

Article

Can the Green Finance Reform and Innovation Improve Green Investment of Heavily Polluting Enterprises?

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Abstract: Determining whether the Green Finance Reform and Innovation Pilot Zone (GFRI) promotes the green investment (GI) of enterprises is practically important for China to achieve the “double carbon” goal early. This study examines the effect of GFRI on GI by the relevant data of listed heavily polluting enterprises in China from 2011 to 2020 and a difference-in-difference model. The results show that GFRI improves the GI of enterprises, and GFRI can enhance GI by promoting reputational costs and loan scale. The improvement effect is also more significant for state-owned enterprises, enterprises with high financing constraints, enterprises in regions with high environmental regulation intensity, and enterprises with executives’ financial backgrounds. The improvement in GI can further enhance the value of enterprises after the implementation of GFRI. The study provides a direct answer to the key question of whether the GFRI can actually support high-quality economic development.

Keywords: green finance; green investment; difference in difference; reputational cost; loan scale



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1. Introduction

China’s 14th Five-Year Plan proposes the promotion of the construction of ecological civilization, which emphasizes green development and the coexistence of humans and nature. Enterprises, as major contributors to environmental pollution, are responsible for preventing pollution, protecting the ecological environment, and working toward carbon peaking and carbon neutrality goals. However, the ecological environment, as a public good, poses externalities and social burdens in terms of environmental pollution control costs. This situation often leads to a lack of motivation for enterprises to invest in environmental protection and governance [1]. The green investment (GI) by enterprises plays a crucial role in driving green development and ensuring sustainability [2,3]. Currently, the scale of GI by Chinese enterprises falls short [4,5], with GI in 2022 accounting for only 1.5% of the country’s GDP. This amount barely meets the minimum international standard for environmental protection expenditure to control environmental degradation. Therefore, determining the way to incentivize enterprises to actively mitigate pollution and increase their level of GI is crucial.

The Chinese government has actively promoted a green financial system and introduced various green finance (GF) policies in recent years. One important policy is the implementation of the GFRI in 2017. Extensive research has shown that this GFRI significantly impacts energy efficiency, green innovation, debt financing costs, and financialization level [6–11]. The core measures of the policy include developing diversified financing tools such as green credit, green bonds, and green insurance to expand financing channels for green projects. An information platform has also been established to provide data on corporate pollution emissions, violations, and participation in environmental pollution liability insurance. This platform enhances accountability for environmental responsibility. GFRI aims to broaden financing channels for green funds, establish comprehensive corporate environmental responsibility disclosure, and encourage social capital involvement in

green project investments to achieve sustainable development goals for enterprises [8,10]. Scholars have studied the influencing factors of GI from the nature of property rights, green management, corporate governance, and senior managers' characteristics. For example, the level of GI of state-owned enterprises is higher than that of other enterprises, which indicates that the GI scale of enterprises has significant property rights heterogeneity [12]. In terms of green management and corporate governance, research shows that enterprises' advocacy of green culture, the implementation of environmental management systems, and equity incentives can promote GI [13,14]. In terms of executives' characteristics, Yacob et al. (2019) found that executives' green awareness can help enterprises improve GI [15]. However, research on the microlevel impact of GFRI on enterprise green transformation, specifically in terms of GI, is lacking.

GFRI represents a form of market-based environmental regulation (ER). The relationship between ER and corporate GI has been extensively investigated in the academic field, which yields three different categories of literature. The first category, which is based on the Porter hypothesis, suggests that appropriate increases in ER intensity by the government not only can reduce environmental pollution but also can stimulate technological progress and enhance green efficiency, which motivates companies to increase their GI voluntarily [16–21]. The second category of literature argues that a negative relationship exists between ER and corporate GI [22–25]. Orsato (2006) suggests that companies need to allocate significant human and financial resources to undertake GIs in the short term, which may not yield corresponding economic benefits. This situation ultimately causes companies to lose their motivation for GI [21]. The third category of literature argues that significant uncertainty exists in the internal and external environment of enterprises, such as the uncertainty of the game between polluting enterprises and the government and the mismatch between the timing of ER implementation and the life cycle of enterprises [26–28]. The literature has verified the effect of GF policy on restraining the expansion of backward production capacity in heavily polluting industries. However, little attention has been given to the effect of GF policy on guiding heavily polluting enterprises to achieve green transformation. The questions to be addressed in this work are as follows: Will GFRI increase the GI of enterprises, which forces them to undergo green transformation? What are the microchannels through which GFRI affects the GI of enterprises? Will GFRI generate heterogeneity in the GI of different enterprises? Can GFRI increase the market competitiveness of enterprises by enhancing their GI? In recent years, more and more developed and emerging economies have been promoting the construction of green finance markets, constructing a green finance development system, and expanding financing channels for green enterprises and projects to achieve the goal of sustainable development. This study can provide a reference for other countries to build green financial systems.

