Journal of Innovation and Development
ISSN: 2958-4752 | Vol. 9, No. 2, 2024

Research on the Influence of Innovation Vouchers and Government Procurement on the Green Innovation of Small and Medium-sized Enterprises

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Abstract: This paper selects Chinese small and medium-sized board and Shanghai and Shenzhen A-share listed companies on GEM from 2018 to 2022 as research samples, and uses two-way fixed effect model to test the impact of two demand-side innovation policies, innovation voucher and government procurement, on green innovation of small and medium-sized enterprises and their combination mechanism. The study found that: (1) innovation vouchers and government procurement policies can promote green innovation of small and medium-sized enterprises, and there are synergistic effects between the two types of policies. After a series of robust tests, the results are still established. (2) Mechanism inspection shows that enterprise R & D investment and corporate social responsibility are the role mechanism of the combination of innovation voucher and government procurement policy affecting the green innovation of small and medium-sized enterprises.(3) Heterogeneity test shows that the two types of policies have a stronger role in promoting green innovation in non-state-owned enterprises. Based on the combination of policy tools, this paper expands the perspective of enterprise green innovation, which is of great significance to further rely on innovation policy tools to promote enterprise innovation.

Keywords: Innovation vouchers; government procurement; small and medium-sized enterprises; green innovation.

1. Introduction

In September 2020, China proposed for the first time a “dual-carbon” target, that is, striving to achieve carbon peak by 2030 and carbon neutrality by 2060. The 20th National Congress of the Communist Party of China (CPC) proposed to “accelerate the green transformation of the development mode”, therefore, “green innovation” has been given the mission of the times. Enterprise green innovation is an inherent requirement for implementing the new development concept and realizing high-quality development, and it is a powerful engine for promoting the green transformation of economic and social development.

As an important participant in the realization of China's “dual-carbon” goal, the green innovation of small and medium-sized enterprises (SMEs) has become a research issue that deserves more attention. However, compared with traditional innovation, green innovation is more risky, more uncertain, and higher upfront investment, which makes the green innovation of small and medium-sized enterprises face great challenges [1], and it is difficult to realize green innovation simply by relying on the market and the power of enterprises themselves [2]. In this context, the government's innovation policy is of great significance in guiding SMEs to green innovation. According to supply-push theory and demand-pull theory, government innovation policies can be divided into two categories: supply-side innovation support and demand-side innovation support. The early innovation policy system mainly focuses on supply-side innovation support such as government subsidies, however, with the emergence of drawbacks such as distortion of public resource rationing and frequent rent-seeking by enterprises [3], the research focus of innovation policy has begun to shift to demand-side policies mainly based on innovation vouchers and government procurement.

Most previous studies on demand side policies have focused on the impact of a single policy on the enterprise level [4-5], and some have explored the synergistic effect [6] of the combination of supply side and demand side policies, but did not pay attention to the effect of the traditional demand side policy combination of innovation voucher, the emerging demand side policy and government procurement. Based on this, this paper uses the data of Shanghai and Shenzhen A-share listed companies on the SME board and GEM board in 2018-2022 to discuss the impact of innovation vouchers and government procurement on the green innovation of small and medium-sized enterprises, and studies the action mechanism of the two policy combination.

2. Theoretical Analysis and Research Hypothesis

2.1. Innovation Vouchers, Government Procurement, and Green Innovation in SMEs

Green innovation is the core of the win-win situation of "economic development and emission reduction", and also an important strategy for enterprises to achieve the sustainable development goals. In the process of green innovation, small and medium-sized enterprises are often faced with problems such as insufficient research and development funds and poor resource acquisition ability, which leads to their weak enthusiasm for green innovation. The Porter hypothesis believes that at this stage, the government should give more play to the incentive effect of the demand-side innovation policies on the green innovation of enterprises.

Innovation voucher is an emerging demand-side innovation policy tool, aiming to solve the dual shortage of smes in terms of economic strength and innovation resources [6]. Based on

the view of resource basis and the theory of resource dependence, enterprises must rely on the support of various resources when promoting innovation activities. Innovation vouchers first take the form of "vouchers" to reduce the cost of green innovation, thus easing the financial pressure faced by enterprises in the field of green innovation. Secondly, innovation vouchers also play the role of a bridge, promoting the cooperation between small and medium-sized enterprises and scientific research institutions, introducing authoritative and complementary information, and promoting the application and output of green patents. Finally, the innovation voucher has the effect of resource allocation, which promotes the aggregation of innovation resources to small and medium-sized enterprises, and can help enterprises to more easily obtain all kinds of important external resources necessary to carry out green innovation activities, so as to quickly fill the gaps in some green technology fields.

