Green Bond Issuance under China's Green Finance Reform Pilots: Evidence from Provincial Panel Data

Jin Meng

Shengxiang School of Business, Sanda University, Shanghai, China
f23072113@st.sandau.edu.cn

Abstract. Green bonds now play an increasingly important role in channeling funds toward environmentally sustainable investment under China's dual-carbon strategy. A major institutional change occurred in 2017, when China introduced pilot zones for green finance reform and innovation. Rather than treating that reform merely as background, this paper uses it as the central policy shock to examine whether provincial issuance of green bonds increased after the pilots were launched and whether the response strengthened over time. Possible transmission channels include improved financing conditions for green projects, broader financial support, and more effective disclosure of environmental information. Regional differences in development conditions may also shape the size of the response. Empirically, the study relies on a quasi-natural policy setting and estimates the effect with a difference-in-differences (DID) approach. The regressions additionally account for economic structure, financial conditions, government intervention, openness, technological investment, and environmental regulation, while province-specific and year-specific effects are also included. Further checks based on alternative indicators and robustness exercises are used to assess the stability of the findings. The results are expected to show that the reform pilots raise provincial green bond issuance and that the effect becomes clearer as time passes. The analysis therefore adds evidence on the role of local institutional reform in supporting expansion of the green bond market.

Keywords: Green Finance Reform Pilots; Green Bonds; Provincial Green Bond Issuance; Difference-in-differences.

1 Introduction

As the dual-carbon agenda continues to deepen, green finance has become a more prominent mechanism for directing capital toward sustainable investment and improving the allocation of resources. Within this broader framework, green bonds matter not only because they fund eligible projects, but also because they send signals to investors and help shape the flow of capital. The pilot reform launched in 2017 provides a useful policy setting for identifying whether local institutional experimentation in green credit, disclosure arrangements, bond development, and related infrastructure can promote further expansion of the green bond market.

© The Author(s) 2026
L. C. Yoong (ed.), *Proceedings of the 2026 2nd International Conference on Financial Innovation and Marketing Management (FIMM 2026)*, Advances in Economics, Business and Management Research 408,
https://doi.org/10.2991/978-94-6239-801-6_85

The existing literature may be organized into three main lines of inquiry. One line studies the economic consequences of green finance policies. Chen et al. suggest that these policies influence corporate green transformation through channels such as financing costs and credit spreads [1]. Liu and Xiong show that reform pilots stimulate both innovation input and innovation output [2], and Liu and Wang also document a favorable effect on green innovation at the firm level [3]. A second line focuses on the green bond market itself. Flammer argues that issuing green bonds can support green investment while also affecting corporate behavior and long-horizon investors [4]. Using evidence from China, Wang et al. identify market reactions and signaling effects associated with issuance [5], whereas Qi and Liu examine the greenium in the domestic bond market [6]. Zerbib further shows that pro-environmental preferences affect green bond pricing [7]. A third line emphasizes institutions and policy environment. Zhang et al. report that the pilot policy improves regional energy-saving outcomes [8]. Monk and Perkins connect the spread of green bonds to institutional conditions [9], and Liu, Qi, and Wan argue that the Chinese market has been shaped jointly by policy backing, market demand, and institutional development [10]. Even so, direct provincial evidence remains limited on whether the reform pilots expand green bond issuance and whether that effect changes across time and regions.

On this basis, the study evaluates whether the reform pilots influence provincial issuance outcomes and advances three hypotheses. H1 predicts a rise in issuance after the policy. H2 states that the promoting effect should appear gradually rather than immediately. H3 expects meaningful regional variation in the strength of the policy response.

The empirical test uses a balanced provincial panel for China spanning 2010-2025. The 2017 pilot arrangement is treated as an exogenous policy shock, and the main specification is estimated with a DID strategy. The model further controls for economic development, industrial composition, financial conditions, government intervention, openness, technological input, and environmental regulation. Province-specific intercepts and common time effects are added to absorb unobserved heterogeneity. In this way, the paper offers evidence for evaluating both the pilot reform and its implications for development of the green bond market at the provincial level.