Compared with the previous literature, this study makes several contributions. First, this work establishes a connection between market-based ER and corporate GI by treating the implementation of GFRI as a quasi-natural experiment. We test the effectiveness of the GFRI and provide theoretical support for further improving and replicating the GFRI. Second, this research analyzes the mechanism through which GFRI enhances corporate GI, which demonstrates that expanding the financing channels for green funds and establishing a comprehensive mechanism of corporate environmental responsibility information disclosure are crucial channels through which GFRI promotes corporate GI. Third, this study enriches the research on the influencing factors of GI and provides a new perspective for enhancing GI, which is practically important for promoting enterprise green transformation. Compared with traditional ER measures [29–32], the distinctive feature of GFRI lies in leveraging market-oriented means, encouraging more social capital to invest in green projects through the effective allocation of financial resources, and serving as an effective measure to stimulate enterprises' GI.

2. Policy Background and Research Hypothesis

2.1. Policy Background

In response to the people's yearning for a beautiful ecological environment, the Chinese government has continued to promote the construction of ecological civilization. Thus, ecological civilization is present in a series of major strategic deployments. Green development is the main content of ecological civilization construction. In August 2016, GF was first defined at the national level in the *Guiding Opinions on Building a Green Finance System* issued by the Chinese government. GF can improve the environment, reduce pollution, and achieve efficient conservation and the rational use of resources. In June 2017, China built distinctive GFRI in the Zhejiang, Jiangxi, Guangdong, Guizhou, Xinjiang, and Gansu provinces.

The pilot areas have different levels of economic development, industrial structures, resources, environmental carrying capacities, and resource endowments. This difference indicates that these pilot areas have a certain representativeness. Each pilot area has its own emphasis on the development of GF. Based on the implementation of the "Belt and Road" policy, Xinjiang is positioned to strengthen the financial support of GF for modern agriculture and clean energy through green development. Xinjiang plans to gradually increase the proportion of GF tools in the social financing scale within 5 years and reduce the loan scale and proportion of industries with high pollution and industrial surplus annually. Based on the implementation of big data technology, Guizhou Province is positioned to support the construction of projects and infrastructure related to the ecological environment and poverty alleviation projects through GF and ultimately form a wide coverage and powerful GF service system. Guangdong Province is positioned at the GF cooperation among Guangdong, Hong Kong, and Macao and mainly develops the GF market. Jiangxi Province is positioned at the diversified development of the GF system and enriches the variety of GF products. Zhejiang Province is positioned to increase the scale of green financing through innovation of the GF system, mechanisms, and products to support the green transformation of traditional industries. The development of GF has played a positive role in environmental governance and economic finance in the environment where countries all over the world are striving to seek the path of sustainable economic development.

2.2. Research Hypothesis

The GFRI can fully exploit institutional advantages, mainly in two ways, to help enterprises improve their GI. One is to provide all-round convenient services for the declaration and financing of environmental protection projects. The other is to limit industrial projects of high pollution through the establishment of pollution discharge, environmental illegal blacklist, and other ways. Under the dual effects of positive incentives and negative punishments, enterprises will increase their necessary environmental investment and fully fulfill their social responsibilities.

This study analyzes the effect of GFRI on enterprises' GI from the following two aspects. First, information asymmetry theory posits that a perfect green credit system and credit policy evaluation mechanism are conducive to motivating enterprises to engage in GI. Specifically, the establishment of a GF full-chain environmental information disclosure mechanism and green credit evaluation mechanism in the pilot area can force enterprises to engage in GI. The GFRI incorporates enterprises' green information, environmental violations, and participation in environmental pollution liability insurance into the national credit information sharing platform and enterprise credit system. This can alleviate the information asymmetry between internal and external stakeholders, which attracts more social capital to green projects and is conducive to the public's external supervision function. Thus, the reputational risk faced by enterprises is increased, and these enterprises are prompted to improve their environmental performance. On the other hand, GFRI links the environmental performance of enterprises with the credit policy evaluation mechanism, embeds green criteria in the credit investigation and review process, and restrains the blind

