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DRIVING GREEN INNOVATION THROUGH PUBLIC PROCUREMENT: EVIDENCE FROM GOVERNMENT PROCUREMENT LISTS AND CORPORATE INNOVATION IN CHINA

Promoção da inovação verde por meio das compras públicas: Evidências a partir das listas de compras governamentais e da inovação corporativa na China

Promoción de la innovación verde mediante la contratación pública: Evidencia de las listas de compras gubernamentales y la innovación corporativa en China

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ABSTRACT

Against the backdrop of intensifying global climate change and deepening ecological civilization construction, stimulating corporate green technology innovation has become a key lever for achieving carbon peak and carbon neutrality goals. Based on data from Chinese A-share listed companies spanning a ten-year period, this paper examines the impact mechanism of government green procurement on corporate green technology innovation. The research finds that government green procurement significantly promotes corporate green technology innovation, with this effect being more pronounced in state-owned enterprises and large enterprises, demonstrating distinct heterogeneity characteristics in terms of ownership and scale. In-depth mechanism testing reveals that government green procurement stimulates innovation vitality through two key pathways: alleviating corporate financing constraints and enhancing corporate reputation. Meanwhile, a sound institutional environment can significantly strengthen policy effectiveness. These findings not only enrich theoretical research on government procurement and corporate innovation but also provide important insights for promoting social green transformation and sustainable development, thereby contributing to multiple Sustainable Development Goals, including responsible consumption, climate action, and inclusive economic growth.
Keywords: government green procurement, green technology innovation, financing constraints, corporate reputation, institutional environment.

RESUMO

No contexto da intensificação das mudanças climáticas globais e do aprofundamento da construção da civilização ecológica, estimular a inovação em tecnologias verdes corporativas tornou-se uma alavanca fundamental para atingir as metas de pico e neutralidade de carbono. Baseado em dados de empresas chinesas listadas no mercado de ações Classe A ao longo de 10 anos, este artigo examina o mecanismo de impacto das compras públicas verdes na inovação corporativa em tecnologias verdes. A pesquisa conclui que as compras públicas verdes promovem significativamente a inovação corporativa em tecnologias verdes, sendo esse efeito mais pronunciado em empresas estatais e de grande porte, demonstrando características heterogêneas distintas em termos de propriedade e escala. Testes aprofundados revelam que as compras públicas verdes estimulam a vitalidade da inovação por meio de dois caminhos: aliviando restrições de financiamento e melhorando a reputação corporativa. Um ambiente institucional sólido pode fortalecer significativamente a eficácia dessa política. Essas descobertas não apenas enriquecem a pesquisa teórica sobre compras governamentais e inovação corporativa, mas também fornecem importantes insights para promover a transformação verde social e o desenvolvimento sustentável, contribuindo assim para múltiplos Objetivos de Desenvolvimento Sustentável, incluindo consumo responsável, ação climática e crescimento econômico inclusivo.
Palavras-chave: *compras públicas verdes, inovação tecnológica verde, restrições de financiamento, reputação corporativa, ambiente institucional.*

RESUMEN

En el contexto de la intensificación del cambio climático global y la profundización de la construcción de una civilización ecológica, estimular la innovación corporativa en tecnologías verdes se ha convertido en un factor clave para alcanzar los objetivos de pico y neutralidad de carbono. Con base en datos de empresas chinas que cotizan en bolsa con acciones A durante un período de diez años, este artículo examina el mecanismo de impacto de las compras públicas verdes en la innovación corporativa en tecnologías verdes. La investigación concluye que las compras públicas verdes promueven significativamente la innovación corporativa en tecnologías verdes, siendo este efecto más pronunciado en empresas estatales y de gran escala, mostrando características distintivas de heterogeneidad en términos de propiedad y escala. Un análisis exhaustivo del mecanismo revela que las compras públicas verdes estimulan la vitalidad de la innovación a través de dos vías clave: el alivio de las restricciones de financiación y la mejora de la reputación corporativa. Por otro lado, un entorno institucional sólido puede fortalecer significativamente la eficacia de las políticas. Estos hallazgos no solo enriquecen la investigación teórica sobre compras gubernamentales e innovación corporativa, sino que también brindan información importante para promover la transformación social verde y el desarrollo sostenible, contribuyendo así a múltiples objetivos de desarrollo sostenible, como el consumo responsable, la acción climática y el crecimiento económico inclusivo.
Palabras clave: *compras gubernamentales verdes, innovación en tecnologías verdes, restricciones de financiamiento, reputación corporativa, entorno institucional.*

INTRODUCTION

As global climate challenges intensify, green technology innovation has emerged as a critical pathway for sustainable development (Lei & He, 2025; Lei & Xu, 2025b). However, the public good nature of environmental technologies creates market failures that limit private sector investment (Borsatto & Bazani, 2021; Salihi et al., 2024). This gap requires government intervention through policy mechanisms that can effectively stimulate corporate innovation while addressing environmental challenges. In recent years, with the continuous expansion of government procurement scale and the deepening of green low-carbon concepts, green procurement has become increasingly important as a demand-side environmental policy tool. By leveraging its scale and demonstration effects, government procurement can directly expand market demand for green products and promote the broader adoption of green consumption concepts across society. This approach helps build stable market expectations and develop momentum for corporate green technology innovation (CGTI) (Tian et al., 2024; Zhang & Jiang, 2022).

