



Assessing the impact of mechanism of green public consumption policy on environmental equity: evidence from China

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Abstract

This study investigates the impact of the mechanism of green public consumption policy on environmental equity and provides a feasible reference for the rational formulation of corresponding policies for China. Establish a mediation effect model using the stepwise regression and bootstrap analysis method, this study explores the direct and indirect effects of fiscal expenditure intensity on environmental equity. The results revealed that increasing fiscal expenditure on energy conservation and environmental protection cannot directly and significantly affect environmental equity, but it has a significant indirect positive impact on environmental equality through fiscal decentralization. It is also found that the impact of green public consumption policy on environmental equity varies in the eastern, central and western parts of China. Our findings indicated that the expenditure of energy conservation and environmental protection indirectly affects environmental equity through fiscal decentralization. The willingness of the government to protect the environment regulates the impact of green public consumption policies on environmental equity. The phenomenon of feeding the east from the west of resources and environment is obvious. According to the characteristics of regional development, we should formulate energy conservation and environmental protection policies and adjust the direction of policies to promote regional environmental equity.

Keywords Green public consumption policy · Fiscal decentralization · Environmental equity · Mediation effect · China

1 Introduction

Since the 1960s, in the process of global industrialization and information development, the problems of uneven economic development (Ray, 2020), unfair income distribution, excessive loss of resources and environment (Wu & Chang, 2019), and inequity environment have become common, which has greatly impacted human survival and development.

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In the 1990s, the United States put forward the concept of environmental equity (Washington, 1994; Anderton et al., 1994) and carried out a series of studies. In 2001, the United States Environmental Protection Agency laid out an environmental equity policy: "In the formulation, observance and implementation of environmental laws, regulations and policies, all people, regardless of race, nationality, income, original nationality and education level, should be treated fairly and participate effectively" (Xu, 2016). Many scholars have paid close attention to the problems of resource savings and green public consumption (Lzroiou et al., 2020), optimizing the public consumption environment and promoting environmental equity to realize sustainable development.

Public consumption is noncompetitive and nonexclusive and has a spillover due to its public nature, which may lead to market failure, tragedy of commons or environmental inequity. The inequity of environmental burden is reflected in regional, intergenerational or urban–rural transmission. Specifically, the developed areas develop their own economy at the cost of consuming the resources of underdeveloped areas and destroying their environment. Current consumption overuses public resources, while the ministry considers the needs of future generations; resources and public facilities are primarily provisioned to the city, ignoring rural development. The consumption of regional public goods and the environmental burden caused by consumption present the "Matthew effect"¹ of polarization (Merton, 1968).

Therefore, the local government increased its financial expenditure on energy conservation and environmental protection or taxing the consumption of resource-based products to rectify the market failure of public consumption, reduce the occurrence of tragedy of the commons, and ensure equitable consumption. At the same time, green public consumption is advocated to solve the problem of public goods and semipublic goods shortages, reduce the negative externalities caused by the use of public goods, improve the efficiency of public goods in resource allocation, and further protect public resources and environmental security. However, is the implementation of national and regional green public consumption policy conducive to alleviating environmental inequity? It is of great significance to discuss the above problems to solve the shortage of public resources and alleviate the environmental injustice among regions, generations and urban and rural areas.

Domestic and foreign scholars are also exploring the impact of green public consumption policies on environmental governance, focusing on the impact of environmental policies on environmental governance effects. Many studies have examined the impact of fiscal expenditure, especially environmental expenditure, on ecological and environmental protection from various perspectives. For example, Dong and Zhang (2011) and Zhang (2015) et al. studied the effect of the classification expenditure of waste pollutants on the emission reduction of various pollutants, with different conclusions. The effect of environmental protection expenditure varies by provinces, and some pollution has strong spatial spillover (Li, 2016; Huang, 2017; Liu & Liu, 2017). However, the marginal contribution of environmental protection investment to the quality of environmental protection is not continuously improved, and environmental protection fiscal expenditure has a threshold effect on pollution control (Zhu & Lu, 2017). When environmental protection investment is above a critical value for a long time, it can bring continuous improvement to the environment (Sun, 2004).