expansion of highly polluting enterprises by means of differentiated credit policies that inhibit their credit demand and raise debt financing costs [4]. It also opens up green channels for enterprises' green projects and focuses on meeting energy-saving, environmental protection, and green technology projects. As a result, the environmental performance of enterprises is improved. In the pilot region, if an enterprise exceeds the pollution emission standards or commits environmental violations such as environmental pollution, then it will be included in the blacklist of the environmental protection department. This situation will also convey negative environmental news about the firm to the capital market, which could damage the firm's reputation and value. Thus, the poor environmental performance of an enterprise can reduce investors' recognition of the enterprise's sustainability potential, increase barriers to credit, reduce credit limits, and negatively affect the long-term career development of the company's management. On the contrary, the good environmental performance of companies can effectively increase the value of listed companies, enable access to more credit resources, and lower financing costs. Therefore, when the management encounters the strict environmental information disclosure mechanism and external monitoring mechanism of GFRI, it will actively make GI for preventive motives and actively guide the company to optimize green technology, reduce pollution emissions, and mitigate the negative social externalities caused by production and operation activities. The management can conduct these activities by acquiring energy-saving and emission-reducing equipment or technological renovation.

Second, the GFRI provides diversified green capital financing channels for the technological transformation of enterprises, improves the convenience of financing, and helps promote the GI activities of enterprises. GI is a special investment activity that contributes economic and environmental benefits. In the long term, GI is conducive to improving the energy use efficiency of enterprises, establishing a long-term mechanism for energy conservation and emission reduction, and enhancing the sustainable development capacity of enterprises. In terms of the environmental benefits of GI, if a company wants to achieve environmental benefits in the short term, then it needs to invest high amounts of R&D capital. Therefore, GI has a long investment cycle and faces high uncertainty, which leads to the lack of enthusiasm of enterprises to make GI. The district implementation plan of the GFRI enables the establishment of perfect green industry financing channels in the pilot area and actively guides the flow of social resources to green projects. The pilot areas will open up green channels for green enterprises through diversified financing channels such as green credit, green development funds, and equity pledge financing in regional equity markets. Therefore, GFRI improves the availability of green funds for enterprises, provides whole-chain financial services for green enterprises, and encourages projects focused on green industries and technological transformation. GFRI also provides enterprises with green technological innovation and green transformation projects of traditional industries with sufficient financial support. GFRI can guide various types of social capital to enter the green financial market, effectively alleviate the financing constraints faced by enterprises in conducting GI, improve the convenience of financing when enterprises perform green projects, and optimize the debt structure. Therefore, the diversified financing channels of the GFRI policy provide financing convenience for GI activities of enterprises. This situation motivates them to conduct green technological transformation and achieve the win-win goal of business development and environmental protection.

On the basis of the abovementioned analysis, this study hypothesizes that the GFRI is conducive to improving the enterprises' GI.

3. Model and Data

3.1. DID Model

The DID model has become a common method for evaluating the implementation effect of a policy [33,34]. When evaluating the implementation effect of China's green finance policy, existing research widely uses the DID method for regression analysis [8–10]. To describe the policy impact and effectively overcome the related endogenous problems,

we use the DID methodology to analyze the effect of GFRI on GI, take the pilot and non-pilot enterprises as the treated and control groups, respectively, and add other variables that have an impact on the GI effect. By comparing the differences between the control and treated group prior to and subsequent to the implementation of the GFRI, the net effect of GFRI on GI is measured. This study constructs the following model to examine the effect of GFRI on GI.

$$GI_{it} = \alpha_0 + \alpha_1 Treat_i \times Time_t + \alpha_2 CV_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (1)$$

where GI is the dependent variable, indicating the GI level of the enterprise i in the year t . The key explanatory variables $Treat \times Time$; $Treat$ is a dummy variable of the treatment group, representing the enterprises in pilot areas. We assign 1 as the treatment group, and 0 as the rest. $Time$ is the time dummy variable. The $Time$ is 1 after the implementation of GFRI. The $Time$ is 0 before the implementation of GFRI. CV is the control variables, which influence GI. μ and γ represent the firm and year-fixed effect, respectively. We are most concerned about the double difference term $Treat \times Time$, whose estimated coefficient represents the net impact on the GI of enterprises before and after the implementation of the GFRI. If the coefficient of $Treat \times Time$ is significantly positive, which indicates that the green finance pilot policy can effectively improve the level of GI of enterprises and verifies the research hypothesis of this study.