Existing research has provided an important foundation for understanding the relationship between government procurement and corporate innovation. On one hand, scholars have focused on the policy effects of government green procurement, exploring its impact mechanisms on corporate environmental performance and market competitiveness. On the other hand, researchers have examined the influencing factors of corporate green technology innovation, revealing the operational mechanisms of environmental regulation, market demand, and corporate characteristics (Afshan & Yaqoob, 2023; Lestari et al., 2024). These studies have enriched relevant theories from different perspectives and provided valuable references for policy practice. However, as research deepens, several key scientific questions remain to be resolved. Thus, this study addresses the following overarching research question: How does government green procurement influence corporate green technology innovation, what are the underlying transmission mechanisms, and how do institutional and organizational factors moderate this relationship?

Addressing these research gaps, this paper systematically examines the impact mechanism of government green procurement on corporate green technology innovation using Chinese A-share listed companies from 2012 to 2022 as the research sample. While recent studies have examined aspects of government green procurement's impact on corporate environmental performance (Kou et al., 2024; Tang et al., 2025; Zheng & Wen, 2024), our research offers several key advances. First, we identify and empirically test two critical transmission pathways—financing constraint alleviation and corporate reputation enhancement—that explain how government green procurement translates into innovation outcomes. Second, we examine institutional environment quality as a crucial moderating factor, highlighting how contextual conditions shape policy outcomes. Third, our comprehensive heterogeneity analysis across ownership types and firm sizes offers novel insights for differentiated policy approaches. Finally, our methodological approach, combining fixed effects, instrumental variables, and propensity score matching with extensive robustness tests, provides more reliable causal inference than previous studies.

The paper is structured as follows: The second section reviews relevant literature and proposes research hypotheses; the third section introduces the research design, including sample selection, variable definition, and model specification; the fourth section reports empirical results and conducts robustness tests; the fifth section presents in-depth discussion; and finally, research conclusions are summarized and policy recommendations are proposed.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Literature review

In recent years, as global warming, environmental pollution, and ecological degradation have become increasingly severe (Lei, 2024), balancing economic development with environmental protection has become a major challenge facing governments worldwide. As a key approach to solving environmental problems, green technology innovation has received widespread attention (Lestari et al., 2024; Salihi et al., 2024). However, this innovation often faces high R&D costs and market uncertainty (Borsatto & Bazani, 2021; Usmani et al., 2023), which reduces the enthusiasm of enterprises for adopting it. In this context, the potential for governments, as important market entities, to guide and stimulate green technology innovation through procurement has become increasingly apparent.

As a market-based environmental policy tool, the operational mechanism of government green procurement is primarily reflected in demand-pull effects. On one hand, government procurement can directly create market demand, reducing market risks for corporate green technology innovation. Research shows that government procurement commitments can significantly increase enterprises' willingness to invest in R&D (Tian et al., 2024; Zhang & Jiang, 2022). Recent empirical evidence from China further confirms that government green procurement is an effective policy instrument for stimulating corporate green innovation, demonstrating significant positive effects on firms' environmental technology development (Zou et al., 2025). On the other hand, government procurement has a demonstration effect, capable of guiding private sector green consumption and expanding the market scale for green products. For example, when government agencies adopt electric vehicles, this not only directly increases sales but also enhances consumer purchasing confidence by demonstrating the reliability of this technology (Lei & Xu, 2025a; Zhu et al., 2013). Furthermore, government green procurement can promote healthy competition among suppliers through competitive mechanisms, encouraging enterprises to improve product performance and service quality.

Meanwhile, research on green technology innovation shows that multiple factors influence innovation activities. From an external environment perspective, besides traditional environmental regulatory pressure, market demand uncertainty is an important factor constraining enterprise innovation. Particularly in the green technology field, due to the diversity of technological paths and uncertainty in market acceptance, enterprises face significant innovation risks (Usmani et al., 2023). Considering internal conditions that affect innovation performance, the enterprise's

technological capability, financial strength, and organizational management levels stand out. Research finds that enterprises with stronger absorption and learning capabilities are more likely to achieve breakthrough innovations (Chen et al., 2015; Li et al., 2022). Therefore, reducing innovation risks and fostering stable market expectations have become essential in promoting green technology innovation.

In this context, the combination of government green procurement and green technology innovation has important theoretical value and practical significance. First, considering the mechanisms that drive innovation, government green procurement, through demand-side pressure, complements traditional supply-side environmental regulations, creating a policy mix that more effectively promotes green technology innovation. Second, from a market cultivation perspective, government green procurement can help overcome the "market failure" dilemma of green technology innovation, providing stable support for the commercialization of innovation outcomes. Finally, from an industrial development perspective, government green procurement can accelerate the diffusion and application of green technology, promoting industrial upgrading and structural optimization.

However, despite growing research attention to the effects of government green procurement (Zou et al., 2025), current academic understanding of the underlying transmission mechanisms and contextual factors remains incomplete. While existing studies have established the positive relationship between green procurement and innovation outcomes, the specific pathways through which these effects materialize—particularly the roles of financing constraints and corporate reputation—require deeper investigation. There are notable research gaps, particularly in three areas. First, the micro-level operational mechanisms through which government green procurement influences green technology innovation remain unclear. Second, there is a lack of in-depth discussion on the differential impacts of types of government green procurement on technological innovation. Finally, methods for evaluating the policy effects of government green procurement need improvement.

Therefore, in-depth research on the relationship between government green procurement and green technology innovation is of great significance. From a theoretical perspective, this research helps enrich environmental policy and innovation theory, particularly valuable in understanding the operational mechanisms of demand-side policy tools. From a practical perspective, research findings can provide a basis for government optimization of procurement policy design and improvement of policy implementation effects, while also providing reference for enterprises formulating innovation strategies. This not only helps promote green technology innovation development but also provides new ideas and solutions for addressing global environmental challenges.

