



How the Green Finance Policy of China's Central Bank Helps the Green Transformation of Enterprises

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Abstract. We conducted a quasi-natural experiment, based on the Medium-term Lending Facility (MLF) collateral expansion and green bonds are included as eligible collateral since then. We adopts a triple-difference method to empirically test whether the green finance policy of China's Central Bank collateral promotes the green transformation of enterprises and its effect channels. The findings are as follows: (1) The green finance policy of China's Central Bank collateral includes green bonds rated AA or above as eligible collateral assets, which releases the incentive signal for green innovation and promotes the green transformation of related enterprises; (2) The policy can reduce the bond financing costs of enterprises by reducing the bond issue spreads, so that enterprises can obtain more funds and take the initiative in green transformation.

Keywords: green finance policy · MLF expansion · Green transformation

1 Introduction

Achieving carbon peaking and carbon neutrality is a broad and profound systemic change in economic society. How to promote green transformation and help achieve carbon peaking and carbon neutrality goals? Green transformation is inseparable from the improvement and development of green finance system. In June 2018, China's Central Bank expanded the range of collateral for the Medium-term Lending Facility (MLF) to include green bonds rated at least AA into the collateral framework. By combining green finance support policies with collateral-based monetary policy tools, the aim is to structurally regulate financial resources and direct them to the green economy. The Central Bank included green bonds in the expansion of Medium-term Lending Facility collateral, sending out a strong and favorable signal of vigorously supporting green development. But can green finance policies succeed in gaining the support of macro monetary policies to encourage enterprises to actively pursue green transformation? This paper will focus on the problem.

1.1 Related Literature

Bonds are a direct financing channel for enterprises. And green bond is a big pillar of China's green finance policy. Issuing green bonds can significantly improve the corporate value [1]. After issuing green bonds, the company's environmental performance has been improved, with higher environmental rating and lower carbon dioxide emission [2]. The dual attributes of "bond" and "green" make green bonds of great significance for the sustainable development of enterprises [3]. Green bonds are an emerging green financial instrument with a particularly rapid development in China. China's Central Bank has included qualified green bonds into the Medium-term Lending Facility (MLF) as collateral, adding macro-monetary policies to help green finance promote green transformation. Existing studies on MLF collateral expansion policy have not paid much attention to green finance factors [4–6]. Only Chen, G.J., et al. [7] believe that the policy significantly improves green innovation of brown enterprises.

By summarizing the existing literature, the potential paths for the green finance policy of China's Central Bank collateral to affect the green transformation of enterprises are as follows: first, give play to the value of bond asset pledge, affecting the scarcity and price of bonds and reduce the bond financing costs of green innovation of enterprises by reducing the bond issuance spreads. Based on the Fire Buy theory, when the Central Bank introduces unlimited liquidity supply, banks' demand for collateral assets will increase, resulting in increased scarcity of related assets and rising prices in the short term [8]. Eligible securities can be refinanced or purchased by central banks, which may affect their repo rates, liquidity and secondary market prices [9]. Chen, H., et al. [4] found that the decline of bond collateral ability would lead to the increase of the credit spread in the secondary market. Wang, Y.Q and Wu, X. [5] found that the increase in the collateral ability of bonds reduces the bond issuance spread. Chen, G.J., et al. [7] found that the inclusion of AA and above green corporate bonds and financial bonds as eligible collateral significantly reduced the issue spread of green bonds and produced a positive green effect. Second, bond financing can create favorable conditions for enterprise innovation by reducing the cost of debt financing and extending the term of debt [10]. Compared with credit, bond financing saves the cost of indirect financing price attached by financial intermediary to maintain operation and normal profit [10], so that enterprises have more funds for internal innovation and risk diversification; The long term of bond financing can enhance the periodic matching between corporate debt financing and corporate innovation projects, and escort the smooth development of innovation projects; Bond liquidity enables investors to sell or buy related bonds according to their own preferences through bond market trading, helping enterprises to match investors with inclusive investment behaviors, reducing the search cost and financing cost of green innovation subjects, and stabilizing the source of innovation funds [11, 12]. Based on the comprehensive analysis of the related literature, we proposes a hypothesis as below:

Hypothesis 1. The implementation of the green finance policy of China's Central Bank collateral can promote the green transformation of relevant enterprises.