The theory of innovation externalities points out that SMEs are more likely to encounter risks in their innovation activities, and their investment may not be converted into expected returns, which to a large extent suppresses their enthusiasm in green innovation. However, as the most important demand-side innovation policy tool, government procurement can help SMEs to reduce risks and promote green innovation. On the one hand, due to the characteristics of large scale, long cycle and high value, the government will not easily replace the suppliers once the contract is signed, and the risk of default is very low, which brings stable effect to the production and operation of green products for small and medium-sized enterprises. On the other hand, government procurement has the function of green environmental protection and promoting enterprise innovation. As the government has set high standards and strict requirements in the production process and quality of product procurement, enterprises will focus more on improving the environmental quality of products and increase investment in research and development, so as to promote the green innovation process of enterprises [7].

In conclusion, the hypotheses H1, H2.

H1: Innovation vouchers can help to promote green innovation for SMEs.

H2: Government procurement is helpful to promote green innovation for SMEs.

2.2. Synergistic Effect of Innovation Voucher and Government Procurement

With the deepening of the integration of the government and society, the effect of policies not only depends on a single policy, but also needs to pay attention to the cooperation between different policies [8]. Zhao Kai and Li Lei (2023) [9] found that the multi-tool combination strategy composed of direct subsidies, tax incentives and government procurement is the best subsidy implementation strategy for the government, both in encouraging enterprise innovation investment and improving the quality of enterprise innovation.

Although the innovation vouchers and government procurement in this paper are both demand-side policy tools, they are actually fundamentally different, and the combination of the two types of policies may produce unexpected synergies.

On the one hand, the combination of innovation vouchers and government procurement policies can promote the green innovation of small and medium-sized enterprises through "direct + indirect" methods. Innovation coupon has the advantages of some r & d subsidies, when small and medium-sized enterprises in the process of green innovation, can apply to the government for science and technology innovation, innovation vouchers as "securities", equivalent to directly for small and medium-sized enterprises provide financial support, reduce the cost of green innovation, directly promote the small and medium-sized enterprises to green innovation activities. At the same time, government procurement can use its policy guidance function to guide other enterprises in the market to invest in green technology innovation in some fields through advance procurement, so as to indirectly promote the green innovation of small and medium-sized enterprises through the change of market demand. On the other hand, the combination of innovation vouchers and government procurement policy can promote the green innovation of enterprises from both internal and external perspectives. Because innovation voucher is a policy designed for small and medium-sized enterprises, therefore, innovation vouchers can accurately reduce the cost of small and medium-sized enterprises green innovation, and help small and medium-sized enterprises and universities and scientific research institutions cooperation platform, get more green innovation resources information and technical personnel, provide guarantee for small and medium-sized enterprises, improve the ability of green innovation, from the internal to promote small and medium-sized enterprises active green innovation. At the same time, the "high standards" and "strict requirements" of government procurement can supervise the procurement of small and medium-sized enterprises with greener products from the market perspective, and promote the green innovation of small and medium-sized enterprises from the outside.

Based on this, the hypothesis H3 of this paper is proposed.

H3: The combination of innovation vouchers and government procurement policy has a synergistic effect on the green innovation of smes.

2.3. The Intermediary Role of R & D Investment and Corporate Social Responsibility

In the process of production and operation, R & D and innovation of enterprises, R & D investment is an important factor influencing the green innovation of enterprises, which is of great significance for promoting the transformation of achievements and improving the efficiency of green technology innovation of enterprises [10]. However, the input and output of innovation are uncertain, and the disorder and low efficiency of resource allocation may lead to problems in the capital operation of enterprises, cause financing constraints, and thus reduce the investment of enterprises in R & D.

The theory of information asymmetry points out that due to the small scale and the lack of resource information, small and medium-sized enterprises are often at a disadvantage in social communication, and urgently need the support of government policies to alleviate the problem of "adverse selection" faced by them. Based on the signal transmission theory, enterprises can use various external signals to enhance the confidence of external investors, so as to attract more external investment. When enterprises get innovation vouchers and government procurement, no doubt to external investors convey more powerful positive signal, so under the same conditions, external investors tend to invest the "government certification", thus alleviate the external financing constraints,

make the enterprise to improve the r & d of green innovation project, promote the green innovation of the enterprise [11].