Research hypotheses

First, as a demand-side environmental policy tool, government green procurement guides enterprise behavior by creating stable market demand for green products (Gourdon & Messent,

2019). From a market mechanism perspective, the government, as the largest single buyer, directly influences enterprises' revenue structure and profit expectations through its procurement decisions. When governments increase green procurement efforts, enterprises will proactively increase green technology R&D investment and enhance product environmental attributes to compete for government procurement orders. This demand-pull effect has been verified in multiple empirical studies. For example, research has found that government green procurement significantly promotes enterprise environmental performance (Wang et al., 2024). Building on signaling theory, government green procurement transmits policy commitment signals that reduce market uncertainty for environmental innovations (Ma et al., 2021). When governments demonstrate consistent demand for green products through procurement, they provide credible market signals that encourage long-term R&D investment by reducing innovation risks and establishing stable revenue expectations. Additionally, according to competitive advantage theory (Peranginangin, 2015), enterprises can not only secure government procurement orders through green technology innovation but also gain first-mover advantages under increasingly strict environmental regulations and establish technical barriers. Existing research has also confirmed that enterprise participation in government green procurement can significantly improve their innovation efficiency and market competitiveness (Li et al., 2018). Based on the above analysis, this paper proposes:

> H1: Government green procurement has a significantly positive effect on promoting corporate green technology innovation.

When discussing the transmission paths through which government green procurement influences corporate green technology innovation, we first focus on financing constraints as an important mediating mechanism. Government procurement contracts serve as credible signals to financial markets, reducing information asymmetry and improving firms' access to external financing (Wang et al., 2024; Yang & Li, 2024). Specifically, financial institutions such as banks often treat government procurement contracts as high-quality credit credentials, not only willing to provide more credit support to enterprises but also offering more favorable loan rates. Meanwhile, the stable procurement income obtained by enterprises can also enhance their debt servicing ability, optimize their asset-liability structure, and fundamentally improve their credit status. Existing research shows that government procurement can significantly alleviate corporate financing constraints and reduce financing costs (Harland et al., 2019; Xu et al., 2020; Yang & Li, 2024). The alleviation of financing constraints provides sufficient financial guarantee for enterprises to conduct green technology innovation, enabling them to make long-term R&D investments. This is particularly important in the green technology innovation field, as environmental technology R&D often has characteristics of large investment, long cycles, and high risk, and sufficient financial support is a basic condition for sustained innovation activities. Related research has also found that the reduction of financing constraints significantly promotes enterprise innovation input and innovation output (Brown et al., 2012; Yue et al., 2023; Zhang, 2023). Accordingly, we propose:

H2: Government green procurement promotes corporate green technology innovation by alleviating financing constraints.

Corporate reputation is another important transmission path through which government green procurement influences innovation. Government procurement orders signal superior environmental performance to stakeholders, enhancing corporate reputation through demonstrated compliance with stringent environmental standards (Agyabeng-Mensah et al., 2023). Media often report positively on enterprises participating in green procurement, enhancing their social image and brand value (Byrum, 2019). This reputation effect influences enterprise innovation behavior from multiple dimensions. First, a good corporate reputation helps enterprises obtain more market opportunities, establish brand premiums, and bring sustained economic benefits, providing financial support for subsequent innovation activities. Second, the enhancement of corporate reputation can strengthen cooperation relationships with stakeholders such as suppliers and customers, promoting the acquisition and integration of innovation resources. Third, a good social image can also enhance employee pride and identification, stimulating enthusiasm for innovation. Existing research shows that the enhancement of corporate reputation can significantly promote technological innovation and green transformation (Fu et al., 2024; Geng et al., 2024). Meanwhile, the enhancement of corporate reputation can also strengthen their sense of social responsibility, making them more focused on environmental protection and sustainable development, thus promoting green technology innovation at the strategic level. Empirical research has also found that enterprises with good reputations are more inclined to increase environmental and innovation investment (Bux et al., 2024; Waqas & Tan, 2023). Based on this, we propose:

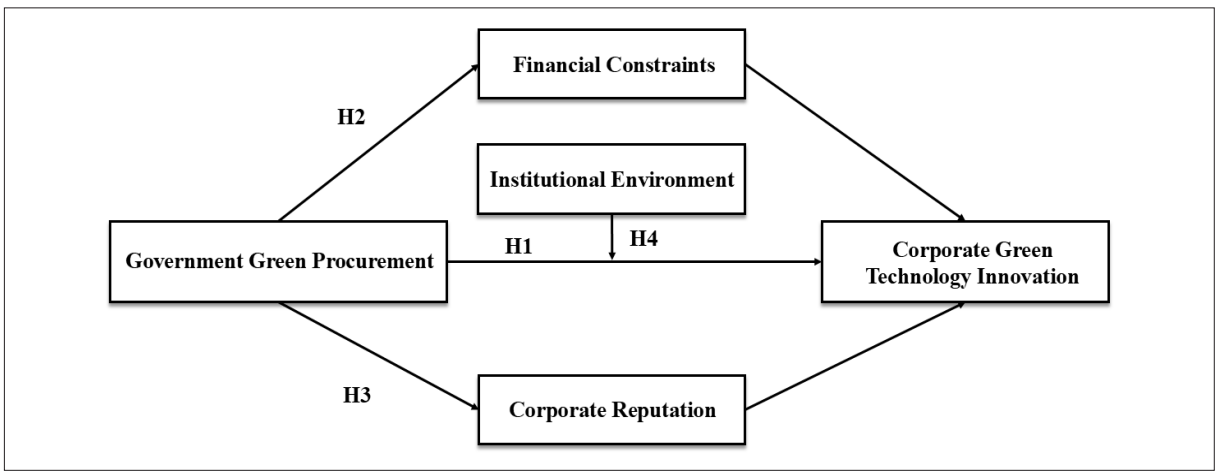
H3: Government green procurement promotes corporate green technology innovation by enhancing corporate reputation.