3.2. Data and Variable

3.2.1. Data Source

The green transformation of heavily polluting enterprises is crucial to China's sustainable development, and they may be more affected by GFRI. Therefore, the Chinese A-share heavily polluting listed firms from 2011 to 2020 are selected as the research object. The samples with missing data in the sample period and the enterprises (marked as ST or *ST) that suffered serious losses in the sample period are eliminated. All continuous variables are winsorized at the 1% level. The firm data come from the Wind database. The classification of heavily pollution industries is based on the *Notice on Printing and Distributing the Industry Classification Management List for Environmental Protection Verification of Listed Companies*.

3.2.2. Variable Definition

GFRI: $Treat \times Time$ measures the effect of GFRI on GI. $Treat$ is used to define enterprises in pilot cities, setting the $Treat$ of pilot enterprises to 1 and the $Treat$ of non-pilot enterprises to 0. $Time$ is used to identify the time of GFRI on the basis of the time point of policy occurrence.

GI: GI is an investment made to reduce carbon emissions and air pollutant emissions, and its essence is the investment expenditure of enterprises which has a friendly impact on the environment [35]. Referring to the practice of Ding et al. (2023) [36], we measure GI by the total investment expenditure directly related to enterprises' environmental protection. Since the amount of GI of some enterprises is 0, in order to reduce the impact of heteroscedasticity, this study adds 1 to the amount of GI and then takes the natural logarithm.

Control variables (CV): Referring to the practice of Wang et al. (2017) [4] and Ding et al. (2023) [36], this study selects variables such as the enterprises' size and financial condition, which may influence GI as the control variables. Table 1 lists the related variables and the descriptive statistics.

Table 1. Descriptive statistics.

	Obs	Definition	Mean	Sd	Min	Max
GI	3633	The logarithm of total green investment expenditure (RMB)	16.108	4.685	0	25.398
lnsize	3633	The logarithm of enterprise's total assets (RMB)	22.709	1.375	20.055	26.331
lnage	3633	The logarithm of enterprise's age	2.431	0.666	0.693	3.367
roa	3633	The ratio of net profit to total assets	0.033	0.053	−0.228	0.266
lev	3633	The ratio of liabilities to total assets	0.476	0.203	0.052	0.969
growth	3633	The growth rate of total assets	0.105	0.219	−0.449	2.042
equity	3633	The ratio of shareholding ratio between the enterprise's largest shareholder and the second largest shareholder	14.697	34.411	1	778.166
cash	3633	Cash flow of the enterprises	1.415	3.275	−1.667	20.414

4. Results and Discussion

4.1. Benchmark Results

Through Equation (1), we construct a benchmark regression model. Column (1) of Table 2 shows a linear regression result without adding any CV and fixed effects. On the basis of column 1, column 2 and, column 3, we add time and firm fixed effect, respectively, and introduce control variables. The DID coefficients are significantly positive, indicating that the GFRI policy has a significant positive effect on enterprises' GI. Therefore, the hypothesis of this study is verified.

Table 2. The effect of GFRI on GI.

	(1)	(2)	(3)
	GI	GI	GI
Treat × Time	2.689 *** (0.451)	2.575 *** (0.411)	2.765 *** (0.843)
lnsize		1.338 *** (0.0761)	1.226 *** (0.232)
lnage		−0.216 * (0.125)	−0.447 (0.453)
roa		0.165 (1.555)	0.193 (1.842)
lev		0.263 (0.448)	−0.606 (0.767)
growth		−0.179 (0.340)	0.266 (0.355)
equity		0.00190 (0.00122)	0.00439 ** (0.00176)
cash		0.0483 ** (0.0230)	0.0187 (0.0371)
ID Effect	NO	NO	YES
Year Effect	NO	YES	YES
Observations	3633	3633	3558
R-squared	0.004	0.18	0.468

Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2. Robustness Tests

4.2.1. Parallel Trend and Placebo Test

The premise behind the use of a DID model for policy evaluation is meeting the parallel trend assumption. That is, if the GFRI policy is not implemented, then the trend of the changes in the GI level between the pilot and non-pilot enterprises should be parallel.

Referring to the approach of Zhou et al. (2023) [1], this study conducts event analysis to perform a parallel trend test.

$$GI_{it} = \beta_0 + \sum_{t=2014}^{2020} \beta_t Treat_i \times Time_t + \beta_1 CV_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (2)$$

where coefficient β_t is the key coefficient of Equation (2), representing the difference between the experimental group and control group. Columns 1 and 2 of Table 3 report the results of the parallel trend test. The DID model coefficients ($Treat \times Time_{2014}$, $Treat \times Time_{2015}$, $Treat \times Time_{2016}$) are not significant, which means that the parallel trend test is passed. Then, we assume that the establishment periods of GFRI are in 2014, 2015, and 2016, delete the samples from 2017 and later, and then regress them separately based on Equation (2). The coefficients of $Treat \times Time$ in columns 3 to 5 are insignificant, which means that the placebo test is passed.

