm of the total number of directors
Top1	The largest shareholder	The shareholding ratio of the largest shareholder
Inta	Intangible asset	The ratio of net intangible assets to total assets
Tobin Q	Tobin’s Q ratio	The ratio of firm market value to total assets
Insr	The institutional investor	The proportion of the shares held by institutional investors in the total shares of listed enterprises

Table 3 Impact of GFRIPZ on CF

	(1)	(2)	(3)
	CF	CF	CF
<i>treat</i> × <i>post</i>	−0.013*** (0.0028)	−0.009*** (0.0021)	−0.006*** (0.0016)
CV	No	No	Yes
Firm FE	No	Yes	Yes
Year FE	No	Yes	Yes
Obs	18,834	18,834	18,834
<i>R</i> ²	0.746	0.747	0.758

Robust standard errors are in parentheses, the same as in the following table

columns (2) to (3) display the regression outcomes of adding the control variables, year, and firm fixed effects. The coefficients of *treat* × *post* from the first to third columns in Table 2 have little differences and are significantly negative at 1%. Thus, GFRIPZ can significantly restrain CF. Ding et al. (2021) found that mandatory ER has restrained CF through financial constraint. Qi and Duan (2022) found that market-based ER has restrained CF. The result of this study is consistent with those of the existing literature, which means that the result of this study have a certain degree of scientific validity. Subsequently, we conduct a series of robustness tests to ensure the robustness of the result.

Table 4 Parallel trend and counterfactual test

	(1)	(2)	(3)	(4)	(5)
	CF	CF	CF	CF	CF
<i>treat</i> × <i>post</i>			0.0016 (0.0076)	0.0018 (0.0094)	0.011 (0.0102)
<i>treat</i> × <i>post</i> 2014	0.007 (0.028)	0.005 (0.033)			
<i>treat</i> × <i>post</i> 2015	0.008 (0.027)	0.006 (0.028)			
<i>treat</i> × <i>post</i> 2016	0.009 (0.034)	0.005 (0.028)			
<i>treat</i> × <i>post</i> 2017	−0.007*** (0.0027)	−0.004*** (0.0013)			
<i>treat</i> × <i>post</i> 2018	−0.012*** (0.003)	−0.004*** (0.001)			
<i>treat</i> × <i>post</i> 2019	−0.011*** (0.003)	−0.006*** (0.002)			
CV	No	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Obs	18,834	18,834	8520	8520	8520
<i>R</i> ²	0.742	0.763	0.664	0.645	0.653

Robustness test

Parallel trend and counterfactual test

We conduct a parallel trend test according to Model (4). Before the GFRIPZ implementation in 2017, the DID coefficients in Table 4 were insignificant. After GFRIPZ implementation, the DID coefficients in Table 4 have become significantly negative. That is, the parallel trend test is passed. We refer to the counterfactual test method adopted by Martinus and Blyde (2013) and set a virtual time point for the occurrence of policy artificially forward. For the sake of preventing the impact of counterfactual policy experiments and the implementation of real GFRIPZ from being confused, only the sample before the implementation of GFRIPZ was included in the regression. We assume that the establishment periods of GFRIPZ were in 2014, 2015, and 2016. Then, we conduct regression according to Model (1). The coefficients of *treat* × *post* from the third to fifth columns of Table 4 are insignificant, which means that the counterfactual test is passed.

Replace the measurement method of CF

We tested the robustness using two-indicator measurement methods of CF. First, referring to the method of Ding et al. (2021), financial assets are defined as eight categories of accounting items, including trading financial assets, held to maturity investments, investment real estate, long-term

equity investments, available for sale financial assets, derivative financial assets, and dividends receivable. On this basis, they are summed up into new financial assets and then divided by total assets to re-measure CF. As columns 1 and 2 in Table 5 show, regardless of whether control variables are added or not, the DID coefficients are still negative and passed the 10% significance level, which shows that the results obtained are robust. Second, we replace the CF index with a dummy variable. If the enterprise holds financial assets, then the value is 1; otherwise, it is 0. As columns 3 and 4 in Table 5 show, the estimation coefficients of *treat* × *post* are also negative at the 10% level, indicating that GFRIPZ can still restrain CF after replacing the measurement method of CF.

Propensity score matching (PSM)–DID estimation

For the sake of avoiding pilot and nonpilot enterprises’ characteristics affecting the identification effect, we conducted a PSM on the samples based on the control variables of enterprises and conducted an empirical test using the matched samples. Specifically, this study sets the nonpilot enterprises as the control group, and its selection steps are as follows: Logit regression is used to estimate the propensity score. The dependent variable is a dummy variable if it is a pilot enterprise, and the independent variables are control variables. Then, we calculate the propensity score for each sample. Second samples are selected from nonpilot enterprises through kernel matching, the nearest neighbor matching, and radius matching, which are used as matching samples for pilot enterprises. Subsequently, we regress the matched samples according to Model (1). The DID coefficients in Table 6 are significant at 10%.

