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How Fiscal–Financial Coordination Promotes Corporate Green Innovation: Evidence from the Green Interest Subsidy Policy

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Article

Keywords: Fiscal–financial coordination, Green innovation, Green credit interest subsidy, Risk sharing, Complementary monitoring

Posted Date: July 2nd, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9999401/v1

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Additional Declarations: No competing interests reported.

How Fiscal–Financial Coordination Promotes Corporate Green Innovation: Evidence from the Green Interest Subsidy Policy

Abstract： Whether fiscal–financial coordination can stimulate corporate green innovation through complementary policy functions remains insufficiently examined. Using the implementation of the green credit interest subsidy policy as a quasi-natural experiment, this paper employs a staggered difference-in-differences approach to examine how fiscal–financial coordination affects firms' green innovation. The results show that fiscal–financial coordination significantly promotes firms' level of green innovation, primarily by incentivizing firms to engage in substantive green innovation. Mechanism analyses suggest three channels. First, the coordination between fiscal incentives and financial supply eases firms' financing constraints. Second, joint risk sharing by governments and banks increases firms' willingness to undertake green innovation risks. Third, complementary monitoring by governments and banks helps curb corporate greenwashing. Further analysis shows that fiscal–financial coordination also contributes to simultaneous improvements in firms' environmental and economic performance.

Key words： Fiscal–financial coordination; Green innovation; Green credit interest subsidy; Risk sharing; Complementary monitoring

1. Introduction

Fiscal and financial policies are two central instruments in China's green-transition policy framework, and both play an essential role in encouraging firms to pursue green innovation(Yu et al., 2021; Houston and Shan, 2022; Hu et al., 2021). However, each instrument has clear limitations when used in isolation (Ma et al., 2023), because government agencies and financial institutions operate under different objectives and incentives. On the fiscal side, public funding is limited in scale and often narrow in coverage, making it difficult to meet the growing financing needs of green innovation (Yu et al., 2021; Zhang et al., 2021). Information asymmetries may also encourage firms to obtain subsidies without making genuine environmental improvements or to overstate their environmental performance, thereby reducing the efficiency of public spending (Hong et al., 2023; Xing et al., 2021). On the financial side, green projects often involve long investment horizons, low returns in the early stages, and substantial uncertainty (Zhou et al., 2022). As profit-oriented institutions, financial intermediaries may therefore lack sufficient incentives to expand green finance when expected returns do not adequately compensate for perceived risks (Zhou et al., 2021; Huang et al., 2023). These

constraints highlight the need for better coordination between fiscal and financial policies to support green innovation more effectively.

The rationale for such coordination lies not only in the limitations of green fiscal policy and green finance when each operates in isolation, but also in their distinct transmission channels and complementary policy functions. These complementarities create several channels through which fiscal and financial policies can jointly support green innovation. On the one hand, green fiscal policy can use risk-sharing arrangements and return-enhancing incentives to encourage financial institutions to provide green financial products and services (Ma et al., 2023), thereby leveraging limited public resources to mobilize broader financial support. On the other hand, green finance can offset the limited scope and durability of fiscal support by providing a broader and more sustainable source of funding for green innovation. In addition, joint oversight by government agencies and financial institutions can help verify whether firms are genuinely engaged in green innovation (Houston and Shan, 2022), while strengthening the credibility of green projects and the transparency of environmental information. These considerations suggest that coordination between green fiscal policy and green finance is both feasible and necessary. Effective coordination can integrate resources, draw on the comparative strengths of each policy instrument, and enhance overall policy effectiveness, thereby enabling governments, financial institutions, and firms to share the gains from green innovation while jointly bearing its risks.

The literature on the policy drivers of green innovation has grown substantially, with most studies focusing on the incentive effects of individual policy instruments, including green credit, environmental regulation, fiscal subsidies, and tax incentives (Flammer, 2021; Hu et al., 2023). More recently, as policy coordination has gained prominence in macro-level governance, some studies have begun to examine the combined effects of multiple policy instruments. However, two gaps remain. First, existing research on fiscal–financial policy coordination has focused mainly on areas such as local government debt (Gao et al., 2021) and rural revitalization (Tang and Sun, 2022), leaving its role in green innovation insufficiently examined. Second, although some studies draw on Meade's theory of policy conflicts to analyze the joint effects of multiple policy instruments on green innovation (Ma et al., 2023; Tchorzewska et al., 2025), they tend to emphasize interactions among different policies and the amplifying effects of policy mixes. Less attention has been paid to how a specific coordination instrument embeds fiscal and financial policies within the same institutional arrangement and generates complementarities between them. As a result, there is still limited empirical evidence on the firm-level channels through which fiscal–financial policy coordination affects green innovation.

Building on these gaps, this paper examines whether coordination between fiscal and financial policies promotes firms' green innovation, viewing the two policies as functionally complementary. We focus on interest subsidies for green credit, one of the most widely used instruments that combines fiscal support with financial allocation, and use this setting to identify the underlying mechanisms.

Using data on Chinese A-share listed firms from 2009 to 2023, we estimate the policy effects with a staggered difference-in-differences (DID hereafter) design. The baseline results show that fiscal–financial policy coordination, implemented through interest subsidies for green credit, significantly increases firms' green innovation, with the effect driven mainly by substantive green innovation. This finding remains robust after a series of tests, including placebo tests，methods that account for heterogeneous treatment effects, stricter definitions of the treated and control samples, propensity score matching, and tests that rule out competing explanations. Heterogeneity analyses further show that the policy effect is stronger in regions with greater fiscal capacity, in financially underdeveloped regions, among firms outside heavily polluting industries, among non-state-owned firms, and among larger firms.

Mechanism analyses reveals that fiscal–financial policy coordination promotes firms' green innovation through three main channels. First, the combination of fiscal incentives and financial support eases firms' financing constraints. Second, joint risk sharing by governments and banks increases firms' willingness to undertake the risks associated with green innovation. Third, complementary monitoring by governments and banks helps curb greenwashing by discouraging firms from overstating their environmental performance. Further analyses suggest that fiscal–financial policy coordination improves both economic and environmental performance.

This paper contributes to the literature in three main respects. **First**, it extends the literature on policy support for green innovation. While existing studies have largely examined the effects of individual policy instruments, this paper identifies how the coordination and complementarity between fiscal and financial policies can incentivize firms to undertake green innovation. **Second**, it contributes to the literature on policy coordination. Unlike studies that examine the combined effects of multiple policies from the perspective of policy mixes, this paper focuses on interest subsidies for green credit, an institutional arrangement that integrates fiscal incentives with financial resource allocation. This focus highlights the importance of incorporating functional complementarity at the policy-design stage: coordination arises from the integrated use of fiscal and financial policies, rather than from the simple layering of separate policy instruments. **Third**, by drawing on theories of policy coordination, market failure, and information asymmetry, this paper clarifies the firm-level mechanisms through which fiscal–financial policy coordination promotes green innovation and identifies the boundary conditions under which such coordination is more effective. In doing so, the paper not only explains the distinctive advantages of fiscal–financial policy coordination over individual policy instruments, but also specifies the channels through which its effects operate. These insights provide theoretical guidance and practical policy levers for improving policy design and enhancing the governance of green innovation.

The remainder of this paper is organized as follows. Section 2 introduces the policy background and develops theoretical hypotheses on the impact of fiscal–financial policy coordination on green

innovation and its underlying mechanisms. Section 3 outlines the empirical strategy and data. Section 4 presents the baseline results and a series of robustness checks. Section 5 examines the mechanisms and conducts heterogeneity analyses. Section 6 further assesses the effects of fiscal–financial policy coordination on firms' economic and environmental performance and explores the factors that condition these effects. Section 7 concludes and discusses policy implications.

2. Policy background and theoretical hypotheses

2.1 Policy background

To achieve a comprehensive green transition in economic and social development, China has gradually developed a green policy framework that includes fiscal and tax policies, financial policies, investment policies, pricing policies, industrial policies, and regional pilot programs. The complexity of this transition requires these policies to move beyond isolated implementation toward closer coordination, so that they can generate policy synergies greater than the sum of their individual effects. In fact, the idea and practice of policy coordination in this area are not new. As early as 2001, the *Interim Measures for the Administration of Central Government Interest Subsidy Funds* issued by the Ministry of Finance, together with subsequent sector-specific policy documents, referred to the use of coordinated measures such as fiscal interest subsidies to support the development of energy-saving and environmental-protection industries. Guided by central-level policy design, local governments have continued to explore ways to coordinate fiscal and financial policies. Among these efforts, interest subsidies for green credit have become one of the most widely used fiscal–financial coordination instruments.