Table 3. Parallel trend and placebo test.

	(1)	(2)	(3)	(4)	(5)
	GI	GI	GI	GI	GI
Treat $\times$ Time			−0.957 (1.311)	−0.853 (1.224)	−1.044 (1.439)
Treat $\times$ Time ₂₀₁₄	−2.513 (1.725)	−2.411 (1.710)			
Treat $\times$ Time ₂₀₁₅	1.009 (1.024)	1.234 (1.000)			
Treat $\times$ Time ₂₀₁₆	−0.556 (1.416)	−0.608 (1.398)			
Treat $\times$ Time ₂₀₁₇	1.308 * (0.726)	1.392 * (0.764)			
Treat $\times$ Time ₂₀₁₈	2.877 *** (1.062)	2.8 *** (1.027)			
Treat $\times$ Time ₂₀₁₉	3.498 *** (1.143)	3.415 *** (1.08)			
Treat $\times$ Time ₂₀₂₀	2.49 ** (1.244)	2.43 ** (1.179)			
CV	NO	YES	YES	YES	YES
ID Effect	YES	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES	YES
Observations	3558	3558	2036	2036	2036
R-squared	0.461	0.469	0.312	0.319	0.317

Robust standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4.2.2. Excludes Interference from Other Policies

If other pilot policies occur in the same period, the estimation results may mistakenly capture the impact of other policies on GI, rather than the impact of GFRI policy. In 2013, the Chinese government launched a carbon trading policy aiming to encourage enterprises to reduce carbon emissions through market-oriented means, which is likely to have an impact on GI of enterprises. Referring to the practice of Zhou and Qi (2022) [37], the samples in pilot carbon areas are removed and re-estimated. As Table 4 shows, The DID coefficients are significant. China actively carried out a pilot low-carbon city policy in 2010. To eliminate interference, the samples in pilot cities are removed and re-estimated. As Table 4 shows, the DID coefficients remain significant.

Table 4. Excluding the impact of other policies.

	(1)	(2)
	Carbon Trading Policy GI	Low-Carbon City Policy GI
Treat $\times$ Time	1.675 *** (0.492)	1.583 *** (0.427)
CV	YES	YES
ID Effect	YES	YES
Year Effect	YES	YES
Observations	3011	2865
R-squared	0.344	0.346

Robust standard errors in parentheses, *** $p < 0.01$.

4.2.3. PSM-DID

We selected control variables as identifying characteristics of the sample and used the PSM method to match enterprises in pilot areas and non-pilot enterprises to eliminate sample selection bias and obtain bias-free estimates. Then, the DID model was used to regress the matching results. As Table 5 shows, the DID coefficients were positive, suggesting that the conclusion of this study has good robustness.

Table 5. PSM-DID.

	(1)	(2)	(3)
	GI	GI	GI
Treat $\times$ Time	2.893 *** (0.453)	2.67 *** (0.415)	2.683 *** (0.871)
CV	NO	YES	YES
ID Effect	NO	NO	YES
Year Effect	NO	YES	YES
Observations	2933	2933	2933
R-squared	0.006	0.171	0.448

Robust standard errors in parentheses, *** $p < 0.01$.

4.2.4. Other Robustness Tests

The DID method may be more accurate in the estimation of short-term period samples [1]. The sample time of this paper is from 2009 to 2020. During the sample period of this paper, there may be other unobservable factors that interfere with the DID model. We reduced the sample time to 2014 to 2018 and then re-estimated based on Equation (1). The coefficient of *Treat $\times$ Time* in Table 6 is still significant. In addition, this study added an interaction of the city fixed effect and the time fixed effect to the benchmark model to control the economic factors at the city level, such as financial development and R&D investment. As Table 6 shows, the DID coefficient is still positive.

Table 6. Other robustness tests.

	(1)	(2)
	Change Sample Interval GI	Confounding Factors at the City Level GI
Treat $\times$ Time	2.143 *** (0.592)	2.754 *** (0.843)
CV	YES	YES
ID Effect	YES	YES
Year Effect	YES	YES
Observations	1835	3558
R-squared	0.386	0.468

Robust standard errors in parentheses, *** $p < 0.01$.