Climate and environmental policy effect elimination

China has implemented some climate and environmental policies during the GFRIPZ process. For example, China’s seven provinces implemented a carbon trading market in 2013. To eliminate the interference of the province-level

Table 5 Explained variable replacement

	(1) CF	(2) CF	(3) CF	(4) CF
<i>treat</i> × <i>post</i>	−0.007* (0.0037)	−0.005* (0.0026)	−0.013* (0.0069)	−0.011* (0.0059)
CV	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs	18,834	18,834	18,834	18,834
R ²	0.746	0.747	0.758	0.759

Table 6 PSM–DID estimation

	(1) CF	(2) CF	(3) CF
	Kernel matching	Nearest neighbor matching	Caliper matching
<i>treat</i> × <i>post</i>	−0.003*** (0.001)	−0.002* (0.0011)	−0.004* (0.0022)
CV	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs	16,854	9853	13,621
R ²	0.711	0.724	0.726

climate policy, we add the cross-multiplication term of province FE and year FE to Model (1) according to Zhou and Qi (2022). The DID coefficient in column 1 of Table 7 is still significant. At the city level, China implemented the low-carbon city pilot policy covering 87 cities from 2010 to 2017. To eliminate the interference of the city-level climate policy, we add the cross-multiplication term of city FE and year FE to Model (1). The DID coefficient in column 2 of Table 7 remains significant at the 1% level. At the industry level, China implemented an *Environmental Protection Law* aimed at limiting emissions from heavily polluting industries in 2015. To eliminate the interference of the industry-level environmental policy, we add the cross-multiplication term of industry FE and year FE to Model (1). The DID coefficient in column 3 of Table 7 remains significant at the 1% level.

Impact mechanism test

We analyze the mediating effect of ECE according to Models (2) and (3). The coefficients of ECE and *treat* × *post* in columns 1 and 2 of Table 8 are significant at 10%,

Table 7 Climate and environmental policy effect exclusion

	(1) CF	(2) CF	(3) CF
<i>treat</i> × <i>post</i>	−0.005*** (0.0017)	−0.007*** (0.0022)	−0.006*** (0.0014)
CV	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Province × year FE	Yes	No	No
City × year FE	No	Yes	No
Industry × year FE	No	No	Yes
Obs	18,834	18,834	18,834
R ²	0.732	0.738	0.744

Table 8 Mediating effects of ECE and RDE

	(1) ECE	(2) CF	(3) RDE	(4) CF
treat × post	0.141*** (0.009)	−0.0057*** (0.0016)	0.034*** (0.011)	−0.0047*** (0.0014)
ECE		−0.0046* (0.0014)		
RDE				−0.015* (0.0081)
CV	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs	18,834	18,834	18,834	18,834
R ²	0.907	0.741	0.849	0.722

indicating that ECE is the mediating variable for GFRIPZ to restrain CF. GFRIPZ guides more funds to clean-up projects through green funds to drive the development of the environmental protection industry. On the contrary, enterprises that do not carry out cleaning projects cannot obtain funds through the green channel and cannot enjoy the preferential policies of green finance (Zhou et al. 2023a, b). GFRIPZ also brings economic resources, preemptive markets, political resources, and other advantages to green enterprises. Therefore, GFRIPZ can stimulate enterprises to increase ECE to achieve green transformation and reduce the level of financial investment. Therefore, GFRIPZ can restrain CF by increasing the firm's ECE.

We analyze the mediating effect of RDE according to Models (2) and (3). The coefficients of RDE and *treat × post* in the third and fourth columns are significant at 10%, indicating that RDE is the mediating variable for GFRIPZ to restrain CF. The GFRIPZ is a powerful signal for China to release to enterprises that the state has implemented long-term and rigorous environmental governance. According to the Porter effect, the GFRIPZ helps to promote firms to increase R&D investment and reduce their long-term production costs. Specifically, after the implementation of GFRIPZ, the production cost of enterprises may rise in the short term because of the upgrading and transformation of equipment during green production. However, ER will force enterprises to focus more on R&D, which can enable enterprises to improve production processes and reduce long-term production costs (Porter 1991). When the production cost of an enterprise decreases continuously in the long term, it will help the enterprise to gain a competitive advantage. Therefore, GFRIPZ can promote polluting enterprises to increase the scale of RDE, thereby leading to the decline of their financial investment level. Therefore, GFRIPZ can restrain CF by increasing the firm's RDE.