Interest subsidies for green credit refer to fiscal subsidies provided by local governments for the interest payments on eligible firms' green loans. In essence, this policy uses public funds as a lever to mobilize more market-based capital for green industries and projects, and represents a typical form of coordination in which fiscal support guides financial resource allocation. The policy primarily supports enterprise projects in areas such as energy conservation and environmental protection, clean energy, green manufacturing, and low-carbon technology R&D. In their implementation rules, local governments clearly define eligibility requirements concerning firms' industry attributes, project registration or filing status, environmental ratings, and other access conditions. For eligible projects, the government allocates interest-subsidy funds to relevant banking institutions, which then reduce the actual loan interest rates borne by enterprises accordingly. In terms of subsidy intensity, local interest-subsidy rates generally range from 10% to 50% of the benchmark lending rate for the corresponding period, or of the actually applied interest rate, with subsidy periods typically lasting one to three years. For qualified green enterprises, the interest-subsidy policy has a substantive cost-reduction effect and can effectively incentivize firms to pursue green innovation and low-carbon transformation. By lowering the financing costs associated with green lending, the policy encourages

banks to expand green credit and direct financial resources toward green sectors such as energy conservation, environmental protection, and clean energy, thereby supporting the low-carbon transition. At the firm level, reduced interest expenses allow firms to obtain external financing at lower cost and strengthen their incentives to invest in green innovation. In addition, the implementation of this policy has promoted the development of local criteria for identifying green projects and the establishment of related project registries, thereby strengthening the institutional foundation for green innovation through improved standard setting.

Since 2017, local governments across China have gradually introduced interest subsidies for green credit. To date, 25 provinces, including Zhejiang, Guangdong, Shandong, and Jiangsu, have adopted related measures. Fig. 1. shows the number of regions implementing this policy since 2016. The number of pilot cities increased from 13 in 2017 to 69 in 2023, while the policy coverage expanded from clean energy and pollution control to broader stages of the industrial chain, including green manufacturing and low-carbon technology R&D. Although local governments differ in their eligibility requirements, subsidy rates, subsidy periods, and other implementation details, these practices have formed a coordinated pattern characterized by central policy guidance and differentiated local implementation.

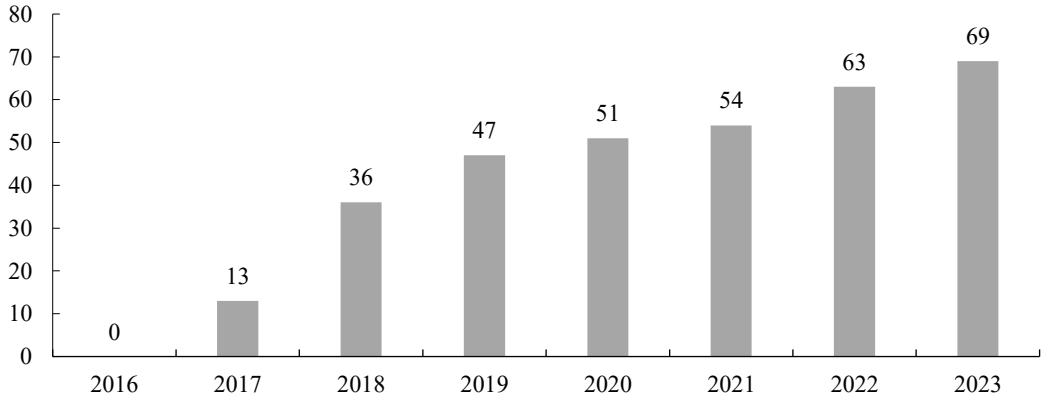


Fig. 1. Cumulative Number of Cities Implementing Interest Subsidies for Green Credit

Interest subsidies for green credit involve both fiscal authorities and financial institutions, making them a typical example of fiscal–financial policy coordination. By using fiscal subsidies as a lever to direct credit resources toward green sectors, this policy design goes beyond the limitations of stand-alone fiscal subsidies or financial support. Accordingly, this paper treats interest subsidies for green credit as a concrete institutional arrangement that embodies fiscal–financial policy coordination and as an observable policy shock. It examines the underlying mechanisms and policy effects through which such coordination promotes green innovation, thereby providing empirical evidence and policy implications for accelerating green innovation and improving the macroeconomic policy framework.

2.2 Theoretical hypotheses

Unlike existing studies that examine fiscal–financial policy coordination from the perspective of the combined effects of different types of policies (Ma et al., 2023), this paper adopts a policy-complementarity perspective. Following the logic of "functional policy complementarity–coordination effects–green behavioral responses," it examines how interest subsidies for green credit operate through three dimensions: resources, incentives, and behavior.

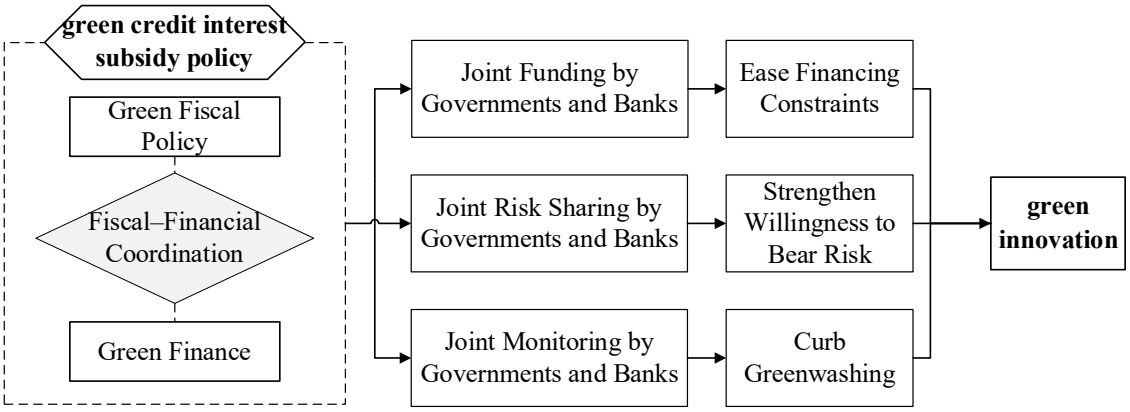


Fig. 2. Mechanisms of green credit interest subsidy policy

As a concrete instrument of fiscal–financial policy coordination, interest subsidies for green credit integrate fiscal subsidies with credit allocation. By combining the strengths of fiscal and financial policies while offsetting their respective limitations, this instrument can provide additional support for firms' green innovation (Ma et al., 2023; Song et al., 2025). First, the policy operates through the credit market. Fiscal funds provide return-enhancing incentives and risk compensation, encouraging financial institutions to expand the supply of green credit. In this way, limited public funds can leverage a much larger amount of financial resources, while the positive environmental externalities of green projects are converted into preferential financing conditions for firms, thereby easing the financing constraints that often hinder green innovation (Yu et al., 2021). Second, the policy brings governments, financial institutions, and firms into the green innovation process and allows them to share transition risks. By using public funds to help diversify risk, the policy can alleviate the practical difficulties that make financial institutions reluctant to lend and firms reluctant to undertake green transformation. As a result, firms' previously constrained willingness to invest in green innovation can be released. In addition, during policy implementation, both banks and government agencies conduct end-to-end monitoring of fund use, helping prevent greenwashing and the misallocation of funds and ensuring that firms engage in genuine green innovation (Xing et al., 2021; Hu et al., 2023). Accordingly, we propose the following hypothesis.

Hypothesis 1. (H1): As a fiscal–financial coordination instrument, interest subsidies for green credit promote firms' green innovation.

Although fiscal and financial policies have provided important support for China's green and

low-carbon transition, existing support remains insufficient relative to the large financing needs of green innovation (Yu and An, 2024; Wang and Fan, 2023). This insufficiency stems mainly from the difficulty of reconciling the profit-seeking nature of financial capital with the positive externalities of green innovation, a problem further constrained by the limited scale of fiscal resources. Together, these factors create substantial financing constraints for firms engaged in green innovation, reflecting a typical form of market failure. Interest subsidies for green credit can help address this problem in two ways. First, by subsidizing loans for green projects, governments can partially secure the expected returns of financial institutions. This material incentive increases their willingness to participate in green projects and expand green credit business (Ma et al., 2023; Song et al., 2025), thereby generating a multiplier effect from public funds, attracting large-scale financial capital to green and low-carbon sectors (Jin et al., 2022), and improving the availability of green finance. Second, whether subsidies are paid directly to firms or provided to financial institutions, which then offer green loans at preferential interest rates, the policy can reduce the overall cost of obtaining green credit and ease the problem of costly financing. In sum, interest subsidies for green credit can ease firms' financing constraints by expanding the scale of credit and lowering borrowing costs, thereby providing greater financial support for green projects and promoting firms' green innovation. Accordingly, we propose.

Hypothesis 2. (H2): Interest subsidies for green credit ease firms' financing constraints through the coordination between fiscal incentives and financial support, thereby promoting firms' green innovation.

Green projects are typically characterized by long investment horizons and substantial transition risks. If the transition fails, financial institutions may face a higher risk of non-performing green loans. As a result, risk concerns and regulatory pressure may lead financial institutions to adopt a cautious approach to green credit. Interest subsidies for green credit help address this problem by allowing fiscal intervention to share part of the transition risk and reduce the potential losses that financial institutions may incur from unsuccessful green projects (Song et al., 2025). This, in turn, increases their willingness to supply green credit. For firms, the joint participation of governments and financial institutions also helps share transition risks, strengthening firms' willingness to bear such risks and encouraging them to engage in green innovation earlier and more actively. In addition, interest subsidies directly reduce firms' interest burden, enabling them to undertake long-term green investment at a lower incremental cost (Jin et al., 2022). Lower financing costs release internal resources, improve financial resilience, and enhance firms' risk-bearing capacity, thereby encouraging them to undertake higher levels of transition risk (Zhou et al., 2022). From the perspective of resource bricolage theory, when firms have stronger willingness and capacity to bear risk, they are more likely to identify, integrate, and mobilize internal and external resources (Manso, 2011; Busch and Barkema, 2021), explore potential investment opportunities, improve resource allocation efficiency, and ultimately direct more resources toward green innovation. Accordingly, we propose.