The institutional environment, as an important external factor, will profoundly impact the outcomes of government green procurement policies. Institutional theory suggests that strong institutional environments—characterized by higher marketization levels, comprehensive legal systems, and robust property rights protection—enhance the effectiveness of government policies (Jin & Lei, 2023). In such contexts, government green procurement signals become more credible and stable, encouraging enterprises to make long-term investments in innovation. Additionally, well-functioning market mechanisms and property rights protection reduce transaction costs and innovation risks, amplifying policy effectiveness (Musole, 2009). Additionally, standardized government behavior and transparent procurement processes can reduce enterprise transaction costs in participating in green procurement and improve policy efficiency. Related research has also found that improvement in the institutional environment significantly strengthens the promoting effect of government policies on enterprise innovation (Fuentelsaz et al., 2024; Smink et al., 2015). Empirical research further shows that in regions with high marketization levels and favorable legal environments, the driving effect of government procurement on enterprise technological innovation is more significant (Gourdon & Messent, 2019). Therefore, we propose:

H4: A favorable institutional environment strengthens the effect of government green procurement in promoting corporate green technology innovation.

The analysis of these research hypotheses lead to a comprehensive theoretical framework that reveals the operational mechanisms and boundary conditions of government green procurement's influence on corporate green technology innovation from three dimensions: direct effects, transmission mechanisms, and moderating effects (see Figure 1). This theoretical framework has both solid theoretical foundations and support from existing empirical research, laying a solid foundation for subsequent empirical testing. The analysis enhances understanding of government green procurement policy effects and provides important references for policy optimization and institutional construction.

Figure 1. Research Frame



RESEARCH DESIGN

Data sources

China presents an ideal context for examining the relationship between government green procurement and green technology innovation for several reasons. First, as the world's largest carbon emitter and second-largest economy, China's commitment to carbon peak and carbon neutrality goals makes its green innovation policies particularly significant for global sustainability efforts. Second, China's government procurement system has undergone substantial reforms since 2012, with increasing emphasis on environmental criteria, providing a rich policy landscape for analysis. Third, the diversity of China's industrial structure, ownership types, and regional development levels offers valuable heterogeneity for examining differential policy effects. Finally, China's unique institutional environment, characterized by strong government influence alongside growing market mechanisms, provides insights into how policy tools operate in transitional economies.

Panel data from Chinese A-share listed companies from 2012 to 2022 was analyzed, providing a comprehensive decade-long view of procurement-innovation dynamics. Government green procurement data was manually collected from the "Environmental Labeling Products Government Procurement List" and the "Energy-Saving Products Government Procurement List" published on the Chinese Government Procurement website. After 2019, as government departments ceased publishing these two lists and switched to implementing preferential and mandatory procurement based on item catalogs and certification documents, this study collected enterprise energy-saving product and environmental labeling product certification information from platforms such as the China Quality Certification Center, the Environmental Certification Center of the State Environmental Protection Administration (SEPA), and the CNRDS database, matching them with the "Government Procurement Item Catalog" by product category. Enterprise green patent data was obtained from the Patent Search System of the State Intellectual Property Office. Enterprise financial data and other characteristic data were sourced from CSMAR and WIND databases. To ensure data quality, the following samples were excluded: (1) listed companies in specialized industries such as finance and insurance; (2) listed companies with abnormal statuses, such as ST and *ST; (3) samples with significant missing data. Additionally, to reduce the influence of extreme values, all continuous variables were winsorized at the 1% and 99% percentiles.

Variable definitions

For the dependent variable, we selected corporate green technology innovation (CGTI) as the outcome variable, measured as the natural logarithm of the number of green patent applications plus one to address data skewness. The stability of the findings was verified through robustness tests using alternative measures, including the natural logarithm of granted patents plus one.

For the explanatory variable, this study selects government green procurement intensity (GGPI) as the core independent variable. As the largest single buyer, government procurement behavior has a significant impact on CGTI. The GGPI is measured by dividing the total amount of green procurement contracts obtained by the enterprise by its operating revenue, using manually collected data from the "Environmental Labeling Products Government Procurement List" and the "Energy-Saving Products Government Procurement List." This indicator not only reflects the scale of enterprise participation in green procurement but also considers enterprise scale heterogeneity.

For mediating variables, this study selects corporate financing constraints (CFCs) and enterprise reputation (REP). CFCs are measured using the KZ index (Lei & Xu, 2024), which involves five dimensions: cash flow, investment opportunities, debt level, cash dividends, and cash holdings, with higher index values indicating more severe CFCs. REP is measured based on news media coverage, using the CNRDS database to collect listed companies' news report data, employing machine learning methods for sentiment analysis of news texts (Shapiro et al., 2022), and calculating the proportion of positive reports as a proxy variable.

The institutional environment (INS) was selected as the moderating variable, and the quality of the INS affects the implementation effectiveness of government green procurement policies (Jin & Lei, 2023). This study uses the China Marketization Index to measure the INS of various regions, with higher index values indicating better INS.