4.3. Mechanism Analysis

4.3.1. Reputational Cost

As a unique resource of the enterprise, reputation can bring various resources to the enterprise and enhance its competitiveness. Reputation cost refers to the loss caused by negative public opinion on the operation of an enterprise [38]. Referring to the practice of Gallemore et al. (2014) [38], we use the proportion of advertising expenses to operating revenue to measure enterprises' reputational costs. A triple interaction item ($Treat \times Time \times Repucost$) was added to Equation (1) to test the impact mechanism of GFRI. As Table 7 shows, the coefficient of $Treat \times Time \times Repucost$ is significant, indicating that GFRI policy can improve GI by increasing the reputational cost of enterprises. The GFRI establishes a full chain environmental information disclosure mechanism in the pilot area and incorporates the enterprise pollution information, environmental violations, and the participation of environmental pollution liability insurance into the national credit information sharing platform and enterprise credit reporting system, which greatly improves the reputational cost faced by pilot enterprises [39]. The negative environmental information of an enterprise can lead to negative evaluations from stakeholders or the public, thereby affecting the enterprise's market performance. In order to restore its reputation, the enterprise needs to invest more in green projects for reducing environmental pollution. The higher the reputational cost, the stronger the enterprise's motivation for GI.

Table 7. Mechanism research.

	(1)	(2)
	GI	GI
Treat $\times$ Time	2.541 * (1.411)	1.855 * (1.013)
Treat $\times$ Time $\times$ Repucost	1.115 * (0.586)	
Treat $\times$ Time $\times$ Loan		0.956 * (0.505)
Repucost	1.991 * (1.087)	
Loan		1.253 * (0.666)
CV	YES	YES
ID Effect	YES	YES
Year Effect	YES	YES
Observations	3558	3558
R-squared	0.451	0.446

Robust standard errors in parentheses, * $p < 0.1$.

4.3.2. Loan Scale

The loan scale refers to the borrowing funds that enterprises borrow from banks and other financial institutions to expand reproduction. We used the proportion of loans to total assets to measure the loan size of the enterprise. A triple interaction item ($Treat \times Time \times Loan$) was added to Equation (1) to test the impact mechanism. As Table 7 shows, the coefficient of $Treat \times Time \times Loan$ is significant, indicating that the GFRI can improve GI by increasing the loan size of enterprises. The GFRI provides diversified green capital financing channels for enterprises' green investment activities, improves financing convenience, and can effectively alleviate the financing difficulties of enterprises' green investment projects. When the financing constraints faced by enterprises for research and development activities become smaller, the borrowing scale of enterprises will increase. With more borrowing funds, enterprises tend to invest in green areas. Therefore, the GFRI promotes the expansion of the borrowing scale of enterprises, thus stimulating the increase of investment in the green field.

4.4. Heterogeneity Analysis

4.4.1. Ownership

Previous studies have concluded that state-owned enterprises (SOEs) have significant institutional advantages, and SOEs not only pursue short-term economic benefits but also shoulder more social responsibilities and pay more attention to the comprehensive benefits of environmental and social benefits. However, non-SOEs often focus on economic benefits and pursue short-term profit maximization, lacking consideration for environmental benefits. GFRI may have heterogeneous effects on GI across ownership types. Table 8 shows that the incentive effect is more pronounced in SOEs. Compared with non-SOEs, SOEs are larger in scale, have closer connections with the government and financial institutions, and face lower financing constraints. After the implementation of the GFRI policy, under the pressure of government, SOEs have a greater incentive to reduce emissions. And SOEs will also be supported by more green funds provided by financial institutions when carrying out green transformation. Therefore, the GFRI policy can more effectively promote the GI level of SOEs.

Table 8. Heterogeneity results.

	(1)	(2)	(3)	(4)
	GI SOEs	GI Non-SOEs	GI High FC	GI Low FC
Treat × Time	3.11 *** (0.862)	0.493 (1.943)	2.89 *** (0.731)	1.223 (1.886)
CV	YES	YES	YES	YES
ID Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
Observations	1966	1576	1779	1779
R-squared	0.476	0.431	0.412	0.464

Robust standard errors in parentheses, *** $p < 0.01$.