Hypothesis 3. (H3): Interest subsidies for green credit enhance firms' willingness to bear risk by enabling governments and financial institutions to jointly share the risks associated with green innovation, thereby promoting subst47antive green innovation.

Green innovation projects are characterized by substantial information asymmetries (Hu et al., 2023). In the absence of effective external monitoring, firms may develop opportunistic incentives and engage in strategic behavior to obtain fiscal and financial resources while avoiding regulatory scrutiny (Xing et al., 2024). Traditional fiscal subsidies may give rise to moral hazard because the use of funds is often difficult to track effectively. By contrast, interest subsidies for green credit can curb greenwashing, including symbolic environmental claims unsupported by substantive action, by establishing a multi-actor and end-to-end monitoring system. First, financial institutions can draw on their advantages in risk screening, information acquisition, and data analysis to conduct ex ante screening of green projects and ongoing monitoring of fund use, ensuring that credit funds are actually directed to green activities. Second, when firms apply for interest subsidies, government agencies usually commission independent third-party institutions to professionally assess and certify the green attributes of firms or projects, thereby providing an additional layer of public review and eligibility screening. Finally, during policy implementation, governments and banks often establish information-sharing platforms, such as green project registries and environmental violation databases. These platforms can substantially reduce information asymmetries and monitoring costs, while increasing the risk of detection and the difficulty of engaging in greenwashing (Qian et al., 2025). This, in turn, encourages firms to undertake genuine green innovation. Accordingly, we propose.

Hypothesis 4. (H4): Interest subsidies for green credit curb firms' greenwashing through complementary oversight by government agencies and banks, thereby promoting substantive green innovation.

3. Empirical model, data and variables

3.1 Empirical model

This paper treats interest subsidies for green credit as a concrete institutional arrangement that embodies fiscal–financial policy coordination and as an observable policy shock. This setting allows us to identify the effect of fiscal–financial policy coordination on firms' green innovation. Specifically, we regard the introduction of interest subsidies for green credit by cities as a quasi-natural experiment. Because the timing of policy adoption varies across cities, we employ a staggered difference-in-differences model to estimate the policy effect. The treatment timing for the treated group is defined as the first year in which the policy is implemented in a city. The econometric model is specified as follows:

$$GI_{i,c,t} = \alpha + \beta \times GSubsidy_{c,t} + \gamma Controls_{i,c,t} + \delta_i + \lambda_t + \varepsilon_{i,c,t} \quad (1)$$

In Eq. (1)., the subscripts i, c and t, denote the firm, city, and year, respectively. The dependent variable $GI_{i,c,t}$ measures the green innovation of firm i in city *c* during year t. The key explanatory variable $GSubsidy_{c,t}$ is a dummy variable indicating whether the city has implemented interest subsidies for green credit. It equals one for firms whose registered city has introduced the policy and for the years after its implementation, and zero otherwise. The coefficient β is the coefficient of interest, capturing the effect of interest subsidies for green credit and reflecting how fiscal–financial policy coordination promotes firms' green innovation. $Controls_{i,c,t}$ denotes a set of firm-level and industry-level control variables. The model also includes firm fixed effects δ_i and year fixed effects λ_t, which absorb time-invariant firm characteristics and common shocks affecting all firms during the sample period. $\varepsilon_{i,c,t}$ is the random error term.

3.2 Variables and data

Green innovation (*GI*) A common practice in the existing literature is to measure green innovation by the natural logarithm of one plus the number of green patent applications. However, Cohn et al. (2022) and Chen and Roth (2024) point out that this transformation may lead to several problems, including difficulties in economic interpretation, biased estimates, and limited comparability of model fit across specifications. To avoid these concerns, this paper follows Hu and Shi (2025) and measures green innovation by the share of green patent applications in a firm's total patent applications. This measure captures the firm's green technological orientation in its innovation activities. We further distinguish green innovation into substantive green innovation and strategic green innovation, proxied by the share of green invention patent applications in total patent applications (*GIi*) and the share of green utility model patent applications in total patent applications (*GIu*), respectively.

Green Credit Subsidy Policy (*GSubsidy*). The key explanatory variable in this paper captures whether a firm is exposed to the policy intervention of interest subsidies for green credit. We manually collect policy information from PKULaw, Law-Star, and the official websites of provincial and municipal governments. If, during the sample period, the city where a firm is registered issues policy announcements or implementation guidelines that explicitly include substantive incentive provisions for green loan interest subsidies and operational measures, such as subsidy rates, eligibility requirements, and funding sources, firms registered in that city are classified as treated from the year in which the policy takes effect. Firms are assigned to the control group if their registered city never issues such a policy, or if the policy document contains only general principles without specific implementation details. The timing of policy adoption varies across regions from 2017 to 2023. For cities that once implemented the policy but later explicitly abolished it, firms in those cities are not included in the treated group. In addition, we cross-check the policy issuance dates and effective dates across different sources to ensure accuracy and consistency.

3.2.1 Control variables

This paper includes a set of firm-level and industry-level control variables to mitigate potential bias arising from omitted variables. These controls include firm size (*Size*), leverage (*Lev*), return on equity (*Roe*), cash holdings (*Cash*), capital intensity (*Density*), firm growth (Growth), total factor productivity (*TFP*), and industry competition level (*HHI*). The definitions and descriptions of each variable are presented in Table 1.

Table 1 Variable Definitions and Explanations

Variable Category	Variable Name	Symbol	Measurement
Dependent Variables	Green Innovation	*GI*	(Green patent applications / total patent applications) × 100%
	Substantive Green Innovation	*GIi*	(Green invention patent applications / total patent applications) × 100%
	Strategic Green Innovation	*GIu*	(Green utility model patent applications / total patent applications) × 100%
Explanatory Variable	Green Credit Subsidy Policy	*GSubsidy*	Equals 1 after the implementation of interest subsidies for green credit in the firm's location, and 0 otherwise
Control Variables	Firm Size	*Size*	Natural logarithm of total assets
	Leverage	*Lev*	Total liabilities / Total assets
	Return on Equity	*Roe*	Net profit / shareholders' equity
	cash holdings	*Cash*	Net cash flow from operating activities / Total assets
	Capital Intensity	*Density*	Total assets / Operating revenue
	Firm Growth	*Growth*	Year-on-year growth rate of operating revenue
	Total Factor Productivity	*TFP*	Measured by the LP method
	Industry Competition Level	*HHI*	Herfindahl-Hirschman Index

This paper uses Chinese A-share listed firms from 2009 to 2023 as the initial sample. Except for the data on interest subsidies for green credit, all other data are obtained from the CSMAR and CNRDS databases. We merge data from different sources by stock code and clean the sample as follows: observations with missing key variables are excluded; firms in the financial and insurance industries, as well as all ST and ST firms, are removed; and all continuous variables are winsorized at the 1% level in both tails to mitigate the influence of outliers. The final sample contains 31,298 firm-year observations. Table 2 reports the descriptive statistics. On average, green patent applications account for 5.7683% of total patent applications, indicating that the overall intensity of green innovation in the sample is relatively low. Notably, the median share of green patent applications is zero, suggesting that more than half of the sample firms have not engaged in green innovation. This pattern indicates insufficient endogenous incentives for green innovation among firms. Moreover, the relatively large standard deviation of green innovation measures suggests substantial differences across firms in their green innovation activities.

Table 2 Descriptive Statistics

Variables	Obs	Mean	Std.	Min	Max	Med
GI	31298	5.7683	15.0772	0.0000	88.8889	0.0000
GIi	31298	3.1462	9.5094	0.0000	57.8947	0.0000
GIu	31298	2.2527	7.2227	0.0000	45.4546	0.0000
GSubsidy	31298	0.2555	0.4362	0	1	0
Size	31298	8.4328	1.2761	6.2315	12.5090	8.2308
Lev	31298	0.4092	0.1947	0.0574	0.8662	0.4021
Roe	31298	0.0529	0.1317	-0.6999	0.3013	0.0668
Cash	31298	0.0508	0.0646	-0.1270	0.2382	0.0482
Density	31298	2.2525	1.4825	0.4133	9.1406	1.8620
Growth	31298	0.1313	0.2801	-0.4926	1.2096	0.0994
TFP	31298	8.3788	1.0165	6.3829	11.1909	8.2620
HHI	31298	0.0421	0.0787	0.0044	0.4047	0.0088

4. Baseline results

4.1 Baseline regression results

Table 3 reports the baseline regression results. In Columns (1) and (2), the dependent variable is green innovation (*GI*). The coefficients on the policy variable are significantly positive at the 5% level, indicating that fiscal–financial policy coordination implemented through interest subsidies for green credit effectively encourages firms to improve their overall level of green innovation. We further distinguish green innovation into substantive green innovation (*GIi*) and strategic green innovation (*GIu*), with the corresponding results reported in Columns (3) and (4) and Columns (5) and (6), respectively. The results show that fiscal–financial policy coordination implemented through interest subsidies for green credit significantly increases the share of green invention patent applications, but has no significant effect on the share of green utility model patent applications. This suggests that, when the incentive function of fiscal policy is combined with the resource-allocation function of financial policy, the policy not only increases the overall level of green innovation but also encourages firms to allocate more resources to substantive green innovation activities with higher technological content and stronger innovation quality.