Factors that might affect CGTI were selected as control variables, including the enterprise size (SIZE), represented by natural logarithm of total assets; the asset-liability ratio (LEV), represented by total liabilities divided by total assets; enterprise age (AGE), calculated as the natural logarithm of years listed plus one; board size (BOARD), which corresponds to the number of board members; and the first shareholder's shareholding ratio (FIRST), defined as the number of shares held by the largest shareholder divided by the total shares.

Model specification

Our research employs panel data econometric modeling with fixed effects to control for unobserved time-invariant heterogeneity across firms. We utilize a two-way fixed effects approach that incorporates both industry and year fixed effects to account for industry-specific characteristics and temporal trends. For statistical inference, we calculate robust standard errors clustered at the firm level to address potential heteroskedasticity and serial correlation issues. Our instrumental variable analysis employs two-stage least squares (2SLS) estimation to address endogeneity concerns, with first-stage F-statistics reported to test for weak instruments. The propensity score matching approach uses nearest-neighbor matching with replacement to address potential selection bias.

To test the research hypotheses, we developed the econometric models presented below. First, to test the impact of government green procurement on CGTI, a baseline regression model is constructed:

$$CGTI_{it} = \beta_0 + \beta_1 GGPI_{it} + \beta_2 \text{Control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

where i and t represent enterprise and year, respectively, CGTI represents the level of corporate green technology innovation, GGPI represents government green procurement intensity, Control represents the control variable group, μ_i and λ_t represent industry fixed effects and year fixed effects, respectively, and ε_{it} is the random disturbance term.

Second, models were constructed to test the mediating effects:

$$EFC_{it} = \alpha_0 + \alpha_1 GGPI_{it} + \alpha_2 \text{Control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$REP_{it} = \alpha_0 + \alpha_1 GGPI_{it} + \alpha_2 \text{Control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

$$CGTI_{it} = \gamma_0 + \gamma_1 GGPI_{it} + \gamma_2 EFC_{it} + \gamma_3 \text{Control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

$$CGTI_{it} = \gamma_0 + \gamma_1 GGPI_{it} + \gamma_2 REP_{it} + \gamma_3 \text{Control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (5)$$

Finally, to test the moderating effect of the institutional environment, the following interaction effect model is constructed:

$$CGTI_{it} = \delta_0 + \delta_1 GGPI_{it} + \delta_2 GGPI_{it} \times INS_{it} + \delta_4 \text{Control}_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (6)$$

To account for potential regional collinearity and cross-sectional dependence, we included industry and year fixed effects in all models, which helps control for unobserved time-invariant industry characteristics and time-variant common shocks. Additionally, our instrumental variable approach helps address potential endogeneity arising from regional factors.

RESULTS ANALYSIS

Descriptive statistical analysis

This section begins with a descriptive statistical analysis of the main research variables. As shown in Table 1, the average level of corporate green technology innovation (CGTI) among Chinese listed companies was 2.31, with a median of 2.15 and a standard deviation of 1.43, indicating that there is still considerable room for improvement, with significant differences among enterprises. The average government green procurement intensity (GGPI) was 0.086, indicating that government green procurement contracts accounted for an average of approximately 8.6% of enterprise operating revenue, a relatively low proportion reflecting the need to strengthen this intensity. The mean value of corporate financing constraints (CFC) was -0.845, and the mean value of enterprise reputation (REP) was 0.634, reflecting that sample enterprises generally have good financing environments and relatively positive market images. The mean value of institutional environment (INS) was 8.245, indicating steady progress in China's marketization process, though regional development imbalances still exist.

Table 1. Descriptive Statistical Analysis

Variable	N	Mean	Median	S.D.	Min	Max
CGTI	12,450	2.310	2.150	1.430	0.000	5.860
GGPI	12,450	0.086	0.073	0.094	0.000	0.412
CFC	12,450	-0.845	-0.912	1.234	-3.456	2.789
REP	12,450	0.634	0.612	0.189	0.125	0.967
INS	12,450	8.245	8.312	1.678	4.235	10.000

Continue

Table 1. Descriptive Statistical Analysis

Concludes

Variable	N	Mean	Median	S.D.	Min	Max
SIZE	12,450	22.345	22.156	1.345	19.234	26.789
LEV	12,450	0.456	0.434	0.213	0.087	0.912
AGE	12,450	2.678	2.745	0.567	0.693	3.912
BOARD	12,450	8.934	9.000	1.789	5.000	15.000
FIRST	12,450	0.345	0.323	0.145	0.089	0.749

Baseline regression analysis

The baseline regression results in Table 2 show that GGPI is strongly and positively correlated with CGTI levels, verifying that government green procurement significantly encourages corporate innovation. This result indicates that government green procurement not only directly expands market demand for green products but also incentivizes enterprises to increase green technology R&D investment through policy guidance. In terms of economic effects, every 10-percentage-point increase in GGPI will lead to approximately a 15.6% increase in enterprise green patent applications. This fully demonstrates that the demonstration effect and scale effect of government procurement can effectively drive corporate green innovation, helping economic and social green transformation development. The positive relationship between board size and green innovation likely reflects that larger boards bring diverse expertise and oversight that support more innovative activities. Enterprise size positively affects innovation as larger firms typically possess more resources for R&D activities. The significant relationship between shareholding ratio and CGTI suggests that concentrated ownership may facilitate more efficient decision-making for long-term investments in green innovation. In addition, we performed variance inflation factor (VIF) tests for all models, with all values below the conventional threshold of 10, indicating no severe multicollinearity issues.