2 Research Design

2.1 Baseline Regression

The green finance policy of China's Central Bank collateral includes AA grade small and micro enterprises, green and "agriculture, rural areas and farmers" financial bonds and AA, AA + grade corporate credit bonds into the scope of eligible collateral, making them have mortgage value, and highlighting the priority of green bonds, releases the signal of green transformation to enterprises. This paper uses the following model to test whether the policy can promote the green transformation of relevant enterprises:

$$\begin{aligned} \text{innovation}_{ijt} = & \beta_1 + \beta_2 \text{post}_t * \text{treat}_i * \text{ib}_j + \beta_3 \text{post}_t * \text{treat}_i + \beta_4 \text{post}_t * \text{ib}_j \\ & + \beta_5 \text{post}_t * \text{ib}_i + \beta_6 \text{post}_t + \beta_7 \text{treat}_i + \beta_8 \text{ib}_j + \gamma \text{controls}_{it} + \delta_i + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (1)$$

Subscript i represents the bonds issued by the enterprises, j is the bond issuance market, and t is the date; innovation_{ijt} stands for enterprise green innovation, we use the number of green patent applications and authorizations to measure the extent of the enterprise green transition [13]; post_t , treat_i and ib_j are time, bond and issue market dummy variables respectively. We also controlled some corporate financial variables, as shown in Table 1. δ_i is the industry fixed effect, θ_t is the year fixed effect, and ε_{ijt} is the random error term. Robust standard error is used in this paper.

2.2 Further Analysis: How the Policy Promotes Green Transformation of Enterprises?

On the basis of model (1), we add the quadruple-difference term $\text{post} * \text{treat} * \text{ib} * \text{spread}$ to explore the potential effect channels of the policy on the green transformation of enterprises: whether the policy can reduce the financing costs of corporate bonds through bond issue spreads, so that enterprises can obtain more financial resources for R&D and innovation activities, and form a virtuous cycle of green innovation.

$$\begin{aligned} \text{innovation}_{ijt} = & \beta_1 + \beta_2 \text{post}_t * \text{treat}_i * \text{ib}_j * \text{spread}_{ijt} + \beta_3 \text{post}_t * \text{treat}_i * \text{ib}_j \\ & + \beta_4 \text{post}_t * \text{treat}_i + \beta_5 \text{post}_t * \text{ib}_j + \beta_6 \text{treat}_i * \text{ib}_j + \beta_7 \text{post}_t + \beta_8 \text{treat}_i + \beta_9 \text{ib}_j \\ & + \gamma \text{controls}_{it} + \delta_i + \theta_t + \varepsilon_{ijt} \end{aligned} \quad (2)$$

The variable settings of other parts of model (2) are the same as those of model (1). Spread is the bond issue spread, expressed as the bond issue interest rate minus the yield to maturity of risk-free bonds (Treasury bonds) with the same maturity.

2.3 Data Sources

The bond data in this paper are the primary market data of corporate bonds, medium-term notes and financial bonds rated AA or above. Since China's green bond market was officially launched at the end of 2015, the sample period is from January 1, 2016 to September 31, 2022. The data of bond and corporate financial indicators are from WIND database. The green patent data are invention and utility model patent data of A-share

listed companies from 2016 to 2021 from Chinese Research Data Services (CNRDS) database. And company code and company name from CSMAR database. We matched all the data according to the actual issuer name and the company code.

The original data are processed as follows: (1) Eliminate the data with negative credit spread and serious missing variables, and eliminate ST and ST* company data; (2) Excluding the bonds with “X + Y” maturity and “progressive” interest rate, these two types of bonds’ interest rate cannot represent the real financing cost of enterprises [6]. (3) All data were identified at 1% and 99% to exclude the influence of outliers.

3 Empirical Evidence on the Effect of the Green Finance Policy of China's Central Bank Collateral on Green Transformation of Enterprises

3.1 Baseline Regression Results

We used a triple-difference model (DDD) to empirically test whether the green finance policy of China's Central Bank collateral can achieve its original intention -- to release incentive signal to enterprises for green innovation and guide enterprises to focus on green transformation.

Table 2 shows the main results of baseline regression. It can be seen that the policy significantly promotes the green innovation of related enterprises issuing bonds that meet the requirements of new eligible collateral in the interbank market. The policy promotes the green transformation of relevant enterprises, and relevant enterprises puts more emphasis on green innovation, forming a virtuous circle.

3.2 Potential Effect Channels of the Policy on Green Transformation of Enterprises

This part attempts to explore the potential effect channels of the green finance policy of China's Central Bank collateral on green transformation of enterprises: whether to influence the scarcity and price of bonds by assigning collateral value of bonds, reduce corporate bond financing costs through bond issuance spreads, enable enterprises to obtain more funds and focus on green innovation. The test results are shown in Table 3:

It can be seen that the green finance policy of China's Central Bank collateral reduces the financing costs of corporate bonds through reduced bond issuance spreads, enterprises obtain more funds and take the initiative in green transformation.