A possible explanation is that, when selecting recipients of interest subsidies, government agencies are more likely to support substantive innovation projects with technological breakthroughs and long-term emission-reduction potential (Xing et al., 2021). Financial institutions, in their green credit approval processes, also place greater emphasis on the genuine green attributes and long-term return prospects of projects. Under the joint influence of fiscal incentives and financial screening, fiscal and financial resources are more likely to flow to substantive green innovation activities that have higher technological content and clearer environmental benefits. Overall, the baseline results confirm that fiscal and financial policies form effective functional complementarity through the

institutional arrangement of interest subsidies for green credit, which is then translated into firm-level incentives for green innovation. Hypothesis 1 is therefore supported.

Table 3 Baseline regression

	(1)	(2)	(3)	(4)	(5)	(6)
	GI	*GI*	*GIi*	*GIi*	*GIu*	*GIu*
GSubsidy	0.4842**	0.4677**	0.5139***	0.4770***	-0.0382	-0.0073
	(0.2293)	(0.2341)	(0.1516)	(0.1531)	(0.1109)	(0.1142)
Size		0.2526		0.3954		-0.0035
		(0.3770)		(0.3105)		(0.1633)
Lev		0.2508		0.1631		-0.0848
		(0.8578)		(0.6591)		(0.4393)
Roe		0.0433		0.1205		0.1665
		(0.8037)		(0.6277)		(0.3403)
Cash		-0.8904		-0.0236		-0.9088
		(1.2429)		(0.8293)		(0.7073)
Density		0.0972		-0.0636		0.0172
		(0.1307)		(0.1171)		(0.0843)
Growth		0.2210		-0.0759		0.1443
		(0.3419)		(0.2120)		(0.1672)
TFP		-0.1299		-0.2232		-0.1370
		(0.3886)		(0.3466)		(0.1850)
HHI		0.0160		-3.0090*		3.0643**
		(2.3771)		(1.6817)		(1.3699)
cons	5.6556***	4.3105*	3.0356***	1.7894	2.2624***	3.3168***
	(0.0586)	(2.3346)	(0.0387)	(1.8133)	(0.0283)	(1.2527)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
adj.R^2	0.4336	0.4336	0.3869	0.3869	0.4091	0.4092
N	31298	31298	31298	31298	31298	31298

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors, and the same applies below.

4.2 Testing parallel trend assumption.

Before the policy intervention, the dependent variable should follow similar time trends in the treated and control groups. This requirement, known as the parallel trend assumption, is a prerequisite for identifying causal effects using a difference-in-differences model (Rambachan & Roth, 2023). Only when this assumption holds can the observed post-policy difference be interpreted as a treatment effect; otherwise, the estimated coefficient may be biased. This paper uses an event-study approach to examine whether the treated and control groups exhibit similar pre-policy trends. This test helps ensure that the baseline results are driven by interest subsidies for green credit rather than by other

confounding factors. We set Eq. (2). to examine this assumption.

$$GI_{i,c,t} = \alpha + \sum_{n=-5}^{5} \beta_n \times GSubsidy_{c,t}^{n} + \gamma Controls_{i,c,t} + \delta_i + \lambda_t + \varepsilon_{i,c,t} \quad (2)$$

To minimize potential interference from policy anticipation effects, this paper uses the second period before policy implementation as the reference period when assessing the parallel trends assumption. The results are shown in Fig. 3. Before policy implementation, the confidence intervals of the estimated coefficients for the pre-treatment periods all include zero, indicating that there is no statistically significant difference in green innovation between the treated and control groups before the policy takes effect. This evidence is consistent with the parallel trend assumption. Fig. 3. also shows that, in the year of policy implementation, there is no substantive difference in green innovation between the treated and control groups, suggesting that the effect of fiscal–financial policy coordination does not emerge immediately and is subject to a clear lag. In practice, after the policy is issued, firms need to submit applications for interest subsidies during the application period, while government agencies must conduct centralized eligibility reviews and allocate funds. This operating process—characterized by scattered applications, centralized review, and batch disbursement—means that firms often receive the actual policy incentives much later than the formal implementation date. In addition, the process from receiving financial support to increasing R&D investment, achieving technological breakthroughs, and producing patentable green innovation outcomes involves an inherent R&D and commercialization cycle. These factors explain why the policy effect appears with a certain delay.

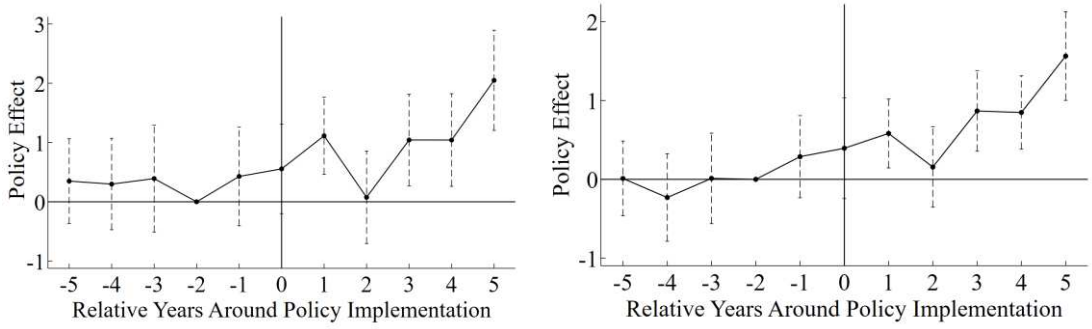


Fig. 3. The results of parallel trend testing

Note: The left panel presents the estimation results and 90 % confidence intervals for the dependent variable, *Green Innovation*. The right panel presents the estimation results and 90 % confidence intervals for the dependent variable, *Substantive Green Innovation*

4.3 Placebo test

If there are confounding factors that are correlated with both interest subsidies for green credit and firms' green innovation, and if the effects of these factors are persistent, the estimates may be biased. Therefore, this paper further conducts a placebo test to rule out the possibility that the baseline results are driven by other policies or random factors. Specifically, we randomly assign policy-

adopting cities and fictitious policy implementation years to construct a pseudo key explanatory variable, which is then used to replace the actual policy shock variable in the baseline model. Fig. 4. plots the kernel density distributions of the estimated coefficients and p-values of the key explanatory variable based on 1,000 random draws. The distribution of the estimated coefficients is centered around zero and follows a normal distribution. These findings suggest that unobservable characteristics have a minimal effect on our primary estimates.

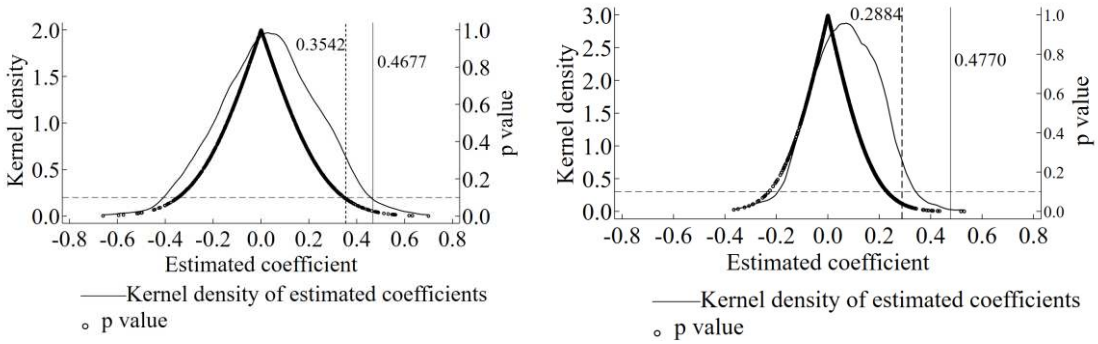


Fig. 4. Results of placebo test

Note: The left shows the placebo test results with *Green Innovation* as the dependent variable. The right shows the placebo test results with *Substantive Green Innovation* as the dependent variable. The intersection between the vertical solid line and the horizontal axis represents the true estimates from columns 2 and 4 of Table 3， while the vertical dashed lines indicate the bounds of the 95% confidence interval of the estimates obtained from random sampling.

4.4 Heterogeneous treatment effects

Existing studies have shown that, in staggered DID settings, never-treated units are not the only control group. The TWFE estimator may also use units treated at different times as controls for one another (Goodman-Bacon, 2021), which can give rise to the “negative weights” problem. Because the estimate from a two-way fixed effects (TWFE) regression is a weighted average of treatment effects across different cohorts and periods (Sun and Abraham, 2021), it may fail to recover an unbiased estimate even when the parallel trends assumption holds. This problem becomes more serious when treatment effects vary across groups or over time (Borusyak et al., 2024).