¹ [Ⓞ]It comes from a fable in the gospel of Matthew in the Bible: "If somebody has something, you should give it to him to make him redundant; If somebody doesn't have it, you should take what he has." The social phenomenon reflected is polarization, with more and less.

On the other hand, some scholars believe that investment in pollution control has no significant effect on the pollution reduction and ecological environment protection of industrial enterprises, and the effect of environmental financial subsidies and environmental protection loans on pollution control is limited (Li & Shen, 2008; Lin & Sun, 2016; Lu & Tian, 2014). Obviously, green public consumption policy not only includes environmental protection investment but also pays attention to the impact of other green public consumption policies, including fiscal decentralization, on environmental quality, and they believe that the effect on environment protection varies with the degree of fiscal decentralization (Xue & Pan, 2012; Yan & Zhong, 2012; Yu, 2013). Scholars have carried out in-depth and systematic research on environmental protection policies, but there are few related studies on the impact of environmental policies on environmental equity.

This paper focuses on the mechanism and effect of green public consumption policy on environmental equity to establish a policy system including incentives and constraints and explore its impact on environmental equity. For the impact of green public consumption policy on environmental equity, there are several aspects that need to be further studied. First, environmental equity is comprehensively measured, which provides a basis for analyzing the impact of environmental policies on environmental equity. Second, we should use the appropriate model to explore the mechanism of the effect of green public consumption policy on environmental equity. The impact of environmental policies on environmental equity may be direct or indirect.

Therefore, on the basis of research by scholars, this paper takes 31 provinces of China as the research objects, adopts a moderated intermediary effect model to study the mechanism of the effect of green public consumption policies on environmental equity, and discusses the direct and indirect effects of energy conservation and environmental protection fiscal expenditure on environmental equity. The following contents are arranged as follows: The second part analyzes the mechanism of green public consumption policy impact on environmental equity, to explore the theoretical relationship between green public consumption policy and environmental equity. In the third part, we build a moderating mediating effect model and conduct a comparative analysis on the impact of green public consumption policy on environmental equity in various regions. In this part, we also select variables, measure or give the value of variables, and introduce the source of the data. The fourth part is the result analysis, which analyzes China as a whole and the eastern, central and western regions individually and explores the regional differences in green public consumption policy impacts on environmental equity. In the fifth part, we present the conclusion and policy implications. The last part of this paper is discussion of limitations and the scope of future research.

2 Theoretical framework and mechanism analysis of the impact of green public consumption policy on environmental equity

2.1 Theoretical framework

Marshall put forward externality theory (Marshall, 1890) in his book *Principles of Economics*. He claimed that an economic subject (producer or consumer) had a favorable or unfavorable effect on the welfare of bystanders in his or her own activities. This favorable effect brought benefits, and the unfavorable effect brought losses (or costs); the favorable influence is a positive externality, and the unfavorable influence is a negative externality.

For the environment, market failure is mainly caused by externalities due to the nature of public goods. Internalizing the positive and negative externalities of the environmental economy is the key to eliminating market failure in the environment. On the one hand, positive externalities are internalized through incentive means, such as preferential treatment and reward, to further improve the utilization rate of resources and the advanced technology of pollution control. On the other hand, negative externalities should be internalized by constraint means, which means that all those who use natural resources and environmental capacity should pay for their own consequences. Polluters must bear the cost of pollution reduction measures when they can change the environment in a way accepted by the relevant authority to achieve environmental intragenerational, intergenerational and regional equity. Therefore, this paper establishes a theoretical framework for the analysis of the impact of green public consumption policy on environmental equity, which is "environmental regulation → environmental incentive (internalization of positive externality)/ environmental constraint (internalization of negative externality) → environmental equity."