Table 9 Heterogeneity effect of GFRIPZ on CF

	(1) CF	(2) CF	(3) CF
treat × post	0.001 (0.0453)	−0.004* (0.0021)	−0.005* (0.0027)
treat × post × soe	−0.008*** (0.0021)		
treat × post × mmy		−0.068* (0.0036)	
treat × post × pollution			−0.043* (0.0031)
CV	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs	18,834	18,834	18,834
R ²	0.812	0.763	0.803

Heterogeneity analysis

We analyze the heterogeneous effect of GFRIPZ on CF from the perspective of firm property rights. Faced with the pressure of emission reduction brought by the GFRIPZ, firms expect that the future cash flow will be adjusted by ER and there will be greater risks. Firms will prefer to invest more financial assets and increase liquidity reserves to deal with operational risks. However, owing to the existence of soft budget constraints and implicit government guarantees, state-owned firms can obtain more financial subsidies and bank credit, and the financing constraints are lower (Qi et al. 2021). Therefore, under the GFRIPZ, state-owned firms often do not hold excessive financial assets in the short term to cope with future cash flow risk. Based on this, we expect that GFRIPZ can significantly inhibit the level of state-owned firms' financialization. In this study, the property right nature is a dummy variable. The value assigned to state-owned firms is 1, and the value assigned to nonstate-owned firms is 0. We multiply the variable of *treat × post* and the dummy variable of the nature of property rights to verify the heterogeneous impact of the firm property right. The coefficient of *treat × post × soe* in Table 9 is negative, indicating that the inhibition of GFRIPZ on CF is mainly embodied in state-owned firms.

We analyze the heterogeneous effect of GFRIPZ on CF from the firm managerial myopia perspective. The restriction of GFRIPZ on CF mainly stems from the dominant position of capital profit motive when firms make investment decisions. Short-sightedness of management will cause firms to sacrifice long-term interests in pursuit of short-term financial performance. Therefore, this study expects that the GFRIPZ will play a stronger role in restraining CF among firms with lower managerial myopia.

With reference to the practice of Qi and Duan (2022), we selected R&D expenditure reduction to measure the firm's managerial myopia, that is, the ratio of the difference between the R&D expenses of the enterprise this year and last year and the total assets of the enterprise last year. The smaller this indicator is, the higher the firm's managerial myopia degree is. This study multiplies the variable of $treat \times post$ and the managerial myopia. The coefficient of $treat \times post \times mmy$ in Table 9 is significantly negative, indicating that the restraint of GFRIPZ on CF is mainly embodied in firms with low-degree managerial myopia.

We analyze the heterogeneous effect of GFRIPZ on CF from the firm pollution degree perspective. GFRIPZ raises the loan threshold of polluting enterprises and increases their financing constraints (Wang et al. 2022). Enterprise will actively research and develop advanced production equipment and technology, carry out cleaner production, and achieve transformation and upgrading for long-term development. Therefore, polluting firms will increase environmental and R&D expenditures and reduce financial investment behavior. Thus, this study expects that the GFRIPZ will play a stronger role in restraining CF among polluting firms. We take the proportion of sulfur dioxide emissions of different industries in 1995 as the basis for the division of high-polluting industries, according to Deschenes et al. (2017). If the proportion of SO₂ emissions of an industry in the total national emissions exceeds 5%, then the industry is considered a high-polluting industry. This study sets a dummy variable of pollution degree and assigns 1 to firms in high-polluting industries and 0 to other firms. Then, this study multiplies the variable of $treat \times post$ and the dummy variable of firm's pollution degree. The coefficient of $treat \times post \times pollution$ is negative in third column of Table 9, indicating that the restraint of GFRIPZ on CF is mainly embodied in high-polluting firms.

Conclusions and policy implications

This study examines China's GFRIPZ, which has recently gained extensive attention. This study tests the impact of GFRIPZ on CF through the DID method using the data of Chinese listed firms from 2013 to 2020. The results show that GFRIPZ significantly inhibits CF. The result of the intermediary effect shows that GFRIPZ can restrain CF by increasing ECE and RDE. Furthermore, the results of heterogeneity show that the inhibition of GFRIPZ on CF is stronger in state-owned firms, firms with low-degree managerial myopia, and polluting firms. This research has important implications for understanding the green finance policy because of China's rapid economic growth and serious pollution problem. According to the results of this study, the government can curb the CF level and promote the green

transformation and upgrading of enterprises by optimizing the green finance policy.

First, as GFRIPZ can significantly restrain CF, the government should further expand the scope of GFRIPZ. Each pilot zone can develop green finance policies tailored to local conditions according to its own resource conditions and expand the inhibition of green finance policy on CF. In addition, the government should give full play to the important role of green finance in supporting green recovery, accelerate the construction of the green financial system, further improve green financial standards, and establish a standard system that is in line with international standards.

Second, in the context of China's carbon-neutral target and the rapid construction of the national carbon market, banks and other financial institutions should accelerate the development of green financial products. Green financial products can attract more social capital to low-carbon industries and enterprises. These products bring benefits to enterprises that research and develop energy-saving and emission-reduction technologies and develop voluntary emission-reduction projects. In addition, green financial products reduce their green transformation pressure and enable enterprises to voluntarily and efficiently carry out clean development work.

Third, the government should strengthen the synergy among various policies and alleviate the operating and capital pressure brought by green financial policies on enterprise transformation. That is, the government should coordinate other policy means, such as financial subsidies and tax relief. Thus, firms can avoid responding to short-term cash flow fluctuation risk by increasing financial investment to a certain extent, and enterprises are encouraged to increase R&D investment.

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Data availability Data are available on request.

Declarations

Ethics approval Not applicable.

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