A foreign scholar found that in addition to improving the green innovation performance of enterprises by increasing r & d investment, it can also promote enterprises to actively carry out green innovation [12] by enhancing corporate social responsibility. At present, a large number of literature has verified the relationship between CSR and green innovation. For example, Yangcheng et al. (2024) [13] found that, given other conditions, CSR mediated the attention of urban green development and enterprise green technology innovation; Ran Di et al. (2023) [14] found that the good performance of CSR can significantly promote the output of enterprise green technology innovation by providing more redundant resources. Based on this, this paper further discusses the relationship between the CSR in innovation policy and green innovation.

In the market economy system, enterprises, as the economic subject aiming at profit, are often difficult to consciously assume their social responsibilities. Therefore, it is necessary for the government to intervene effectively through diversified means, such as economic incentives, laws and regulations, and policy guidance, so as to promote enterprises to fulfill their corresponding social responsibilities. According to stakeholder theory, green innovation needs more stakeholder support than traditional technological innovation. By combining innovation vouchers and government procurement policy, can be enterprises, government, research institutions and other stakeholders closely together, to help enterprises get the recognition and support of stakeholders, promote enterprises to play a bigger role in the performance of social responsibility, at the same time also can get more green resources and green information, in order to promote the innovation of green enterprise. In addition, in the process of fulfilling social responsibilities, enterprises tend to pay more attention to social and environmental issues, and this sense of responsibility encourages enterprises to more actively participate in green innovation activities [15].

Based on the above analysis, hypotheses H4 and H5 are proposed.

H4: The combination of innovation vouchers and government procurement policies promotes the green innovation of small and medium-sized enterprises by increasing enterprise r & d investment.

H5: The combination of innovation vouchers and government procurement policies is promoted by enhancing corporate social responsibility.

3. Research Design

3.1. Sample Selection and Data Source

In this paper, the a-share listed companies on the SME board and the GEM are taken as the research samples, and the year 2018-2022 is selected as the research range. Based on the authenticity and availability of the data, the samples are treated as follows: (1)eliminates ST and PT enterprise samples;(2)eliminates the enterprise samples in the financial industry; (3)eliminates the enterprise samples with missing data. In addition, in order to reduce the outliers on the empirical results, the 1%, 99% quantile of all continuous variables were reduced, and 8382 observations were obtained. The data of the innovation voucher in the paper comes from Guotai 'an (CSMAR) database, the government procurement data comes from the official website of Chinese government procurement, the green innovation data comes from CNRDS database, the relevant data of corporate social responsibility comes from Wind database, and the basic information and financial data of enterprises are all from Guotai' an database.

3.2. Variable Setting

Interpreted variable: Green Innovation (Patent). Drawing on the method of Yuan Yikai et al. (2024) [16], this paper selects the natural logarithm of green patent applications plus 1 as the explained variable. Among them, green patents include green practical patents and green invention patents.

Explanatory variable: innovation voucher (ivh). By identifying the information of government subsidies in the national Taian database, manually find out the relevant information related to the enterprise innovation voucher, and set up virtual variables, the value of the ivh value is 1, and the ivh value is 0; government procurement (igp). Find the relevant information of government procurement on the official website of Chinese government procurement, and measure whether the enterprise has accepted government procurement by checking the enterprise's government procurement announcements. Virtual variables are also set. For the enterprise that accepts government procurement, the igp value is 1, and if the enterprise that accepts government procurement does not accept government procurement, the igp value is 0.

Intermediation variable: Corporate social responsibility (CSR). Measured by zheng esg disclosure score, it is divided into 9 grades according to enterprise performance, with 1-9 points; R & D investment (RD). Measured by the proportion of annual R & D expenses in operating revenue.

Control variables: In order to reduce the problems caused by missing variables, the following variables were selected as control variables with reference to previous studies. It includes the enterprise age (Age), measured by the listing from the year of study; the size of the enterprise (Size), measured by the natural logarithm of the total assets of the enterprise at the end of the year; the asset liability ratio (Lev), measured by the ratio of the total liabilities to total assets of the enterprise (Fix), measured by the ratio of fixed net assets to total assets at the end of the year; the capital intensity (K), measured by the ratio of the number of senior executives (LnSE), measured by the total number of senior executives of the enterprise.