Table 2. Baseline Regression Results

Variable	(1)	(2)
	CGTI	CGTI
GGPI	1.564***	1.523***
	(4.68)	(4.56)
SIZE		0.234***
		(3.57)
LEV		-0.456**

Continue

Table 2. Baseline Regression Results

Concludes

Variable	(1)	(2)
	CGTI	CGTI
		(-2.34)
AGE		0.123*
		(1.90)
BOARD		0.045**
		(2.23)
FIRST		0.345***
		(3.68)
N	12,450	12,450
Industry	YES	YES
Year	YES	YES
Adjust R^2	0.234	0.312

Note: T-values are shown in parentheses; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Robustness tests

Robustness tests were conducted from multiple dimensions to ensure the reliability of research conclusions. First, the natural logarithm of the number of granted green patents plus one was used as an alternative indicator for the dependent variable. Compared to patent applications, granted patents better reflect the quality level of enterprise innovation, as only patents that pass strict examination can be granted. The regression results in Table 3 show that the promoting effect of government green procurement on enterprise green patent grants remains significant.

Table 3. Alternative Dependent Variable

Variable	(1)	(2)
	CGTI	CGTI
GGPI	1.345***	1.289***
	(3.57)	(3.42)
N	12,450	12,450

Continue

Table 3. Alternative Dependent Variable

Concludes

Variable	(1)	(2)
	CGTI	CGTI
Controls	NO	YES
Industry	YES	YES
Year	YES	YES
Adjust R^2	0.198	0.287

Second, considering potential endogeneity issues, we used the instrumental variable method. The average GGPI of other enterprises in the same region and industry is selected as an instrumental variable (IV) for the following reasons: On one hand, this variable in enterprises in the same region and industry is influenced by the same local government policy environment, highly correlated with the enterprise's own GGPI, satisfying the correlation requirement; on the other hand, other enterprises' procurement situations will not directly affect the enterprise's own innovation decisions, only working indirectly through the policy environment, satisfying the exogeneity requirement. The two-stage least squares estimation results in Table 4 show that the first-stage F-statistic is far greater than 10, indicating no weak instrument problem, and the second-stage results continue to support the main conclusions of this study.

Table 4. Instrumental Variable Analysis

Variable	(1)	(2)
	GGPI	CGTI
IV	0.678***	
	(4.57)	
Instrumented GGPI		1.456***
		(3.79)
Controls	YES	YES
N	12,450	12,450
Industry	YES	YES
Year	YES	YES
Adj_R^2	0.345	0.289
F-statistic	45.678	

Finally, to mitigate sample selection bias, the propensity score matching method was employed. Specifically, using control variables as covariates, the nearest neighbor matching method (1:1 ratio, allowing replacement) was used to match enterpises with high GGPI (treatment group) with enterprises with low GGPI (control group). The balance test of the matched sample showed no significant differences between the treatment and control groups on paired variables, indicating good matching quality. Table 5 reports the regression results of the matched sample, with the GGPI remaining significantly positive, further supporting the study's findings. While our instrumental variable may potentially capture some shared regional or industry shocks, we have employed multiple robustness checks, including alternative variable measurements and propensity score matching, to validate our findings. Additionally, we controlled for industry and year fixed effects to mitigate the influence of common shocks.

Table 5. Results of PSM Analysis

Variable	(1)	(2)
	Before Matching	After Matching
	CGTI	CGTI
GGPI	1.523***	1.432***
	(4.56)	(4.29)
N	12,450	8,234
Controls	YES	YES
Industry	YES	YES
Year	YES	YES
Adjust R2	0.312	0.289

Heterogeneity analysis

Further research found that the effect of government green procurement on CGTI shows significant heterogeneity characteristics, with specific results presented in Table 6. From the ownership dimension, state-owned enterprises showed a stronger innovation response to government green procurement policies (coefficient 1.789, significance level 1%), significantly higher than private enterprises' response level (coefficient 1.234). This phenomenon deeply reflects the characteristics of government-enterprise interaction under China's unique institutional environment. State-owned enterprises, as important carriers of policy implementation, not only have natural policy sensitivity but also bear the mission of implementing national strategies.

Meanwhile, the close connections between state-owned enterprises and government departments enable them to obtain policy signals more quickly and respond, coupled with their institutional advantages in resource acquisition and financing channels, all help them more effectively transform policy incentives into innovation output.

Table 6. Heterogeneity Analysis Results

Variable	(1)	(2)	(3)	(4)
	State-owned	Private	Large	Medium Small
	CGTI	CGTI	CGTI	CGTI
GGPI	1.789***	1.234***	1.678***	1.123***
	(5.35)	(3.69)	(5.02)	(3.36)
N	3,735	8,715	4,233	8,217
Controls	YES	YES	YES	YES
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
Adjust R^2	0.345	0.289	0.312	0.267
Z-statistic for the difference between groups	2.345**		2.789***	

From the enterprise scale perspective, large enterprises demonstrated a stronger innovation drive under the government green procurement policy (coefficient 1.678, significance level 1%), significantly stronger than small and medium enterprises (coefficient 1.123). This result reveals the key role of innovation resource endowment in policy effect transmission. Large enterprises, with their sufficient R&D investment, professional technical teams, complete innovation infrastructure, and risk resistance capacity, can better grasp policy opportunities and transform market signals into technological breakthroughs. Especially in fields like green technology innovation with relatively high uncertainty and long investment cycles, large enterprises' resource advantages enable them to better bear innovation risks and make sustained investments.

To test if the differences in coefficients across groups were statistically significant, we employed Z-tests comparing the coefficients between state-owned and private enterprises, as well as between large and medium-small enterprises. The Z-statistics (2.345 and 2.789 respectively) confirmed that these differences were statistically significant at conventional levels ($p < 0.05$ and $p < 0.01$ respectively).