4.4.2. Financial Constraint

Financial constraint refers to the various restrictions and constraints faced by enterprises in the financing process. The SA index is composed of the two variables of completely exogenous enterprise age and enterprise scale, excluding endogenous variables, which can avoid the measurement errors [40,41]. Referring to the practice of Hadlock and Pierce (2010) [40], we use the SA index as a financing constraint (FC) indicator and divide the sample into high and low FC groups by median. Table 8 shows that the incentive effect of GFRI is more pronounced in high FC enterprises. The green transformation of enterprises cannot be achieved without a large amount of long-term capital investment, and FC is one of the key factors hindering the green transformation of enterprises. External financing is an important source of funding for enterprises to carry out green projects [42]. Compared to enterprises with low FC, enterprises with higher FC often face higher transformation risks and are usually unwilling to make GI. However, when the GFRI policy is implemented and the FC faced by enterprises is alleviated, their willingness to make green investments will increase.

4.4.3. Environmental Regulation

Environmental regulation is the regulation of various behaviors that pollute the public environment with the aim of protecting the environment. The intensity of ER is an important factor affecting enterprises' GI. The greater the ER pressure faced by enterprises, the stronger their motivation for GI. We measured the ER intensity by the ratio of regional pollution discharge costs to industrial added value and divided the sample into high and low ER groups by median. Table 9 shows that the incentive effect of GFRI is more pronounced in enterprises of high ER intensity. The stronger the ER, the greater the environmental penalties faced by enterprises. The high cost of pollution emissions will

affect the normal operation of enterprises, and the willingness of enterprises to engage in green transformation will increase. Therefore, ER will strengthen the effect of GFRI on enterprises' GI.

Table 9. Heterogeneity results.

	(1)	(2)	(3)	(4)
	GI High Environment Regulation	GI Low Environment Regulation	GI High Financial Background	GI Low Financial Background
Treat × Time	2.997 *** (0.768)	1.638 (1.744)	2.672 *** (0.668)	1.85 (1.912)
CV	YES	YES	YES	YES
ID Effect	YES	YES	YES	YES
Year Effect	YES	YES	YES	YES
Observations	1779	1779	1135	2423
R-squared	0.428	0.447	0.433	0.489

Robust standard errors in parentheses, *** $p < 0.01$.

4.4.4. Executives with Financial Background

The financial background of executives can affect their business decisions. Executive financial background refers to whether the executive has any relevant financial work experience in the past. Column 3 of Table 9 shows that in the sample enterprises without the financial background of executives, the DID coefficient is not significant. Column 4 of Table 8 shows that in the sample enterprises with financial backgrounds of executives, the DID coefficient is positive at the significance. This indicates that GFRI can motivate enterprises with the financial background of executives to improve GI, while its impact on enterprises without financial background of executives is not obvious. This can also indicate that the leadership with financial background may be more predictive of policy than the senior personnel without financial background. Management with financial backgrounds may also have stronger policy understanding and reaction ability. This will help enterprises obtain the policy dividends provided by the GFRI policy and promote GI.

4.5. Economic Effect of GFRI

Through the above research, it is found that the GF is conducive to stimulating enterprises' GI enthusiasm and promoting green transformation. Can the increase in GI by enterprises be beneficial for enhancing enterprise value and thus enhancing competitiveness? To investigate whether the improvement of GI of enterprises can further enhance the enterprise value with the implementation of GFRI, the following model is constructed by referring to Wang et al. (2022) [42].

$$Vaule_{it} = \alpha_0 + \alpha_1 Treat_i \times Time_t \times GI_{it} + \alpha_2 CV_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (3)$$

The explained variables *Value* in Equation (3) represent enterprise value, which is represented by enterprises' Tobin Q value. As columns 1 and 2 in Table 10 show, the coefficients of *Treat × Time × GI* are significant, which indicates that the improvement of GI can further enhance the value of enterprises after enterprises participate in GFRI. With the government's emphasis on sustainable green development and the call for environmental protection related policies, the public is increasingly paying attention to the enterprises' environmental information. Relevant research indicates that the capital market will react to environmental information of listed enterprises [43]. Ma and Sheng (2022) determined that corporate environmental pollution scandals can lead to a decline in corporate value by studying the public's response to media exposure of corporate environmental protection [44]. By participating in the GFRI, enterprises can improve GI and reduce pollution, which can demonstrate their support for green causes, reflect their sense of social responsibility, and improve their reputation. At the same time, the environmental benefits brought

by the improvement of GI and the reduction of carbon emissions also further accumulate the green reputation of enterprises, enhance investor confidence in enterprises, encourage investors to purchase corporate stocks more actively, and enhance enterprise value.

Table 10. Economic effect of GFRI.

	(1)	(2)
	Value	Value
Treat $\times$ Time $\times$ GI	0.55 *** (0.192)	0.66 *** (0.172)
CV	NO	YES
ID Effect	YES	YES
Year Effect	YES	YES
Observations	3633	3558
R-squared	0.607	0.616

Robust standard errors in parentheses, *** $p < 0.01$.