To examine whether this issue affects the robustness of our findings, we first diagnose the potential bias caused by negative weights using the Bacon decomposition and the decomposition method proposed by de Chaisemartin and D’Haultfoeuille (2020). The Bacon decomposition shows that negative weights account for only 4.8% of the total weight. The diagnostic method proposed by de Chaisemartin and D’Haultfoeuille (2020) further shows that, among 7,997 treatment effects, 6,495 receive positive weights and 1,502 receive negative weights, with negative weights accounting for 18.78%. These results suggest that heterogeneous treatment effects have only a limited influence on

our estimates.

Second, following Sun and Abraham (2021) and Borusyak et al. (2024), we further use DID estimators that are robust to heterogeneous treatment effects to correct for potential bias in the baseline regression. Fig. 5. presents the estimates based on these robust estimators, which are largely consistent with those reported in Fig. 3. Overall, after accounting for heterogeneous treatment effects, our baseline findings remain robust.

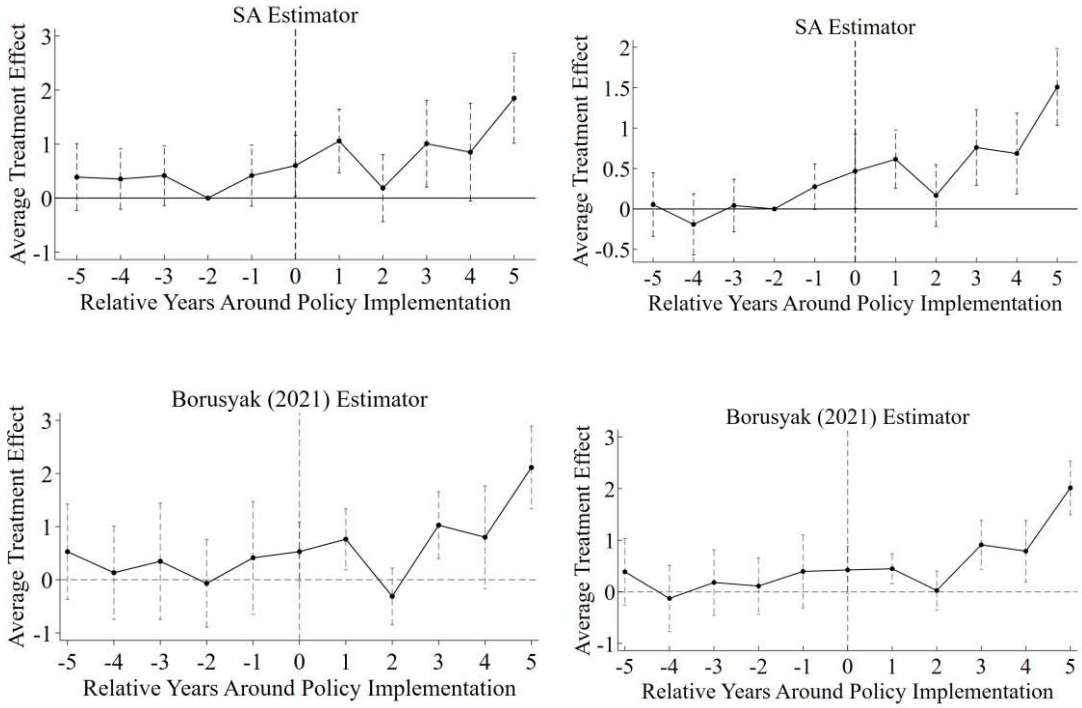


Fig. 5. Estimation results of heterogeneous treatment effects

Note: The left (right) chart in the first row shows the estimates obtained using the robust estimator proposed by Sun and Abraham (2021), with *Green Innovation* (*Substantive Green Innovation*) as the dependent variable. The left (right) chart in the second row shows the estimates obtained using the robust estimator proposed by Borusyak et al. (2024), with *Green Innovation* (*Substantive Green Innovation*) as the dependent variable.

4.5 Self-selection bias

The baseline regression results confirm that fiscal–financial coordination promotes firms' green innovation behavior. However, the estimated results may still be affected by the non-random selection of policy implementation. The green credit interest subsidy policy was not implemented uniformly or randomly nationwide; rather, local governments independently decided whether and when to implement the policy based on local fiscal capacity, green development objectives, industrial structure, financial development, and firms' existing foundation for green transformation. Therefore, regions that implemented the policy and those that did not may have exhibited systematic differences before the policy was introduced.

For example, regions with stronger fiscal capacity, greater emphasis on green development, more abundant financial resources, or a stronger corporate innovation foundation may have introduced the green credit interest subsidy policy earlier. These factors themselves may also affect firms' green innovation levels. If such unobservable regional characteristics simultaneously influence the probability of policy implementation and firms' green innovation behavior, the baseline estimates may capture both the policy treatment effect and the regional selection effect, thereby generating self-selection bias and weakening the accuracy of causal identification.

Therefore, in the baseline regression, this paper includes interaction terms between pre-policy characteristic variables and time fixed effects to alleviate the potential interference of selection bias in the estimation results. The regression results are reported in Columns (1) and (2) of Table 4. The coefficient of *GSubsidy* remains significantly positive, consistent with the baseline regression results. This indicates that, after accounting for self-selection bias, the positive effect of fiscal–financial coordination on firms' green innovation remains robust.

Table 4 The results of self-selection bias, DDD and PSM-DID

	(1)	(2)	(3)	(4)	(5)	(6)
	GI	*GIi*	*GI*	*GIi*	*GI*	*GIi*
	self-selection bias		DDD		PSM-DID	
GSubsidy	1.7385***	1.2526***	0.5825**	0.4972***	0.6077**	0.3702**
	(0.3967)	(0.2617)	(0.2589)	(0.1698)	(0.2614)	(0.1874)
Treat×*Post*×*Loan*			1.9365***	1.2957**		
			(0.7076)	(0.5276)		
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
adj.R^2	0.3580	0.3405	0.4448	0.3952	0.4572	0.4049
N	10991	10991	30908	30908	24929	24939

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors.

4.6 Other robustness tests

This paper further conducts a set of robustness checks from several perspectives, including refining the definitions of the treated and control groups, mitigating self-selection bias, ruling out competing explanations, and controlling for additional fixed effects, to ensure the reliability of the findings.

First, the baseline model identifies the average treatment effect of fiscal–financial policy coordination, implemented through interest subsidies for green credit, on firms' green innovation. However, in cities that have adopted interest subsidies for green credit, some firms may not be directly affected by the policy because they are not involved in green projects. Therefore, to further refine the

treated and control samples and obtain a more precise estimate of the policy effect, this paper employs a triple-difference (DDD) model. The direct beneficiaries of interest subsidies for green credit are firms that obtain green credit. Firms that do not receive green loans during the relevant period are not directly exposed to the policy intervention, even if their registered cities have introduced the policy. Accordingly, this paper augments the DID interaction term with a dummy variable indicating whether a firm obtains green credit after policy implementation, thereby constructing a firm-level measure of policy exposure. The model specification is as follows.

$$GI_{i,c,t} = \alpha + \beta_1 \times Treat_{i,c} \times Post_{c,t} \times Loan_{i,t} + \beta_2 \times Treat_{i,c} \times Post_{c,t} + \gamma Controls_{i,c,t} + \delta_i + \lambda_t + \varepsilon_{i,c,t} \quad (3)$$

In Eq. (3)., $Treat_{i,c}$ is a dummy variable indicating whether the city where a firm is located has implemented interest subsidies for green credit; $Post_{c,t}$ is a dummy variable indicating the post-policy period; and $Loan_{i,t}$ is a dummy variable indicating whether the firm has obtained green credit. $Loan_{i,t}$ is constructed through textual analysis of listed firms' annual reports to identify whether a firm received green credit in each year. The definitions of the other variables are the same as those in the baseline model. The estimation results of the DDD model show that the coefficient β_1 is significantly positive. This indicates that interest subsidies for green credit significantly improve the green innovation of firms that actually obtain green credit. The result suggests that fiscal interest subsidies can generate policy coordination effects only when they are effectively linked with banks' allocation of green credit, and that such coordination can then be translated into firm-level incentives for green innovation. The DDD model results therefore provide further support for the robustness of the main findings.

Second, to mitigate potential bias arising from self-selection, this paper also applies propensity score matching (PSM) to reduce systematic differences between the treated and control groups. Specifically, we use one-to-one nearest-neighbor matching to construct a control sample that is most comparable to the treated sample. Appendix Table 3 reports the distributions of covariates for the treated and control groups before and after matching. The results show that, after matching, there are no significant differences in covariates between the two groups. Appendix Fig. 2. further presents the density distributions of propensity scores after matching, which also support the covariate balance between the treated and control groups. Re-estimating the baseline model using the matched sample, we find that fiscal–financial policy coordination implemented through interest subsidies for green credit continues to significantly promote green innovation and substantive green innovation.