3.3. Model Design

Due to the obvious temporal change trend of policy factors and the differences between industries, the estimation method in this paper adopts the two-way fixed-effect model, in which the individual effects are divided according to the industry. The specific model design is shown as follows:

$$Patent_{it} = \alpha + \beta_1 ivh_{it} + \beta_2 Age_{it} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 Fix_{it} + \beta_6 K_{it} + \beta_7 LnSE_{it} + \mu_j + \delta_t + \varepsilon_{it} \quad (1)$$

$$Patent_{it} = \alpha + \beta_1 igp_{it} + \beta_2 Age_{it} + \beta_3 Size_{it} + \beta_4 Lev_{it} + \beta_5 Fix_{it} + \beta_6 K_{it} + \beta_7 LnSE_{it} + \mu_j + \delta_t + \varepsilon_{it} \quad (2)$$

$$Patent_{it} = \alpha + \beta_1 ivh_{it} + \beta_2 igp_{it} + \beta_3 Age_{it} + \beta_4 Size_{it} + \beta_5 Lev_{it} + \beta_6 Fix_{it} + \beta_7 K_{it} + \beta_8 LnSE_{it} + \mu_j + \delta_t + \varepsilon_{it} \quad (3)$$

Among them, α is a constant term, β_1 to β_8 is the regression coefficient of each variable, i and t represent enterprise and

year respectively, Patentit represents green innovation in i industry t period, ivh and igp represent innovation voucher and government procurement respectively; Age, Size, lev, Fix, K and LnSE represent enterprise age, enterprise size, asset-liability ratio, asset-liability ratio of fixed assets, capital intensity and number of executives; μ_j represents industry fixed effect, δ_t represents annual fixed effect, and ε_{it} represents random interference term. Equations (1) and (2) test the impact of innovation vouchers and government procurement policies on the green innovation of small and medium-sized enterprises respectively. Equation (3) is the result of adding innovation vouchers or government procurement as a control variable on the basis of Equation (1) and (2) respectively.

In addition to examining the impact of innovation voucher and government procurement single policy on the green innovation of small and medium-sized enterprises, this paper further studies the impact of the two combination on the green innovation, that is, the interaction term is added in formula (3), and the measurement model is as follows:

$$Patent_{it} = \alpha + \beta_1 ivh_{it} + \beta_2 igp_{it} + \beta_3 ivh_{it} * igp_{it} + \beta_4 Age_{it} + \beta_5 Size_{it} + \beta_6 Lev_{it} + \beta_7 Fix_{it} + \beta_8 K_{it} + \beta_9 LnSE_{it} + \mu_j + \delta_t + \varepsilon_{it} \quad (4)$$

4. Empirical Analysis

4.1. Descriptive Statistics

As shown in Table 1, the overall observed values of this article are 8,382, and the observation interval is from 2018-2022. Among them, the maximum value of Patent is 4.419, the minimum value is 0, and the standard deviation is 1.084, indicating that there is a certain gap in green innovation between enterprises. After simple calculation, 279 enterprises with innovation voucher and 1341 enterprises have obtained the government procurement policy, indicating that compared with the innovation voucher policy, the use of government procurement policy is more common.

Table 1. Descriptive Statistics

variable	N	Mean	Sd	Min	Max
Patent	8,382	0.883	1.084	0	4.419
ivh	8,382	0.0333	0.179	0	1
igp	8,382	0.160	0.366	0	1
CSR	8,382	3.945	1.214	0	6.250
RD	8,382	6.304	5.400	0.100	32.76
Age	8,382	7.255	4.250	0	18
Size	8,382	21.93	0.991	20	25
Lev	8,382	0.390	0.187	0.0594	0.940
Fix	8,382	0.178	0.123	0.00289	0.553
K	8,382	2.313	1.483	0.473	10.19
LnSE	8,382	1.869	0.353	1.099	2.708
Industry	8,382	39.57	16.35	1	88
year	8,382	2,020	1.399	2,018	2,022