2 Research Design

2.1 Sample and Data Sources

The dataset contains a balanced panel of 31 Chinese provinces observed from 2010 to 2025, producing 496 province-year observations. Core indicators are collected mainly from official public sources, including the National Bureau of Statistics of China, the People's Bank of China, and the National Financial Regulatory Administration, and are cross-checked with provincial yearbooks and policy materials. To improve comparability, the dataset is cleaned by standardizing missing values, units, and scale differences, and variables with large magnitude gaps are transformed logarithmically when appropriate. The treatment indicator is set to 1 for the first batch of pilot provinces,

namely Guangdong, Zhejiang, Jiangxi, Guizhou, and Xinjiang, and 0 for other provinces. The post indicator equals 1 from 2017 onward, reflecting the timing of policy implementation. This design allows a comparison of issuance changes before and after the reform between pilot and non-pilot regions.

2.2 Variable Definitions

Table 1 lists the core variables adopted in the empirical analysis. The two dependent variables, green_bond_issue_100m and ln_green_bond_issue, measure provincial issuance in level form and in logarithmic form. Using both indicators makes cross-region comparison easier and helps mitigate heteroskedasticity.

Table 1. Definitions of the variables.

Variable category	Symbol	Description
Outcome variable	green_bond_issue_100m	Annual provincial issuance of green bonds (100 million yuan)
	ln_green_bond_issue	Logarithm of annual provincial issuance of green bonds
Policy variable	treat	Indicator equal to 1 for pilot-region observations and 0 otherwise
	post	Indicator equal to 1 for 2017 and later years, and 0 otherwise
	did	Interaction between treat and post
Control	ln_gdp_pc	Log of GDP per capita
	share_secondary_pct	Secondary-industry share in GDP (%)
	share_tertiary_pct	Tertiary-industry share in GDP (%)
	loan_gdp_ratio	Loan-balance-to-GDP ratio
	fiscal_gdp_ratio	Fiscal-expenditure-to-GDP ratio
	fdi_gdp_ratio	FDI-to-GDP ratio
	rd_expenditure_100m	R&D spending (100 million yuan)
	env_invest_100m	Spending on environmental pollution control (100 million yuan)

2.3 Model Specification

The empirical specification begins with the basic policy framework and then incorporates controls as well as province-level and year-level effect terms. The estimating equation is presented below:

$$Y_{it} = \alpha_0 + \alpha_1 du_i + \alpha_2 dt_t + \alpha_3 (du_i \times dt_t) + \beta X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

The covariate vector includes ln_gdp_pc, share_secondary_pct, share_tertiary_pct, loan_gdp_ratio, fiscal_gdp_ratio, fdi_gdp_ratio, rd_expenditure_100m, and env_invest_100m. Province-specific effects absorb relatively stable regional traits, while common yearly effects capture nationwide shocks. To limit inference bias from within-province serial dependence, the standard errors are clustered by province. Under this specification, the coefficient of interest captures the policy's net effect on green_bond_issue_100m or ln_green_bond_issue after regional differences and time variation have been taken into account.

2.4 Descriptive Statistics and Baseline Regressions

Table 2 reports summary statistics for the main variables. Provincial issuance differs markedly across regions, which suggests that the green bond market has developed unevenly. A simple comparison of raw means also indicates that pilot provinces display a higher average issuance level than non-pilot provinces.

Table 2. Summary statistics and unadjusted DID comparison.

Variable	N	Mean	SD	Min	Max
gb_issuance	496	77.182	72.180	0.000	276.382
ln_gb_issuance	496	3.108	2.151	0.000	5.625
did	496	0.091	0.288	0.000	1.000
ln_gdp_pc	496	11.051	0.418	10.087	12.384
ind2_share	496	46.398	4.599	13.800	54.670
ind3_share	496	45.500	4.857	35.730	86.000
fin_dev	496	1.186	0.149	0.810	1.618
gov_intervention	496	0.197	0.037	0.113	0.286
openness	496	0.020	0.010	0.001	0.045
rd_level	496	482.580	273.683	94.820	1383.310
env_reg_invest	496	291.985	78.388	162.760	510.530

3 Empirical Results

3.1 Baseline Regression Results

Baseline estimates are reported in Table 3. After introducing province controls, time controls, and the full set of covariates, the estimated did coefficient is 0.170 in the

ln_green_bond_issue equation and remains statistically supported at the 1% level. For green_bond_issue_100m, the coefficient is still above zero, although it is not statistically distinguishable from zero at conventional levels.

Table 3. Benchmark regression estimates.