Third, during the sample period, China also issued the *Green Credit Guidelines* and established green finance reform and innovation pilot zones, both of which may have promoted firms' green innovation and thus affected the robustness of our findings. To address this concern, this paper further controls for these two policies in the baseline model and re-estimates the regressions. The results in

Columns (1) to (4) of Table 5 show that, after controlling for contemporaneous policy interventions, the green innovation effect of fiscal–financial policy coordination implemented through interest subsidies for green credit remains significant.

Finally, in recent years, China has introduced a range of environmental protection and green development measures at both the regional and industry levels. To account for the potential influence of these measures, this paper further includes industry-by-year and province-by-year fixed effects, thereby mitigating the concern that omitted variables at the industry or regional level may confound the results. The results in Columns (1) and (6) of Table 5 show that the baseline findings remain robust.

Table 5 Controlling the effect of other policies and more fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
	GI	*GIi*	*GI*	*GIi*	*GIi*	*GIi*
	Controlling for the Green Credit Guidelines		Controlling for Green Finance Pilot Zones		Including Additional Fixed Effects	
GSubsidy	0.4637**	0.4752***	0.4573**	0.4475***	0.2735*	0.4529*
	(0.2339)	(0.1533)	(0.2321)	(0.1443)	(0.1471)	(0.2630)
other_policy	-0.8632	-0.4033	0.2932	0.8327***		
	(1.0220)	(0.7120)	(0.2605)	(0.2573)		
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE					Yes	No
Province-Year FE					No	Yes
adj.R^2	0.4336	0.3869	0.4336	0.3869	0.3886	0.3865
N	31298	31298	31298	31298	31187	31294

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors.

5. Mechanism analysis and heterogeneity analysis

5.1 Mechanism analysis

The theoretical analysis above suggests that interest subsidies for green credit generate coordination effects through the functional complementarity between fiscal and financial policies. Specifically, these coordination effects operate through three main channels. First, fiscal interest subsidies and the supply of green credit complement each other in resource allocation, jointly easing firms' financing constraints. Second, fiscal intervention and financial allocation interact in risk sharing, strengthening firms' willingness to bear risk. Third, government review and bank screening provide complementary monitoring in project identification and fund supervision, thereby curbing firms' greenwashing behavior and encouraging genuine green innovation. Accordingly, this paper examines the mechanisms from three dimensions: resource provision, risk sharing, and complementary monitoring.

Because prior studies have well established that easing financing constraints, increasing firms' willingness to bear risk, and curbing greenwashing can promote green innovation (Zhou and Xie, 2025; Zhang., 2023), this paper specifies Eq. (4). to identify the effect of interest subsidies for green credit on the mechanism variables. In addition, if the above three mechanisms are present, the policy effect is expected to be stronger for firms with more severe financing constraints, lower willingness to bear risk, or higher levels of greenwashing. Therefore, this paper further introduces interaction terms between the pre-policy mechanism variables and the policy shock variable into the baseline model, as shown in Eq. (5)., to further test the existence of these mechanisms.

$$M_{i,c,t} = \alpha + \beta \times GSubsidy_{c,t} + \gamma Controls_{i,c,t} + \delta_i + \lambda_t + \varepsilon_{i,c,t} \quad (4)$$

$$GIi_{i,c,t} = \alpha + \beta_1 \times GSubsidy_{c,t} \times M_{i,c} + \beta_2 \times GSubsidy_{c,t} + \gamma Controls_{i,c,t} + \delta_i + \lambda_t + \varepsilon_{i,c,t} \quad (5)$$

In Eq. (1)., and Eq. (2)., *M* represents the mechanism variables, including financing constraints (FC), willingness to bear risk (Risktake), and firms' level of greenwashing (Greenwash). The other variables are defined as in the baseline model.

Resource-provision mechanism: fiscal incentives and financial supply jointly ease firms' financing constraints. Following Wang et al. (2025), this paper measures firms' financing constraints using the *FC* index, with a larger absolute value indicating more severe financing constraints. In Eq. (4)., *FC* is used as a continuous variable. In Eq. (5)., *FC* is converted into a dummy variable based on the median value of the *FC* index in 2015: *FC* equals one if a firm's financing constraints are above the median, and zero otherwise.

The coefficient reported in Column (1) of Table 6 is significantly negative at the 5% level, indicating that fiscal interest subsidies and green credit supply form effective complementarity in resource allocation and significantly reduce firms' financing constraints. The coefficient on the interaction term in Column (1) of Table 7 is significantly positive, suggesting that the policy has a stronger effect on green innovation for firms with more severe pre-policy financing constraints. This finding implies that fiscal–financial policy coordination eases firms' funding bottlenecks through resource complementarity and releases their potential for green innovation. The resource-provision mechanism is therefore supported.

Table 6 Impact of the green credit interest subsidy policy on mechanism variables

	(1)	(2)	(3)	(4)
	FC	*Ristake*1	*Ristake*2	*Greenwash*
GSubsidy	-0.0071**	0.1315**	0.3360***	-11.6777***
	(0.0035)	(0.0630)	(0.1241)	(4.4838)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
adj.R^2	0.8842	0.7573	0.6801	0.3839

N	29981	24526	24526	9780

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors.

Table 7 Regression Results by Pre-Policy Characteristics

	(1)	(2)	(3)	(4)
	Gli	*Gli*	*Gli*	*Gli*
GSubsidy	0.9150***	0.1669	0.2935	0.7127**
	(0.3291)	(0.1974)	(0.2759)	(0.3067)
Gsubsidy×FC	1.1604**			
	(0.5344)			
GSubsidy×Risktake1		1.5291***		
		(0.3774)		
GSubsidy×Risktake2			1.1461**	
			(0.4548)	
GSubsidy×Greenwash				1.2260***
				(0.3915)
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
adj.R^2	0.3775	0.3871	0.3867	0.4150
N	18437	14044	14044	7686

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors. The dependent variable is Substantive Green Innovation.

Risk-sharing mechanism: fiscal intervention and financial allocation jointly strengthen firms' willingness to bear risk. Existing studies commonly follow Cao et al. (2021) and measure firms' willingness to take risks using industry-adjusted profitability volatility. The underlying logic is that firms with higher risk tolerance and a stronger willingness to take risks are more willing to accept fluctuations in profits, which is reflected in greater volatility in earnings-based financial indicators Liu and Wu, 2023). However, this logic does not fully apply in the context of this study. After firms receive interest subsidies for green credit, fiscal subsidies directly reduce their interest burden and smooth cash flow and profitability. At the same time, to ensure loan repayment, banks continuously monitor firms' operations, which may also restrain excessive profit volatility. Therefore, even if interest subsidies for green credit increase firms' willingness to take risks, they do not necessarily lead to greater earnings volatility.

In view of this, following Olalere and Mukuddem-Petersen (2023), this paper uses R&D expenditure as a share of total assets and R&D investment per employee as proxy variables for firms' risk taking. Larger values indicate greater investment in risky projects and stronger willingness to bear risk. Similarly, in Eq. (4)., the risk-taking variables are continuous variables. In Eq. (5)., each

risk-taking variable is converted into a dummy variable based on the median level of risk taking before policy implementation. The dummy variable equals one if a firm's pre-policy risk-taking level is below the median, and zero otherwise.

The results in Columns (2) and (3) of Table 6 show that fiscal intervention and financial allocation jointly share the risks associated with green innovation, thereby reshaping firms' risk–return trade-off for long-term green projects and strengthening their willingness to bear risk. The results in Columns (2) and (3) of Table 7 further show that the policy has a stronger effect on green innovation for firms with weaker pre-policy willingness to bear risk. The risk-sharing mechanism is therefore supported.

Complementary-monitoring mechanism: government review and bank screening jointly curb firms' greenwashing. Fiscal–financial policy coordination implemented through interest subsidies for green credit creates complementary monitoring through bank loan screening and government certification for interest subsidies. This monitoring complementarity helps constrain firms' strategic disclosure behavior and thereby promotes genuine green innovation. Following Deng et al (2025), this paper constructs a firm-level greenwashing measure (*Greenwash*) by first adjusting ESG disclosure scores and actual ESG performance scores by their respective industry means, then dividing each adjusted score by its own standard deviation, and finally taking the difference between the standardized ESG disclosure score and the standardized actual ESG performance score. The specific formula is as follows:

$$Greenwash_{it} = \left(\frac{ESG_{dis,ijt} - \overline{ESG_{dis,jt}}}{\sigma_{dis}} \right) - \left(\frac{ESG_{rate,ijt} - \overline{ESG_{rate,jt}}}{\sigma_{rate}} \right) \quad (6)$$

In Eq. (6)., $ESG_{dis,ijt}$ and $ESG_{rate,ijt}$ denote the ESG disclosure score and actual ESG performance score of firm *i* in industry *j* in year *t*, respectively. The ESG disclosure score is measured using Bloomberg ESG data, while actual ESG performance is measured using Huazheng ESG ratings. $\overline{ESG_{dis,jt}}$ (σ_{dis}) and $\overline{ESG_{rate,jt}}$ (σ_{rate}) denote the corresponding industry means industry-level standard deviations). $Greenwash_{it}$ captures the divergence between firms' green disclosure and actual green performance. A larger value indicates a stronger tendency toward greenwashing.