2.2 Mechanism analysis of the impact of green public consumption policy on environmental equity

Green public consumption aims to meet people's needs for green consumption and public consumption. Through fiscal expenditure, the government provides green public goods and services to society, improves the overall consumption level and use efficiency of resource products, increases the quality of economic development and social justice, and realizes the consumption behavior of population consumption, economic society and sustainable development of resources and the environment lifestyle (Xu, 2015; 2018). The green public consumption policy is primarily the government's fiscal revenue and expenditure policies in energy development and consumption, environmental governance and protection. This paper constructs a policy system for fiscal expenditure, fiscal decentralization and government environmental protection consciousness as a green public consumption policy system. This system includes both incentive and restrictive policies. As an incentive policy, energy conservation and environmental protection fiscal expenditure is used in various fields of green public consumption and plays an incentive role for enterprises and other environmental regulatory objects. Fiscal decentralization is aimed at local governments and is the incentive of the central government to the main body of environmental supervision. On the other hand, the government's willingness to protect the environment, represented by the proportion of local environmental taxes in the GDP, is a restrictive policy that limits the environmental pollution behavior of enterprises by means of punishment. The theoretical mechanism of the impact of green public consumption policy on environmental equity is as follows:

2.2.1 Green public consumption fiscal expenditure policy corrects the market failure of public product consumption

Because the consumption of public goods has the special attributes of publicity and quasi-publicity, the supply of public goods determined by the market mechanism is far less than

the Pareto optimal state²(Warr, 1982). In the process of consumption, the existence of crowding, free-riding behavior, externality and other characteristics may lead to the tragedy of the commons. When the market mechanism fails to provide public goods and consume public goods, it is necessary for the government to intervene. As the main supplier of public goods, the government's extensive supply of public goods is conducive to promoting the environmental equity, consumption equity and social equity of the entire society. Perhaps the government increases investment in energy conservation and environmental protection and consumption expenditure and widely supplies public products in pollution prevention and control, energy conservation and utilization, energy conservation and emission reduction, conversion of cropland to forest, natural ecological protection, natural forest protection, renewable energy mining and development, comprehensive utilization of resources, sandstorm and desert control, environmental monitoring and supervision, conversion of animal husbandry areas to grasslands, energy affairs management, etc. It is possible that the financial expenditure of energy conservation and environmental protection is used for energy and environmental affairs management, which directly affects energy protection and environmental governance to reduce the burden of regional and environmental resources. In addition, the financial expenditure of energy conservation and environmental protection also plays a role in policy guidance, guiding the direction, scale and structure of enterprise investment through tax, subsidy, and depreciation policies, etc., and indirectly acts on environmental pollution control (Tian et al., 2016).

Based on the above analysis, we can draw corollary 1: The government's expenditure on energy conservation and environmental protection helps alleviate environmental equity.

2.2.2 The difference in fiscal decentralization of green public consumption leads to various levels of environmental equity

After China's reform and opening up, an institutional system of political centralization and economic decentralization has been gradually formed in the governance mechanism of central and local governments. Political rights are centralized from local governments to the central government, and economic rights are decentralized from the central government to local governments. Effective political and economic incentives are formed to cultivate the competition mechanism between local governments to promote the development of the local economy by growth competition government. Therefore, fiscal and tax decentralization is adopted to give full play to the initiative of local governance. The higher the degree of fiscal and tax decentralization, the greater the financial power of local governments, the more sufficient the fund reserves for environmental governance, and the richer the scope and means of governance, which will inevitably promote the improvement of environmental quality. Hence, due to the existence of political centralization and promotion championship mechanisms, local governments choose GDP growth more than environmental protection in the trade-off between economic growth and environmental governance. Because GDP growth is the measurable goal of the economic incentive model, it is easier to show the performance of local governments, so they are more likely to pursue and pay attention to the short-term visible economic benefits in financial expenditure, shift the focus of expenditure to the areas that significantly stimulate economic growth, reduce the

² It is an ideal state of resource allocation. If no one in the economy can make his or her own situation better without making others worse, then this state achieves the optimization of resource allocation.