4.2. Benchmark Regression

Table 2 as the benchmark model regression results, from column (1), the regression coefficient of innovation voucher is 0.104, and through the significance level of 10%, column (2) shows the regression coefficient of government procurement is 0.131, and at 1% level significantly positive, column (1), (2) proved the innovation voucher and government procurement policy can promote the innovation of small and medium-sized enterprises green, so H1, H2. Model (3) is the result of adding an innovation voucher or a government procurement as a control variable on the basis of model (1) and (2), respectively. It can be seen that when the innovation voucher is used as the basic explanatory variable, the coefficient of ivh is still significantly positive at 10%, and when government procurement is considered as the basic explanatory variable, the coefficient of igp is still significantly positive at 1%. Model (4) on the basis of the model (3) joined the innovation voucher and government procurement interaction, study the two policies interact on the green innovation of small and medium-sized enterprises, found that the interaction coefficient significantly at 5% level, so H3 certificate, the innovation voucher and government procurement policy combination of small and medium-sized enterprise green innovation synergistic effect.

Table 2. Benchmark Regression

	(1) Patent	(2) Patent	(3) Patent	(4) Patent
ivh	0.104*		0.096*	0.028
	(0.055)		(0.055)	(0.062)
igp		0.131***	0.129***	0.116***
		(0.029)	(0.029)	(0.029)
ivh*igp				0.328**
				(0.134)
Age	0.003	0.002	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Size	0.444***	0.439***	0.439***	0.439***
	(0.012)	(0.012)	(0.012)	(0.012)
Lev	0.297***	0.299***	0.299***	0.299***
	(0.062)	(0.061)	(0.061)	(0.061)
Fix	-0.121	-0.087	-0.083	-0.082
	(0.096)	(0.096)	(0.096)	(0.096)
K	-0.014*	-0.013*	-0.013*	-0.013*
	(0.007)	(0.007)	(0.007)	(0.007)
LnSE	0.081***	0.074**	0.074**	0.073**
	(0.029)	(0.029)	(0.029)	(0.029)
_cons	-9.379***	-9.264***	-9.280***	-9.270***
	(0.303)	(0.303)	(0.303)	(0.303)
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
N	8382	8382	8382	8382
R^2	0.328	0.330	0.330	0.330

Note: ***, ** ,and * indicate the significance level test of 1%, 5% and 10%, respectively, and the robust standard error is included in parentheses. similarly hereinafter.

4.3. Endurance Test

The endogeneity test was performed due to possible sample selection bias, the benchmark regression results are biased. This paper uses the propensity score matching method (PSM) and Heckman two-stage regression method to solve the possible endogeneity problems.

First, this paper uses the nearest neighbor matching method to match the propensity scores of SMEs. Whether the enterprise obtains the innovation voucher, whether the two policy combination as the processing variables, the PSM neighbor 1:1 matching. The results of the balance test showed that the difference after matching was smaller (match deviation <10%), and the P-value was greater than 0.1, indicating that the match met the balance hypothesis, and the results using PSM were reliable. The matched regression results are shown in Table 3 (1) to (3) of Table 3. The coefficients of innovation vouchers, government procurement and policy combination are 0.160,0.087 and 0.420 respectively, and all of them are significantly positive at the 5% level, which is basically consistent with the benchmark regression results.

Subsequently, this paper used Heckman for further analysis, to accept the innovation voucher, government procurement

and policy combination as the dependent variables, probit variables affecting the possibility of innovation policy as independent variables, and then the inverse Mills ratio was obtained, and the inverse Mills ratio was added to the benchmark regression. Drawing on the research of Zhai Haiyan et al. (2015) [17], this paper selects the following variables as the explanatory variables of probit: R & D investment in t-1 phase, enterprise age, enterprise size, and shareholding by institutional investors. The regression results are shown below in Table 3 (4) to (6). It is found that the coefficient of innovation voucher is still positive, and the coefficient of government procurement and policy combination is significantly positive below the 1% level, which again verifies the robustness of the research conclusions in this paper.