Similar to the previous mechanism tests, *Greenwash* is used as a continuous variable in Eq. (4). In Eq. (5)., it is converted into a dummy variable that equals one if a firm's pre-policy level of greenwashing is above the median, and zero otherwise. The results in Column (4) of Table 6 and Column (4) of Table 7 show that interest subsidies for green credit significantly reduce firms' level of greenwashing. Moreover, the policy has a stronger effect on green innovation among firms with more severe pre-policy greenwashing tendencies. These findings suggest that banks' ex ante screening and ex post monitoring of green projects, together with government review and re-examination of eligibility for interest subsidies, create complementary monitoring in project identification and fund

supervision. This mechanism effectively curbs greenwashing and encourages firms to undertake genuine green innovation.

5.2 Heterogeneity analysis

5.2.1Heterogeneity in regional levels

Regional fiscal pressure. Because interest subsidies for green credit require local governments to commit fiscal resources to reward firms for green innovation and incentivize financial institutions to provide green financing, the effectiveness of the policy is closely related to local fiscal capacity (Hu et al., 2024). In regions with stronger fiscal capacity, governments are more likely to offer higher subsidy rates, longer subsidy periods, broader policy coverage, and more timely fund disbursement, thereby allowing public funds to more effectively leverage financial resources. This paper conducts a heterogeneity test based on regional fiscal pressure. Specifically, city-level fiscal pressure is measured by the ratio of the general public budget revenue–expenditure gap to general public budget revenue. Cities with fiscal pressure above the annual mean are classified into the high fiscal pressure group, while the remaining cities are classified into the low fiscal pressure group. The grouped regression results are reported in Columns (1) and (2) of Table 8. The policy effect is more significant in regions with lower fiscal pressure, supporting our expectation.

Level of financial development. The core logic of interest subsidies for green credit is to use fiscal subsidies to leverage financial resources for green innovation. Therefore, the policy effect may depend on the level of regional financial development. In financially developed regions, financial institutions may already have stronger incentives and greater capacity to provide green credit, while firms have access to more diversified and lower-cost green financing channels. As a result, the marginal effect of the policy may be relatively limited. By contrast, in financially underdeveloped regions, where financial resources are relatively scarce and the supply of green credit is insufficient, interest subsidies for green credit are more likely to mobilize additional green credit resources. In such contexts, fiscal incentives can better complement banks' credit allocation and provide support where it is most needed.

This paper measures regional financial development by the ratio of outstanding loans of financial institutions to regional GDP. Based on the annual mean, the sample is divided into financially developed and financially underdeveloped regions for grouped regressions. The results reported in Columns (3) and (4) of Table 8 support the above argument. Fiscal–financial policy coordination implemented through interest subsidies for green credit is more effective in financially underdeveloped regions, indicating that the policy helps alleviate the constraints imposed by insufficient financial resources on firms' green innovation.

Table 8 Heterogeneity analysis at the regional level

	(1)	(2)	(3)	(4)
	regions with lower fiscal	regions with higher fiscal	financially developed	financially

	pressure	pressure	regions	underdeveloped regions
	Regional Fiscal Pressure		Financial Development Level	
GSubsidy	0.3681**	0.3656	0.2583	0.6636***
	(0.1663)	(0.5115)	(0.1579)	(0.2463)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
adj.R^2	0.4171	0.3075	0.3336	0.4097
N	19954	7837	12396	18575

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors. The dependent variable is substantive green innovation.

5.2.2 Heterogeneity in industry levels

Industry pollution characteristics. Since the effects of green-oriented policies may vary with industry pollution characteristics, this paper divides sample firms into those in heavily polluting industries and those in non-heavily polluting industries, based on the *Guidelines for the Industry Classification of Listed Companies* and the *Catalogue for the Classified Management of Environmental Information Disclosure by Listed Companies*. We then conduct grouped regressions. The results reported in Columns (1) and (2) of Table 9 show that fiscal–financial policy coordination implemented through interest subsidies for green credit has a more significant effect on green innovation among firms in non-heavily polluting industries, whereas its effect is relatively limited among firms in heavily polluting industries. This difference is mainly attributable to the higher costs and greater technological barriers associated with green innovation in heavily polluting industries, which make it difficult for policy incentives to take full effect in the short run. By contrast, firms in non-heavily polluting industries tend to have greater technological flexibility and lower transition barriers, giving them a relative advantage in responding to policy incentives.

Industry factor intensity. Green innovation is essentially a process of reallocating production factors. Industries with different factor intensities differ in their transition paths, technological dependence, and financing needs, which may lead to heterogeneous responses to policy incentives. Based on the industry classification standards of the China Securities Regulatory Commission, this paper divides sample firms into three groups: labor-intensive, technology-intensive, and capital-intensive industries. We then examine the effects of interest subsidies for green credit across these groups.

The regression results are reported in Columns (3)–(5) of Table 9. Fiscal–financial policy coordination implemented through interest subsidies for green credit has a positive effect on green innovation in capital-intensive and technology-intensive industries, but does not effectively promote green innovation in labor-intensive industries. A possible explanation is that capital-intensive and technology-intensive industries rely more heavily on sustained capital investment and technological upgrading, and are therefore more likely to benefit from the coordinated support created by lower financing costs through fiscal interest subsidies and expanded green credit supply through banks. By contrast, labor-intensive industries are often dominated by small and medium-sized enterprises. Even

when policy incentives are available, these firms may remain constrained by weaker technological foundations and higher opportunity costs, making it difficult for them to fully release their potential for green innovation.

Table 9 Heterogeneity Analysis at the Industry Level

	(1)	(2)	(3)	(4)	（5）
	Non-heavy Pollution	Heavy Pollution	Capital-intensive	Technology-intensive	Labor-intensive
	Pollution Characteristics		Industry Factor Intensity		
GSubsidy	0.3937**	0.2420	0.9614**	0.3416*	0.4079
	(0.1960)	(0.3803)	(0.3569)	(0.1833)	(0.4113)
Controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
adj.R^2	0.4129	0.3068	0.2707	0.4374	0.0512
N	22016	9282	6601	13289	2277

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors. The dependent variable is substantive green innovation.

5.2.3 Heterogeneity in firm levels

Ownership. State-owned Enterprises (SOEs) and non-state-owned Enterprises (non-SOEs) differ substantially in corporate governance, social responsibility obligations, access to resources, and profit objectives. As a result, their responses to policy shocks may vary (Zhao et al., 2024) This paper divides the sample into SOEs and non-SOEs according to ownership type and conducts heterogeneity analysis. The results reported in Columns (1) and (2) of Table 10 show that the policy effect is significant at the 1% level for non-SOEs, but insignificant for SOEs. A possible explanation is that non-SOEs generally face stronger financing constraints and higher financing costs, and therefore rely more heavily on the coordinated support provided by fiscal interest subsidies and banks' green credit. By contrast, SOEs typically have stronger access to resources and are subject to softer budget constraints, which may weaken their marginal response to this type of policy shock.

Firm size. This paper further examines heterogeneity by firm size. Firms are classified into large and small firms according to whether their total assets exceed the annual sample mean, and regressions are conducted separately for the two groups. The results reported in Columns (3) and (4) of Table 10 show that interest subsidies for green credit significantly promote green innovation only among large firms, while the effect is limited for small firms. A possible explanation is that large firms generally have stronger capital bases and greater capacity for scaled production. Fiscal–financial policy coordination implemented through interest subsidies for green credit can therefore substantially ease their financial constraints by reducing financing costs. By contrast, small and medium-sized firms are constrained by their limited initial capital. Even when they receive interest subsidies, they may still find it difficult to bear the sunk costs of green transformation, which limits the effectiveness of the policy.

Table 10 Heterogeneity Analysis at the Enterprise Level

	(1)	(2)	(3)	(4)
	SOE	Non-SOE	Large-sized Enterprises	Small-sized Enterprises

	Enterprise Ownership Type		Enterprise Size	
GSubsidy	0.3815	0.5321***	0.7765***	0.0319
	(0.2968)	(0.1588)	(0.2392)	(0.3517)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
adj.R^2	0.3557	0.4061	0.3941	0.3920
N	9888	21359	13534	17435

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors. The dependent variable is substantive green innovation.

6. Further discussion

6.1 Economic and emission reduction effects of the green credit interest subsidy policy

Green fiscal–financial policy coordination aims to promote a greener and more sustainable pattern of economic development and to support the broader strategy of comprehensive green transition. The preceding analysis shows that fiscal–financial policy coordination implemented through interest subsidies for green credit promotes firms' green innovation, especially substantive green innovation. A further question is whether these positive effects translate into simultaneous improvements in firms' environmental performance and market competitiveness, thereby reconciling environmental protection with economic development.

To examine this issue, this paper further analyzes the economic and environmental effects of interest subsidies for green credit. Based on the baseline model, we replace the dependent variable with firms' pollution emission measures and total factor productivity and re-estimate the model. The results reported in Table 11 show that interest subsidies for green credit significantly reduce firms' carbon emission intensity and total carbon dioxide emissions, while significantly increasing their total factor productivity. These findings suggest that the coordinated incentives generated by fiscal interest subsidies and green credit supply not only encourage firms to undertake substantive green innovation, but also translate into simultaneous improvements in environmental and economic performance through clean-technology R&D, process upgrading, and more efficient resource use.