3.3 Robustness Test

Parallel Trend Test

The premise that the triple-difference results meet the consistency is that the experimental group and the control group have a common trend before the policy impact. Referring to Wang, Y.Q. and Wu, X. [5], Chen, G.J., et al. [7], this paper uses the following model

Table 1. Variable definition and descriptive statistics

type	variable name	definition	sample size	mean value	standard deviation
Explained variable	Lninve (application)	Number of green invention patent applications plus 1, take the logarithm	2 225	0.720	1.329
	Lnum (application)	Number of green utility model patent applications + 1, take the logarithm	2 225	0.320	0.845
	Lntotal (application)	Total green patent applications plus 1, take the logarithm	2 225	16.560	67.412
	Lninve (authorization)	Green invention patents authorization number + 1, take the logarithm	2 225	0.292	0.817
	Lnum (authorization)	Green utility model patent authorization number + 1, take the logarithm	2 225	0.327	0.838
	Lntotal (authorization)	Green patent authorization amount + 1, take the logarithm	2 225	6.121	29.995
Explanatory variable	post	Before the occurrence of the policy (June 2018), post is 0, after, post is 1.	16 767	0.769	0.422

(continued)

Table 1. (continued)

type	variable name	definition	sample size	mean value	standard deviation
	treat	If the bonds issued by enterprises rated AAA, treat is 0, if the bonds are newly eligible collateral, treat is 1	16 767	0.865	0.342
	ib	If bonds are issued in the interbank bond market, ib is 1, if bonds are issued in the exchange bond market, ib is 0	16 767	0.635	0.481
Control variable	lev	The ratio of total liabilities to total assets	16 767	0.637	0.229
	lr	Ratio of current assets to current liabilities	15 340	2.891	40.026
	cashint	Ratio of operating cash flow to interest expense	13 415	2 254	137 602
	roe	Ratio of net profit to net assets	16 767	0.041	0.102
	liquid	Ratio of net cash flow from operating activities to operating income	16 767	-1.328	172.722
	profit	Year-on-year growth rate of net profit	16 767	0.929	10.761

(continued)

Table 1. (continued)

type	variable name	definition	sample size	mean value	standard deviation
	size	Total assets of the issuing entity at the end of the previous year, take the logarithm	16 295	25.535	1.529
	In net assets	Net assets of the issuing entity at the end of the previous year, take the logarithm	16 274	24.367	1.351

Table 2. Impact on the green transformation of enterprises

variable	(1)	(2)	(3)	(4)	(5)	(6)
	lninve (application)	lnum (application)	Intotal (application)	lninve (authorization)	lnum (authorization)	Intotal (authorization)
post*treat*ib	1.60**	1.36***	1.84***	1.15**	0.78	1.17
post*treat, post*ib, treat*ib, post, treat, ib	YES	YES	YES	YES	YES	YES
solvency	YES	YES	YES	YES	YES	YES
profitability	YES	YES	YES	YES	YES	YES
liquidity	YES	YES	YES	YES	YES	YES
growth ability	YES	YES	YES	YES	YES	YES
enterprise size	YES	YES	YES	YES	YES	YES
industry fixed effect	YES	YES	YES	YES	YES	YES
year fixed effect	YES	YES	YES	YES	YES	YES
sample size	1 219	1 219	1 219	1 219	1 219	1 219
R ²	0.351	0.334	0.364	0.365	0.309	0.375

to verify whether enterprise green innovation has a parallel trend before the occurrence of the policy:

$$\begin{aligned}
 \text{innovation}_{ijt} = & \beta_1 + \sum_{k=-2}^3 \alpha_k [(t = k)\text{post}_t * \text{treat}_i * \text{ib}_j] + \beta_2 \text{post}_t * \text{treat}_i + \beta_3 \text{post}_t * \text{ib}_j + \beta_4 \text{treat}_i * \text{ib}_j \\
 & + \beta_5 \text{post}_t + \beta_6 \text{treat}_i + \beta_7 \text{ib}_j + \gamma \text{controls}_{it} + \delta_i + \theta_t + \varepsilon_{ijt}
 \end{aligned}
 \tag{3}$$

In model (3), t is the year dummy variable. Taking 2018 (the year when the policy occurred) as the benchmark, data of green patent application and authorization of

Table 3. Potential effect channels of the policy on green transformation of enterprises

variable	(1)	(2)	(3)	(4)	(5)	(6)
	Ininve (application)	Inum (application)	Intotal (application)	Ininve (authorization)	Inum (authorization)	Intotal (authorization)
post*treat*ib*spread	0.01	0.07*	0.03	0.03	0.10**	0.11**
post*treat*ib	1.59**	1.26***	1.74**	1.10*	0.62	1.00
post*treat, post*ib, treat*ib, post, treat, ib	YES	YES	YES	YES	YES	YES
controls	YES	YES	YES	YES	YES	YES
industry fixed effect	YES	YES	YES	YES	YES	YES
year fixed effect	YES	YES	YES	YES	YES	YES
sample size	1 219	1 219	1 219	1 219	1 219	1 219
R ²	0.351	0.335	0.364	0.366	0.312	0.378

enterprises in two years (2016 and 2017) before the policy occurred and three years (2019, 2020 and 2021) after the policy occurred are selected to test parallel trends. The remaining variables in the model are set as in model (1).