Further mechanism tests

This study further explored the mechanisms through which government green procurement influences CGTI, with specific results shown in Table 7. The research finds that alleviating financing constraints and enhancing enterprise reputation are two important mediating channels. Specifically, obtaining government green procurement contracts can transmit positive signals to the market, improve enterprise credit ratings and market recognition, thereby helping enterprises obtain more external financing support and alleviating financial pressure for innovation investment. Meanwhile, participating in government green procurement can also enhance enterprise social image and brand value, strengthen stakeholder trust, promote enterprises to actively take environmental responsibility, and increase green innovation investment. Additionally, the moderating effect test of institutional environment shows that good marketization levels and legal environment can strengthen the policy effects of government green procurement, suggesting we should pay attention to the important influence of institutional construction on policy implementation effects.

Table 7. Potential Transmission Path Tests

Variable	(1)	(2)	(3)	(4)	(5)
	CFC	CGTI	REP	CGTI	CGTI
GGPI	-0.567***	1.327***	0.456***	1.264***	1.123***
	(-3.79)	(4.23)	(3.57)	(4.12)	(3.360)
CFC		-0.345***			
		(-3.23)			
REP				0.567***	
				(3.89)	
GGPI×INS					0.234***
					(3.12)
N	12,450	12,450	12,450	12,450	12,450
Controls	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES
Adjust R^2	0.278	0.312	0.289	0.334	0.298

DISCUSSION

Theoretical implications

The significant positive impact of government green procurement on corporate green technology innovation (CGTI) identified in this study enriches our understanding of innovation-driven mechanisms from the demand side. Traditional research on green innovation has predominantly focused on supply-side policies such as environmental regulations, subsidies, and tax incentives (Afshan & Yaqoob, 2023; Borsatto & Bazani, 2021). Our findings complement this literature by demonstrating that demand-pull effects generated through government procurement constitute an equally important driver for corporate innovation. This corresponds with the market-based innovation theory that emphasizes the role of stable market demand in reducing innovation uncertainty and stimulating R&D investment (Tian et al., 2024).

Our exploration of heterogeneity effects reveals that the innovation response to government green procurement varies significantly across different enterprise types, which extends current understanding of policy effectiveness under complex market structures. The stronger innovation response observed in state-owned enterprises resonates with institutional theory that emphasizes the role of formal and informal institutional arrangements in shaping organizational behavior (Jin et al., 2023). State-owned enterprises in China operate within a unique institutional framework where policy signals are transmitted more directly, and resource mobilization is more aligned with national strategic objectives. Similarly, the more pronounced innovation response in large enterprises confirms the resource-based view that emphasizes the importance of organizational capabilities and resource endowments in facilitating innovation activities (Chen et al., 2015). This heterogeneity suggests that the effectiveness of environmental policies depends not only on policy design but also on the structural characteristics of target enterprises.

Our findings complement and extend recent research that similarly documented positive effects of government green procurement on corporate innovation in China (Zou et al., 2025). However, our study advances understanding by revealing specific transmission mechanisms—financing constraint alleviation and reputation enhancement—that were not explored in prior analyses. While previous studies focused primarily on direct procurement effects, our mechanistic analysis provides deeper insights into how policy signals translate into innovation outcomes (Zou et al., 2025). Additionally, our examination of institutional environment as a moderating factor offers novel insights into the boundary conditions of procurement policy effectiveness, suggesting that documented positive effects may vary significantly across different institutional contexts.

Societal implications and sustainable development

Beyond the theoretical contributions, our findings have significant implications for sustainable development and broader societal challenges. Government green procurement, by effectively

stimulating CGTI, directly contributes to several United Nations Sustainable Development Goals (SDGs). Most prominently, it advances SDG 12 (Responsible Consumption and Production) by institutionalizing sustainable procurement practices and creating market incentives for eco-friendly products and services. The resulting acceleration in green technology development further supports SDG 13 (Climate Action) by enhancing technological capacity for climate change mitigation through low-carbon innovations. Additionally, by creating market opportunities for sustainable products, government green procurement contributes to SDG 9 (Industry, Innovation, and Infrastructure) through promoting inclusive and sustainable industrialization.

The policy mechanism examined in this study holds particular relevance for challenges faced by the Global South. Developing economies often struggle with the dual imperatives of economic growth and environmental protection, frequently prioritizing the former at the expense of the latter. Our research demonstrates how government green procurement can simultaneously address both imperatives by leveraging public spending to create markets for green technologies without imposing punitive regulatory burdens that might inhibit economic development. This market-based approach may prove especially valuable in contexts where regulatory capacity is limited but public procurement constitutes a significant portion of the economy. Furthermore, our finding that government procurement can alleviate financing constraints is particularly salient in developing economies where capital markets are often underdeveloped and green technologies face substantial funding challenges.

The broader societal impact of government green procurement extends beyond environmental benefits to include social and economic dimensions of sustainability. By creating stable demand for green products, procurement policies can facilitate industrial upgrading and technological leapfrogging, potentially enabling developing economies to bypass carbon-intensive development stages. The employment opportunities created through green innovation can support inclusive economic growth (SDG 8), while the improvement in environmental quality from widespread adoption of green technologies directly enhances public health and wellbeing (SDG 3). Moreover, our findings on the importance of institutional quality suggest that green procurement initiatives can create positive spillover effects by incentivizing improvements in governance and market institutions, thereby contributing to SDG 16 (Peace, Justice, and Strong Institutions).