Table 11 Environmental and economic performance

	(1)	(2)	(3)	(4)
	Carbon Intensity	*CO_2 Emissions*	*TFP_OP*	*TFP_LP*
	Environmental Performance		Economic Performance	
GSubsidy	-0.0218**	-0.0395***	0.0221**	0.0242***
	(0.0096)	(0.0100)	(0.0107)	(0.0072)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
adj.R^2	0.8646	0.9663	0.9460	0.9698
N	24376	24376	30686	30686

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors. Firms' pollution

emissions are measured by carbon intensity, defined as total carbon emissions divided by operating revenue, and by the natural logarithm of total carbon dioxide emissions. Total factor productivity is estimated using the Olley–Pakes (OP) and Levinsohn–Petrin (LP) methods.

6.2 Factors conditioning the policy effect

The preceding analysis confirms that interest subsidies for green credit significantly promote firms' green innovation. However, the effectiveness of fiscal–financial policy coordination may depend jointly on the institutional environment and firm characteristics. This paper therefore further examines regional institutional conditions and firm-level characteristics to explore how policy effectiveness can be improved and how firms' potential for green innovation can be more fully unlocked.

Intensity of financial regulation. Strict financial regulation is an important safeguard for the effective implementation of relevant policies. It not only helps ensure the smooth operation of interest subsidies for green credit, but also reduces firms' incentives to obtain subsidies through strategic applications or to exaggerate their green governance efforts (Liang, et al., 2025). By facilitating the complementary-monitoring mechanism discussed above, stronger financial regulation can theoretically enhance the policy effect of interest subsidies for green credit. This paper measures regional financial regulatory intensity (*Regulation*) by the ratio of financial regulatory expenditure to the value added of the financial sector. Column (1) of Table 12 shows that the coefficient on the interaction term between interest subsidies for green credit and financial regulatory intensity is significantly positive. This indicates that stronger financial regulation makes it easier to establish effective coordination between government review and bank screening, thereby strengthening the effect of fiscal–financial policy coordination on firms' green innovation.

Regional fintech development. The theoretical analysis above suggests that, after the implementation of interest subsidies for green credit, both financial institutions and government agencies conduct strict reviews of the authenticity of firms' green innovation activities and the use of policy funds. In this process, the application of fintech can strengthen monitoring effectiveness by broadening the scope of information acquisition and improving review efficiency (Qian, et al., 2025). This paper measures regional fintech development (*Fintech*) by the cumulative number of registered fintech firms in each region. We add the interaction term between regional fintech development and interest subsidies for green credit to the baseline regression. The results, reported in Column (2) of Table 12, show that the coefficient on the interaction term is significantly positive. This indicates that fintech improves information connectivity and project identification between fiscal authorities and financial institutions, thereby enhancing the effectiveness of the policy.

Government environmental attention. Existing studies show that regions where governments pay greater attention to environmental issues tend to have more developed environmental evaluation systems and stronger environmental enforcement (Chen, et al., 2024). Under greater regulatory pressure, firms are more likely to internalize environmental costs and actively fulfill their

environmental and social responsibilities. Therefore, in theory, the effect of interest subsidies for green credit should be stronger in regions with higher government environmental attention. This paper constructs an index of government environmental attention (*Attention*) and adds its interaction term with the policy variable to the baseline model for re-estimation. The coefficient on the interaction term, reported in Column (3) of Table 12, is significantly positive. This indicates that when local governments devote more governance resources to environmental objectives, fiscal incentives are more likely to work in tandem with financial resource allocation, thereby strengthening the policy synergy.

Corporate information disclosure. When firms provide more complete information disclosure, banks have access to richer information for ex ante loan approval and ex post monitoring of fund use, and government agencies can rely on more detailed information when reviewing eligibility for interest subsidies. This makes it easier to identify firms with genuine green attributes and to ensure that the policy achieves its intended effects (Li, et al., 2022). This paper measures the level of corporate information disclosure (*Disclosure*) by whether listed firms disclose environment-related information in their corporate social responsibility reports. We then add the interaction term between this variable and interest subsidies for green credit to the baseline regression. The results reported in Column (4) of Table 12 show that a higher level of information disclosure helps strengthen the policy effect. This implies that better corporate information disclosure facilitates more effective information complementarity between government review and bank screening, thereby improving the resource-allocation efficiency of fiscal–financial policy coordination.

Corporate innovation capability. Innovation capability is an important determinant of firms' green innovation (Singh, et al., 2022). This paper therefore examines whether the effect of interest subsidies for green credit varies with firms' innovation capability, that is, whether stronger innovation capability enhances the effectiveness of the policy. We measure corporate innovation capability (*Capability*) by the total number of patent applications filed by a firm. The results reported in Column (5) of Table 12 show that when firms have stronger innovation capability or greater innovation advantages, incentive-based policies are more effective in motivating them to integrate internal and external resources for green innovation. A possible explanation is that firms with stronger innovation capability generally have greater willingness to innovate and a higher tolerance for innovation failure. They are therefore more likely to seize policy opportunities and actively engage in green innovation.

Table 12 Factors conditioning the policy effect

Variables	(1) *Gli*	(2) *Gli*	(3) *Gli*	(4) *Gli*	(5) *Gli*
GSubsidy	0.4515**	0.5263***	0.4181***	0.3614**	0.4539***
	(0.2027)	(0.1771)	(0.1598)	(0.1525)	(0.1266)
Gsubsidy×Regulation	0.7762**				
	(0.3914)				

Gsubsidy×Fintech		0.0004***			
		(0.0001)			
Gsubsidy×Attention			0.0504**		
			(0.0204)		
Gsubsidy×Disclosure				0.3598*	
				(0.1943)	
Gsubsidy×Capability					0.0007**
					(0.0003)
Controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
adj.R^2	0.4030	0.4093	0.3878	0.3868	0.3870
N	27686	22057	31157	31298	31298

Note: * p < 0.10, ** p < 0.05, *** p < 0.01. the same below. The coefficients in parentheses are clustering standard errors. The dependent variable is substantive green innovation.

7. Conclusion

Fiscal–financial policy coordination represents an important direction for reforming China's macroeconomic policy framework. It provides a feasible approach to addressing the limitations of individual policy instruments and strengthening firms' incentives for green innovation. Taking interest subsidies for green credit as the research setting, this paper examines the channels through which fiscal–financial policy coordination promotes green innovation from a policy-complementarity perspective. Using Chinese A-share listed firms from 2009 to 2023, we systematically investigate how interest subsidies for green credit affect firms' green innovation.

The results show that interest subsidies for green credit significantly increase firms' green innovation, with the effect driven mainly by substantive green innovation. This conclusion remains valid after a series of robustness checks. Mechanism analyses show that fiscal–financial policy coordination operates through three channels. First, the coordination between fiscal incentives and financial support eases firms' financing constraints. Second, joint risk sharing by governments and banks strengthens firms' willingness to bear the risks associated with green innovation. Third, complementary monitoring by governments and banks curbs firms' greenwashing behavior. Further analyses show that interest subsidies for green credit also reduce firms' pollution emissions while improving productivity, thereby contributing to simultaneous improvements in economic and environmental performance.

The findings of this paper suggest that future green innovation policies should place greater emphasis on the embedded coordination and functional coupling of different policy instruments. Fiscal and financial policies should form effective complementarities in policy objectives, resource allocation, and monitoring and enforcement, rather than relying merely on an expansion in the number

of policies or the simple layering of policy tools. Compared with stand-alone fiscal subsidies or green credit instruments, fiscal–financial policy coordination can address the financing constraints, risk constraints, and behavioral constraints that firms face in green innovation, thereby more fully unlocking their potential for green innovation.

Based on these findings, this paper offers the following policy implications. First, the institutional design of fiscal–financial policy coordination for green innovation should be further improved. Policy design should focus on the financing needs of green projects and promote the coordinated use of fiscal interest subsidies, risk compensation, green credit, and standards for identifying green projects, so as to strengthen the leverage effect of public funds on financial resources. Second, policy design should fully account for differences in regional fiscal capacity, financial development conditions, firm ownership, and firm size. More targeted and differentiated support policies should be implemented to improve the precision and fit of fiscal–financial policy coordination. Third, the identification of green projects and the supervision of fund use should be strengthened. Government agencies and financial institutions should establish more efficient mechanisms for information sharing and joint review, improve their ability to identify genuinely green projects, and prevent fiscal and financial resources from being eroded by strategic applications and greenwashing. Fourth, corporate green information disclosure, standards for green project certification, and policy evaluation and feedback mechanisms should be continuously improved. These efforts can enhance the transparency, precision, and sustainability of fiscal–financial policy coordination, thereby providing more stable and effective institutional support for firms' green innovation.

Data availability: The datasets generated during and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: Both authors declare that they have no conflict of interest. The authors declare that we have no relevant or material financial interests that relate to the research described in this paper.

Ethics declaration: This article does not contain any studies with human participants performed by any of the authors.

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