	(1)	(2)	(3)	(4)
VARIABLES	M1 lnGB Full controls	M2 lnGB Full controls	M3 GB Full controls	M4 GB Full controls
did	0.170***	0.170***	23.778***	23.778***
	(0.032)	(0.032)	(6.854)	(6.854)
ln_gdp_pc	0.012	0.012	0.303	0.303
	(0.041)	(0.041)	(6.986)	(6.986)
ind2_share	-0.002	-0.002	-0.061	-0.061
	(0.002)	(0.002)	(0.287)	(0.287)
ind3_share	-0.003	-0.003	-0.101	-0.101
	(0.002)	(0.002)	(0.176)	(0.176)
fin_dev	0.109	0.109	-8.288	-8.288
	(0.148)	(0.148)	(23.335)	(23.335)
gov_intervention	0.172	0.172	18.037	18.037
	(0.374)	(0.374)	(52.814)	(52.814)
openness	2.205	2.205	328.408	328.408
	(1.492)	(1.492)	(193.923)	(193.923)
rd_level	0.001***	0.001***	0.163***	0.163***
	(0.000)	(0.000)	(0.014)	(0.014)
env_reg_invest	0.000*	0.000*	-0.003	-0.003
	(0.000)	(0.000)	(0.048)	(0.048)
Observations	496	496	496	496
R-squared	0.999	0.999	0.991	0.991
Number of province_id	31	31	31	31
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Note: Province-clustered standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.				

3.2 Robustness Tests

Table 4 presents additional robustness exercises. When the specification retains only did together with two-way effect terms and excludes the other controls, the did coefficient is estimated at 0.148 and remains statistically meaningful at the 5% level. Because the sign is unchanged, the benchmark inference appears reasonably stable.

Table 4. Robustness check results.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	R1 Baseline	R2 Full controls	R3 To 2024	R4 ln(1+GB)	R5 Placebo2015
did	0.170***	0.170***	0.167***	0.170***	0.126**
	(0.032)	(0.032)	(0.029)	(0.032)	(0.053)
did_fake					0.126**
					(0.053)
ln_gdp_pc	0.012	0.012	1.376	0.012	0.020
	(0.041)	(0.041)	(0.911)	(0.041)	(0.041)
ind2_share	-0.002	-0.002	0.024	-0.002	-0.002
	(0.002)	(0.002)	(0.021)	(0.002)	(0.002)
ind3_share	-0.003	-0.003	0.000	-0.003	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
fin_dev	0.109	0.109	0.169	0.109	0.138
	(0.148)	(0.148)	(0.156)	(0.148)	(0.154)
gov_intervention	0.172	0.172	0.233	0.172	0.061
	(0.374)	(0.374)	(0.363)	(0.374)	(0.330)
openness	2.205	2.205	2.288	2.205	2.175
	(1.492)	(1.492)	(1.431)	(1.492)	(1.497)
rd_level	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
env_reg_invest	0.000*	0.000*	0.001*	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	496	496	465	496	496
R-squared	0.999	0.999	0.999	0.999	0.999

Number of province_id	31	31	31	31	31
Province FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Note: Province-clustered standard errors are shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1.					

3.3 Dynamic Effect Test

Figure 1 reports the event-study pattern. Before the policy took effect, the lead terms are generally insignificant, indicating no clear systematic trend gap between pilot and non-pilot provinces in the pre-reform period. This provides support for the parallel-trend requirement.

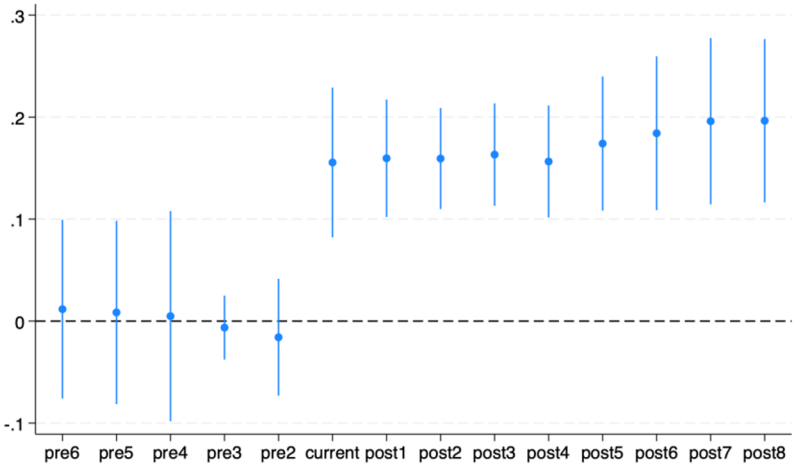


Fig. 1. Event-study dynamic effects of the pilot policy on ln(green bond issuance) (Photo/Picture credit : Original).