Table 3-1. PSM

	(1)	(2)	(3)
ivh	0.160**		
	(0.077)		
igp		0.087**	
		(0.038)	
ivh*igp			0.420**
			(0.180)
IMR			
_cons	-9.103***	-8.873***	-7.759***
	(1.229)	(0.659)	(2.553)
Industry	YES	YES	YES
Year	YES	YES	YES
N	558	2468	118
R^2	0.370	0.354	0.530

Table 3-2. Heckman

	(4)	(5)	(6)
ivh	0.064		
	(0.067)		
igp		0.099***	
		(0.032)	
ivh*igp			0.460***
			(0.137)
IMR	-0.994***	-1.074***	-0.821***
	(0.120)	(0.144)	(0.113)
_cons	-5.329***	0.245	-3.441***
	(0.647)	(1.321)	(0.996)
Industry	YES	YES	YES
Year	YES	YES	YES
N	5649	6307	4650
R^2	0.335	0.336	0.315

4.4. Robustness Test

To further empirical test the reliability of the results, the robustness test from the following two aspects.

One is to change the measurement mode of green innovation. The number of green patent applications lagging behind the first phase and adding 1 natural log [18] are selected to test the impact of innovation policies on the green innovation of small and medium-sized enterprises again. The results are shown in Table 4, (1) to (4), columns (1) and (2) respectively reflect the separate effects of innovation vouchers and government procurement on green innovation of smes. Among them, the effect coefficient of innovation voucher on the green innovation of enterprises is 0.093, but the significance is not high. It may be because there is no lag in the effect of innovation voucher on green innovation, and the effect coefficient of government procurement on the green innovation of enterprises is 0.111, and it has passed the significance level of 1%. Column (3), (4) verify the innovation voucher and the government procurement effect on the green innovation of small and medium-sized enterprises, column (3) also shows that government procurement to the enterprise green innovation, column (4), according to the innovation voucher and the government innovation of enterprise green innovation coefficient of 0.460, and through the 1% of the significance level, shows that two types of policy in promoting the green innovation of small and medium-sized enterprises. Therefore, after replacing the measure mode of the explained variables, the regression results are basically consistent with the previous article, verifying the robustness of the benchmark regression results.

The second is to cross fixed effect. To solve the problem of missing variables, this paper on the basis of the original control industry and year fixed effect, further control provinces-year fixed effect, the results are shown in table 4, column (5), (6), the influence of government procurement on green innovation, the results show that both can promote small and medium-sized enterprise green innovation, by column (7) shows the significance of the government procurement coefficient is stronger, column (8) innovation and government procurement policy combination of regression coefficient of 0.348, and through the 1% significance level, prove that the two types of policy in the process of promoting green innovation of small and medium-sized enterprises have synergistic effect. Overall, it is consistent with the previous results.

Table 4-1. Change the Measurement Method

	(1)	(2)	(3)	(4)
ivh	0.093		0.084	-0.025
	(0.068)		(0.068)	(0.078)
igp		0.111***	0.109***	0.091***
		(0.033)	(0.033)	(0.034)
ivh*igp				0.460***
				(0.161)
_cons	-9.506***	-9.408**	-9.419***	-9.406***
	(0.347)	(0.348)	(0.348)	(0.348)
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
N	6556	6556	6556	6556
R^2	0.330	0.331	0.332	0.332

Table 4-2. Cross Fixation Effect

	(5)	(6)	(7)	(8)
ivh	0.123*		0.115**	0.042
	(0.055)		(0.055)	(0.062)
igp		0.135***	0.133***	0.118***
		(0.029)	(0.029)	(0.030)
ivh*igp				0.348***
				(0.134)
_cons	-9.523***	-9.408***	-9.427***	-9.417***
	(0.307)	(0.307)	(0.307)	(0.307)
Province	YES	YES	YES	YES
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
N	8382	8382	8382	8382
R^2	0.334	0.335	0.335	0.336

5. Analysis of the Impact Mechanisms and the Heterogeneity

5.1. Mechanism Inspection

This section will empirically test the impact mechanism of the combination of innovation vouchers and government procurement policy on the green innovation of smes from two aspects of R & D investment and corporate social responsibility.

Through combing previous studies, it is found that the increase of R & D investment is conducive to the improvement of enterprises' green innovation ability [19], and the performance of corporate social responsibility can also significantly promote the improvement of green innovation level [20]. Therefore, the relationship between these two intermediary variables and green innovation is relatively clear. Based on this, this paper refers to the practice of Jiangboat (2022) [21], and focuses on the influence of explanatory variables on intermediary variables, that is, the impact of the combination of innovation voucher and government procurement policy on R & D investment and corporate social responsibility respectively. The results are shown in Table 5, when the explained variable was R & D investment (RD), the policy combination coefficient was significantly positive at 1%, and H4 was verified; when the explained variable was corporate social responsibility (CSR), the policy combination coefficient was significantly positive at 10%, and H5 was also verified.