Our research also illuminates the social dynamics of sustainable transitions by revealing how policy signals transmitted through procurement can reshape corporate reputation considerations and stakeholder relationships. The reputational benefits identified as a key transmission mechanism demonstrate how government procurement can help align private incentives with public environmental goals, potentially accelerating the social acceptance of green technologies and sustainable business practices. This alignment of public and private interests represents a crucial pathway for overcoming collective action problems that have historically impeded progress on environmental challenges.

Practical implications and global relevance

When comparing our findings with international experiences, both similarities and unique characteristics emerge. Similar to studies in developed economies that show positive connections between government procurement and innovation (Gourdon & Messent, 2019; Harland et al., 2019), our research confirms that demand-pull effects operate consistently across different economic systems. However, the institutional context specificity of our findings raises important questions about policy transferability across different economic systems. While the core mechanism linking government procurement to innovation appears robust across contexts, the heterogeneity patterns we observe reflect China's distinctive institutional characteristics that may not directly translate to other settings. The heterogeneity patterns we observe—particularly the stronger responses from state-owned enterprises—reflect China's distinctive political economy where state actors play more prominent roles in market activities than in typical Western economies. In market-oriented economies with limited state ownership, the preferential response of state-owned enterprises observed in our study would be less relevant, suggesting that policy design should emphasize different mechanisms such as competitive procurement procedures or innovation partnerships with private firms. International experiences also indicate that the effectiveness of green procurement policies depends heavily on implementation details such as certification standards, monitoring mechanisms, and enforcement stringency (Usmani et al., 2023).

The practical implications of our findings extend to policy design in diverse contexts. Similarly, our finding that large enterprises respond more strongly to procurement signals may be less pronounced in economies with more developed financial markets where small and medium enterprises face fewer financing constraints. In such contexts, targeted support mechanisms for smaller firms might be necessary to achieve equitable innovation effects. In developing economies with significant state-owned sectors, leveraging these enterprises as innovation leaders can amplify policy effectiveness, while in more market-oriented economies, targeted incentives for private sector participation may be necessary. Similarly, our finding that institutional quality moderates policy effectiveness suggests that green procurement initiatives should be accompanied by broader institutional reforms in contexts where governance structures are weak. The institutional environment moderation effect we identify suggests that developing economies with weaker governance structures may need to prioritize institutional reforms alongside procurement policy implementation to maximize effectiveness. The financing constraint mechanism highlights the importance of coordinating procurement policies with financial sector initiatives to maximize impact, potentially through green finance instruments that complement procurement incentives.

The demonstrated effectiveness of government green procurement in stimulating innovation also has implications for international climate policy. As countries work to implement their nationally determined contributions (NDCs) under the Paris Agreement, procurement policies offer a politically feasible and economically efficient mechanism for

driving technological change. Unlike carbon taxes or regulations that often face political resistance, procurement policies can generate positive constituencies among suppliers who benefit from new market opportunities. This political economy advantage makes green procurement a valuable addition to the climate policy toolkit, particularly in contexts where more direct interventions face implementation challenges. These differences highlight the importance of adapting procurement policy design to local institutional contexts rather than adopting one-size-fits-all approaches, as our findings demonstrate that while core mechanisms may be universal, their relative importance and optimal implementation strategies vary significantly across different economic and institutional settings.

CONCLUSIONS

This study makes significant contributions to understanding how government green procurement drives corporate green technology innovation (CGTI) by examining data from Chinese A-share listed companies from 2012 to 2022. Our empirical analysis demonstrates that government green procurement serves as a powerful catalyst for corporate environmental innovation through two critical mechanisms—alleviating financing constraints and enhancing corporate reputation—with this effect being moderated by institutional environment quality. Importantly, we identify distinct heterogeneity patterns, with stronger innovation responses in state-owned enterprises and large firms, highlighting the need for differentiated policy approaches. These insights extend beyond theoretical significance to address pressing societal challenges, contributing to multiple UN SDGs and offering valuable lessons for developing economies navigating sustainability transitions. By demonstrating how market-based policy instruments can effectively drive technological progress without direct regulatory intervention, our research provides a framework for designing more effective environmental governance systems that leverage public procurement to accelerate green transformation across diverse institutional contexts.

Limitations and future research

While this study provides valuable insights into government green procurement's innovation effects, several limitations warrant acknowledgment. Our instrumental variable approach and patent-based innovation measures, although rigorously tested, may not fully capture causal relationships or innovation quality variations. The analysis assumes relatively immediate responses to procurement signals, potentially overlooking complex innovation dynamics and time lags. Additionally, omitted variables such as prior R&D commitments and local regulations could influence our findings. Regarding generalizability, institutional differences across countries may limit direct policy transfer of our China-specific results. However, our theoretical framework integrating signaling theory, transaction cost economics, institutional theory, and innovation

systems provides broadly applicable insights. The core mechanisms we identify—demand certainty, financing constraint alleviation, and reputation enhancement—operate across institutional contexts, though their relative importance may vary. Future research should explore alternative identification strategies, complementary innovation measures, and multi-method approaches to deepen understanding of how procurement policies translate into innovation outcomes across different institutional settings.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

DATA AVAILABILITY

The entire dataset supporting the findings of this study is available upon request from the corresponding author. The dataset is not publicly available due to data restrictions and confidentiality requirements.

AUTHORS' CONTRIBUTION

Xue Lei: Conceptualization; Formal analysis; Investigation; Methodology; Writing – original draft; Writing – proofreading, and editing.
Shouchao He: Data curation; Resources; Software; Validation; Visualization; Project administration.