Figure 1 shows the test results of parallel trends of green innovation of enterprises. It can be seen that in the years before the implementation of the green finance policy of China's Central Bank collateral, there is no significant difference in green innovation between the experimental group and the control group. However, after the implementation of the policy, the green innovation of the experimental group was significantly improved. Pass the parallel trend test.

Excluding Other Policy Influences

In June 2017, The State Council approved the pilot establishment of green finance reform and innovation pilot zone to vigorously develop green finance, involving 8 cities and

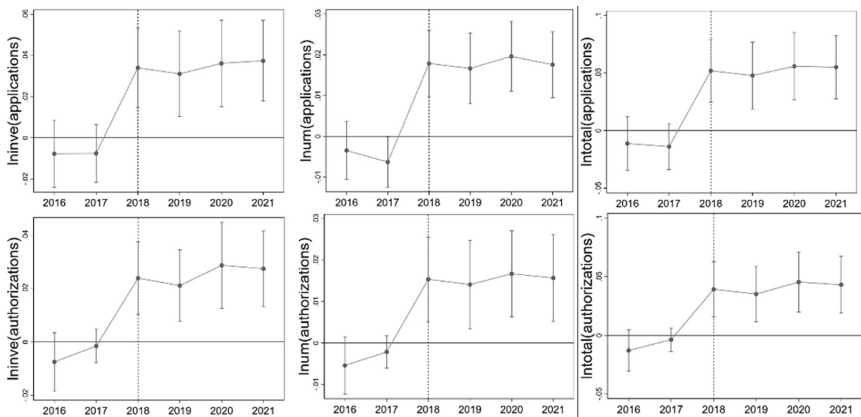


Fig. 1. Parallel trend test

Table 4. Excluding other policy influences

variable	(1)	(2)	(3)	(4)	(5)	(6)
	lninve (application)	lnum (application)	Intotal (application)	lninve (authorization)	lnum (authorization)	Intotal (authorization)
post*treat*ib	1.61**	1.37***	1.80**	1.16**	0.80	1.19
post*treat, post*ib, treat*ib, post, treat, ib	YES	YES	YES	YES	YES	YES
city	YES	YES	YES	YES	YES	YES
controls	YES	YES	YES	YES	YES	YES
industry fixed effect	YES	YES	YES	YES	YES	YES
year fixed effect	YES	YES	YES	YES	YES	YES
sample size	1 219	1 219	1 219	1 219	1219	1219
R ²	0.351	0.335	0.364	0.367	0.314	0.379

regions in 5 provinces. The research results of this paper may be “assisted” by this policy, which also prompts the market to favor green bonds, reduces spreads on green bond issuance, and encourages enterprises to make green transformation. For this reason, this paper further controlled the regional variable city in model (1), which belongs to the green finance reform and innovation pilot zone, and takes city as 1, otherwise takes 0, in order to demonstrate the robustness of the results in this paper.

As can be seen from Table 4, after controlling other green finance policies, green innovation of enterprises still increases significantly, indicating that the effect of green finance policy of China’s Central Bank collateral proposed in this paper is reliable.

4 Conclusion

This paper explores the impact of the green finance policy of China’s Central Bank collateral on the green transformation of enterprises and its potential effect channels. This paper draws the following conclusions:

First, the green finance policy of China’s Central Bank collateral takes into account green bonds, creatively combines monetary policy with green finance policy, and releases an incentive signal to enterprises for green innovation. After the policy takes place, the green innovation of relevant enterprises have been significantly improved. Second, by reducing the financing costs of corporate bonds, the policy enables enterprises to obtain more financial resources and pay more attention to green innovation projects. This policy plays a role in structural adjustment of financial resource allocation and provides strong financial support for enterprises’ green transformation.

Combined with the above research conclusions, we puts forward the following suggestions: Firstly, the innovative monetary policy based on collateral can play a role in the value of assets pledged. The bonds included in the scope of collateral can significantly reduce bond issue spreads and alleviate the financing dilemma of enterprises. Therefore, we should continue to focus on and innovate policies related to collateral to guide financial resources to green areas and weak links of economic development. Secondly, the effective combination of the innovative monetary policy based on collateral and the

green financial policy has not only injected capital vitality into enterprises, but also promoted the green transformation of enterprises. We should take this policy as an important inspiration, introduce more green policies to facilitate the green transformation of enterprises. Thirdly, green transformation is the focus of current economic development, and green bonds are an important financing channel for the green industry. We should speed up the improvement of the institutional framework of green bonds, create a good policy environment for the green bond market, encourage more enterprises to issue green bonds and attach importance to green transformation, so as to make greater progress in China's green development.

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