5. Conclusions, Policy Implications and Limitations

5.1. Conclusions

Developing a low-carbon economy is an inevitable choice for many countries. Under the current economic situation in China, traditional industries are still an important component of the national economy, and some heavily polluting enterprises cannot be completely replaced. However, environmental protection is urgent. Therefore, it is particularly important to find a method that can not only improve the level of environmental protection but also achieve economic restructuring. Determining whether the GFRI promotes the GI of enterprises is practically important for China to achieve the “double carbon” goals early. We used a DID model to examine the effect, mechanism, and heterogeneity of GFRI on GI by using the data of listed enterprises from 2011 to 2020. This paper draws the following conclusions. First, the research hypothesis of this study, that is, GFRI can promote the improvement in the GI of enterprises, has been verified. Second, the GFRI promotes the GI of enterprises by enhancing reputational costs and loan scale. Third, the GFRI is more conducive to improving the GI of SOEs, enterprises with high FC, enterprises in regions with high ER intensity, and enterprises with executives’ financial backgrounds. Fourth, the improvement in GI can further enhance the value of enterprises after the implementation of GFRI. This study enriches the literature in the field of evaluating the effectiveness of GFRI and provides a decision-making reference for improving the design of GFRI and promoting the realization of dual carbon goals.

5.2. Policy Implications

On the basis of the abovementioned research conclusions, we propose the policy implications:

First, this study finds that green finance can promote enterprises’ GI, indicating the effectiveness of GFRI. The government should actively play a guiding role, accelerate the construction of the GF system, continue to promote the establishment of GFRI, and expand the scope of GFRI under the strategic objectives of carbon neutrality and carbon peak. The government should also increase the support of green funds, stimulate the willingness of enterprises to undergo green transformation and development, and provide sufficient financial support for the technological transformation and production process improvement of heavily polluting enterprises. The other suggested tasks for the government are stimulating the enthusiasm of enterprises for GI and realizing high-quality development. In addition, for developing countries, they can learn from China’s approach and implement green finance policies to promote the sustainable development of their green enterprises.

Second, this study finds that the GFRI promotes the GI of enterprises by enhancing reputational costs and loan scale, indicating financing constraints and reputation costs are the intermediary channels through which GFRI affect GI. The government needs to

improve the supporting mechanism of GF and fully exploit the policy effect of GF. On the one hand, the government should strengthen the construction of green information sharing platforms and credit evaluation systems for enterprises, improve the pricing mechanism of green information, and enhance the green reputation risk and transparency of green information for enterprises. On the other hand, the government can launch diversified financing channels within the pilot zone, improve the financing convenience of green funds, alleviate corporate financing constraints, and provide sufficient financial support for GI by enterprises.

Third, the government can establish a green fund monitoring mechanism to strictly control the use of green funds and reduce the risk of GF. The government formulates a unified green project catalog and green fund monitoring mechanism to accurately evaluate the environmental protection attributes and expected environmental and social benefits of different green projects of enterprises. This mechanism also prevents the risk of polluting enterprises obtaining green funds through falsification and false reporting of environmental performance and ensures that social capital truly flows to green projects for promoting the green transformation and development of polluting enterprises.

Fourth, the perception of enterprise managers directly impacts the formulation and decision making of enterprise strategies. Executives with strong environmental awareness also play an extremely important role in the long-term development of the enterprise. The improvement in GI can further enhance the value of enterprises after the implementation of GFRI, which means that enterprises will gain considerable economic benefits after increasing GI. So, enterprise executives should prioritize GI at a strategic level and gradually form a green and low-carbon corporate culture. They should truly integrate it into the process of sustainable development of the enterprise. Senior managers of enterprises should also closely monitor the changes in carbon regulatory direction and social environmental awareness, grasp the development trends of the industry, and adjust enterprise strategies in a timely manner. They should also seize the opportunities brought by policy changes, enhance their market competitiveness through GI, and then bring them first-mover advantages. This way opens up a new path of green development.

5.3. Limitations

Different pilot areas have adopted different green financial tools when implementing GFRI. Green financial tools include green credit, green bonds, and green insurance. Their roles in GI of enterprises are different, which is worthy of in-depth study. Owing to the lack of indicator data to measure green financial tools at the enterprise level, this study can only investigate the effect of GFRI on GI. In the future, this study will collect data on different green financial tools in different regions to specifically evaluate the heterogeneity effects of different green financial tools.

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