4 Mechanism Discussion and Heterogeneity Analysis

4.1 Heterogeneity Analysis

Figure 2 shows that the reform pilots increase issuance in both the high-rd_expenditure_100m subgroup and the low-rd_expenditure_100m subgroup when provinces are classified by pre-policy R&D intensity. The estimated coefficient is larger in the high-R&D subgroup.

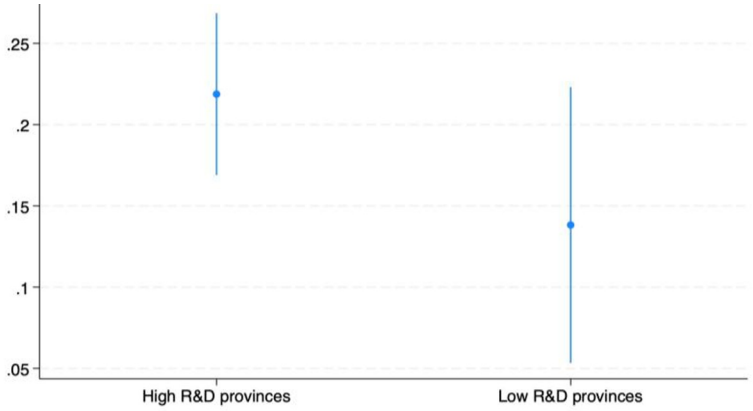


Fig. 2. Heterogeneity of policy effects by rd_expenditure_100m level.

Subgroup estimates are summarized in Table 5 using pre-policy median splits for provincial characteristics. The estimated policy effect remains significantly above zero in every subgroup, but its magnitude differs across them. For instance, when provinces are grouped by rd_expenditure_100m, the low-rd_expenditure_100m subgroup shows a larger coefficient than the high-rd_expenditure_100m subgroup, suggesting that the policy may produce a stronger marginal push where green financial and technological foundations are weaker.

Table 5. Subgroup regression results(Photo/Picture credit : Original).

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	High rd_expenditure_100m	Low rd_expenditure_100m	High Environmental Regulation	Low Environmental Regulation	High Financial Development	Low Financial Development
did	0.162***	0.150***	0.209***	0.158***	0.155***	0.263***
	(0.021)	(0.033)	(0.029)	(0.035)	(0.028)	(0.019)
ln_gdp_pc	-0.028	-0.031	0.003	0.112	0.072**	-0.074
	(0.038)	(0.055)	(0.046)	(0.102)	(0.030)	(0.064)
ind2_share	0.001	0.001	0.001	-0.005*	-0.002	-0.002
	(0.002)	(0.001)	(0.003)	(0.003)	(0.004)	(0.002)
ind3_share	0.002	0.000	-0.000	-0.001	-0.004*	0.000

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	High rd_expenditure_100m	Low rd_expenditure_100m	High Environmental Regulation	Low Environmental Regulation	High Financial Development	Low Financial Development
	(0.001)	(0.002)	(0.001)	(0.004)	(0.002)	(0.003)
fin_dev	-0.014	0.130	0.174	0.152	0.359	-0.085
	(0.120)	(0.188)	(0.183)	(0.255)	(0.231)	(0.219)
gov_intervention	0.015	-0.185	-0.034	0.252	1.420***	-0.753**
	(0.309)	(0.309)	(0.460)	(0.525)	(0.468)	(0.309)
openness	0.647	0.662	2.792	0.532	1.840	1.288
	(1.167)	(1.097)	(1.945)	(1.977)	(1.704)	(2.324)
rd_level	0.000***	0.000	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
env_reg_invest	-0.001**	0.000	0.000	0.001*	0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Observations	256	240	256	240	256	240
R-squared	1.000	1.000	1.000	0.999	0.999	0.999
Number of province_id	16	15	16	15	16	15
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Note: Province-clustered standard errors appear in parentheses. *** p<0.01, ** p<0.05, * p<0.1.						

Taken together, the subgroup evidence indicates that regional fundamentals matter for the size of the policy response. The larger coefficient in the low-loan_gdp_ratio subgroup points to a latecomer advantage in relatively less-developed areas. Table 6 therefore tests whether these subgroup gaps are themselves statistically significant. Since significance inside each subgroup does not automatically imply a significant difference across subgroups, the paper adds interaction terms between the treatment variable and subgroup indicators within a pooled framework.

Table 6. Tests for coefficient differences across subgroups.