Table 5. Mechanistic Testing

	(1) Patent	(2) RD	(3) Patent	(4) CSR
ivh*igp	0.442***	2.286***	0.442***	0.245*
	(0.117)	(0.555)	(0.117)	(0.147)
_cons	-9.349***	2.614*	-9.349***	-4.380***
	(0.303)	(1.431)	(0.303)	(0.379)
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
N	8382	8382	8382	8382
R^2	0.329	0.396	0.329	0.162

5.2. Analysis of Heterogeneity

Since the effect of innovation policies on enterprises' green innovation may be affected by the heterogeneous role of the nature of property rights, this paper categorizes SMEs into SOEs (SOE=1) and non-SOEs (SOE=0) according to the nature of property rights and conducts regression of grouping with the benchmark model. The results are shown in Table 6, which shows that both single policies and policy combinations have a more pronounced role in promoting green innovation in non-SOEs. This may be due to the fact that SOEs have easier access to resources such as talents and technologies related to green innovation, as well as financial support such as tax incentives from governmental departments, and therefore face relatively fewer problems in the process of green innovation. On the other hand, non-state-owned enterprises in the process of green innovation themselves have problems such as lack of funds and difficulty in obtaining resources, which need to be solved with the help of innovation policies. Therefore, innovation vouchers and government procurement have a more obvious role in promoting green innovation in non-state-owned enterprises.

Table 6. Title Heterogeneity

	SOE=1 Patent		SOE=0 Patent	
ivh	-0.191	-0.280	0.119**	0.053
	(0.173)	(0.196)	(0.057)	(0.065)
igp	0.099	0.083	0.129***	0.115***
	(0.085)	(0.086)	(0.031)	(0.031)
ivh*igp		0.405		0.318**
		(0.420)		(0.141)
_cons	-11.184***	-11.138***	-8.982***	-8.977***
	(1.042)	(1.044)	(0.321)	(0.321)
Industry	YES	YES	YES	YES
Year	YES	YES	YES	YES
N	1096	1096	7286	7286
R^2	0.418	0.418	0.323	0.323

6. Conclusion and Implications

Taking SME and GEM Shanghai and Shenzhen A-share listed companies in 2018-2022 as research objects, this paper examines the impact of innovation vouchers and government procurement on green innovation of SMEs, and further analyzes the mediating roles of R&D investment and CSR in it, and draws the following conclusions: firstly, the two demand-side innovation policies, namely, innovation vouchers and government procurement, have a positive impact on SMEs' green innovation, but the facilitating effect of government procurement is more obvious. Second, the policy combination of innovation voucher and government procurement has a synergistic effect on SMEs' green innovation. Third, the two policy combinations can promote SMEs' green innovation through two paths: increasing R&D investment and enhancing corporate social responsibility. Fourth, with regard to the nature of equity, innovation vouchers and government procurement have a more obvious role in promoting green innovation in non-state-owned enterprises than in state-owned enterprises, which are richer in their own resources.

Based on the above conclusions, the following policy insights are drawn: first, the support and publicity of demand-side innovation policies such as innovation vouchers and government procurement should be increased, the scope and strength of the support should be appropriately expanded, and these policies should be reasonably utilized to promote innovation in enterprises of different sizes. Second, more attention should be paid to the superposition effect between different innovation policies. Not all policy superposition can produce synergistic effects; there are also crowding-out effects, substitution effects, etc., and inappropriate policy combinations may lead to the attenuation of effectiveness. Should be reasonable to the supply side, the demand side of the policy combination, as far as possible to stimulate the effectiveness of policy implementation. Thirdly, different innovation policies should be implemented for enterprises of different natures, so as to maximize the utility of resource allocation for innovation support, such as paying more attention to the implementation of policies for non-state-owned enterprises compared with resource-rich state-owned enterprises, and giving more preferential treatment and support. Fourth, the government should increase support for green innovation research and development, and improve the enterprise green innovation mechanism. At the same time, managers also need to pay close attention to the relevant

policies in order to effectively promote the innovation and development of green technology. This will not only significantly enhance the market competitiveness of enterprises and enable them to find new development opportunities in green transformation, but also make positive contributions to sustainable socio-economic development and environmental protection.

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