Group comparison	Base group did	Difference	SE	p-value
High rd_expenditure_100m - Low rd_expenditure_100m	0.138	0.081*	(0.042)	0.064
High Environmental Regulation - Low Environmental Regulation	0.148	0.103***	(0.035)	0.006
High Financial Development - Low Financial Development	0.251	-0.103***	(0.035)	0.006
Interpretation		The interaction term evaluates whether subgroup coefficients differ significantly from one another.		
Note		*** p<0.01, ** p<0.05, * p<0.1. Full controls together with province and year effect terms are included.		

According to Table 6, the interaction coefficient for the rd_expenditure_100m grouping equals 0.081 and is significant only at the 10% level. This suggests that the evidence for a strong between-group difference along this dimension is limited.

In several dimensions, the subgroup with a lower initial base records a larger estimated coefficient, implying that the policy may yield a stronger marginal benefit in less-developed areas. This in turn suggests that future expansion of the program should not rely on a completely uniform support scheme. Regions with stronger starting conditions may gain more from improvements in institutional efficiency, whereas weaker regions may require additional support in project incubation, issuance guidance, and capacity building so that policy assistance can be translated into actual issuance growth.

4.2 Mechanism Discussion

Because of current data limitations, the mechanism discussion remains indirect. Combining theory with the empirical context, the reform may operate through three broad channels: a larger supply of green finance, relaxed financing constraints, and improved environmental information disclosure. Future work could introduce more direct mediating indicators, including green credit balances, green project reserves, and measures of disclosure quality, to identify these channels more precisely.

4.3 Policy Implications

From the policy perspective, closer coordination among implementation, evaluation, and expansion would help form a more complete operating loop for the pilot program, and standards together with disclosure rules for green bonds could be further unified. Where local fundamentals are relatively weak, more attention should be given to project databases, issuance guidance, and credit-enhancement arrangements so that policy support is more effectively converted into issuance growth. A cross-regional comparison mechanism could also help improve the ongoing allocation of green finance resources.

5 Conclusion

Drawing on a provincial panel covering 31 provinces during 2010-2025 and using a DID design, this paper assesses the effect of the reform pilots on green_bond_issue_100m. The findings show that the policy increases green bond issuance, that the effect becomes more visible over time, and that transmission strength differs across regional conditions.

Future policy efforts should continue to regularize assessment of the pilot reforms, strengthen supporting arrangements for local bond issuance, improve disclosure systems and market infrastructure, and tailor support to regional conditions. With better coordination between institutional design and market mechanisms, development of the green bond market can shift from simple expansion in scale toward improvements in quality. This study still has two main limitations. First, the available mechanism variables remain limited, so future research should incorporate more direct mediating measures. Second, provincial data cannot fully reflect behavioral differences at the micro level. Subsequent work may extend the analysis to prefecture-level or firm-level samples and combine indicators such as financing costs and environmental performance to identify the micro transmission channels in greater detail.

References

1. Chen, G.J., Ding, S.J., Zhao, X.Q., et al.: China's green finance policy, financing costs, and corporate green transformation: evidence from the PBOC collateral policy. Journal of Financial Research, 75-95 (2021)
2. Liu, C., Xiong, M.: Green finance reform and corporate innovation: evidence from China. Finance Research Letters 48, 102993 (2022)
3. Liu, S., Wang, Y.: Green innovation effect of pilot zones for green finance reform: evidence from a quasi-natural experiment. Technological Forecasting and Social Change 186, 122079 (2023)
4. Flammer, C.: Corporate green bonds. Journal of Financial Economics (2021)
5. Wang, J., Chen, X., Li, X., et al.: The market reaction to green bond issuance: evidence from China. Pacific-Basin Finance Journal 60, 101294 (2020)
6. Qi, H.J., Liu, S.Q.: Does the Chinese bond market exhibit a greenium? Accounting Research, 131-148 (2021)

7. Zerbib, O.D.: The effect of pro-environmental preferences on bond prices: evidence from green bonds. Journal of Banking & Finance (2019)
8. Zhang, Z., Wang, J., Feng, C., et al.: Do pilot zones for green finance reform and innovation promote energy savings? Evidence from China. Energy Economics 124, 106763 (2023)
9. Monk, A., Perkins, R.: What explains the emergence and diffusion of green bonds? Energy Policy (2020)
10. Liu, S., Qi, H., Wan, Y.: Driving factors behind the development of China's green bond market. Journal of Cleaner Production 354, 131705 (2022)

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