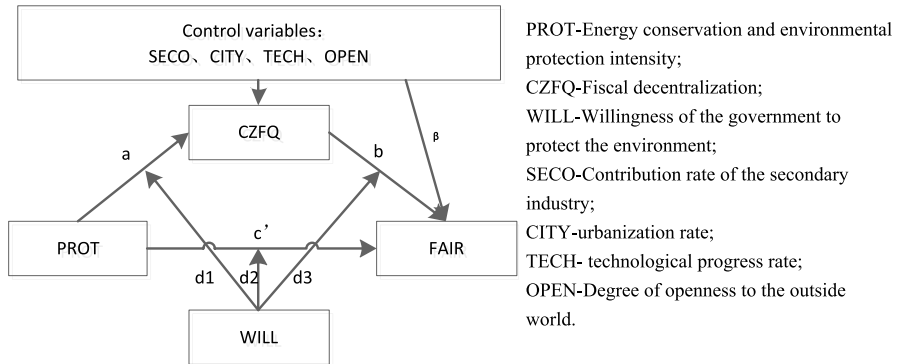


Fig. 1 Mechanism framework of the effect of green public consumption policy on environmental equity

scale of environmental protection expenditure, and ignore social and ecological benefits, thus affecting the quality and environment of the ecological environment. As a result, the degree of decentralization of local finance may affect the efficiency of local government financial expenditure, which results in environmental equity.

Based on the above analysis, we can draw corollary 2: increasing the fiscal decentralization of local governments may help the government govern the environment and promote environmental equity.

2.2.3 The role of the government's environmental protection consciousness in adjusting the influence of green public consumption policies on environmental equity

The implementation effect of the policy is closely related to the will of the government. Economic development usually comes at the cost of environmental pollution. Under the contradiction between economic development and environmental protection and under the incentive mechanism of the GDP performance view, local governments with economic growth intentions may relax environmental regulations and devote themselves to the development of the local economy, reduce the collection of resources and environmental taxes for economic development, and even allow enterprises to discharge pollutants, resulting in a serious regional environmental burden, environmental pollution and a decline in environmental quality. Consequently, a conscious or farsighted environmental protection willingness of the government may result in the positive externalities of environmental governance being considered. When implementing environmental economic policies, stricter environmental regulations will be implemented (Qi & Hu, 2013), heavier resources and environmental taxes will be imposed on industries or enterprises that heavily pollute, and the production costs of industries and enterprises will be improved. The environmental compliance of enterprises is conducive to promoting the progress of green technology (Fu & Geng, 2019), improving the sustainable performance of enterprises (Rajesh, 2020), reducing the regional environmental pollution burden, and promoting environmental equity. Therefore, the willingness of local governments to protect the environment may alter the financial expenditure of energy conservation and environmental protection to affect the result of environmental equity.

Based on the above analysis, we can draw corollary 3: Increases in the government's willingness to protect the environment help enhance the environmental equity effect of green public consumption policy.

The mechanism framework of green public consumption policy's impact on environmental equity is shown in Fig. 1. The intensity of energy conservation and environmental protection has a direct impact on environmental equity. Increasing and reducing energy conservation and environmental protection investment and adjusting investment direction may directly affect regional environmental burden and promote or inhibit environmental equity, which is expressed as path c' . Energy conservation and environmental protection investment indirectly affect environmental equity through fiscal decentralization; endow local governments with more resource power, environmental finance and taxation; and ensures that the local government has more sufficient investment funds for energy conservation and environmental protection, which urges local governments to use them for resource conservation and environmental governance, thus affecting environmental equity, expressed as path a - b . The government's willingness to protect the environment may enhance or weaken the effect of energy conservation and environmental protection investment on environmental equity, expressed as path $d1$ - $d3$. The impact of other factors on environmental equity is expressed as path β .

3 Model construction and analysis methods

3.1 Model construction

To explore the impact of green public consumption policy on environmental equity, this paper attempts to explore the direct and indirect effects of fiscal expenditure intensity on environmental equity. We build an intermediary effect model, test the indirect effect of energy conservation and environmental protection expenditure on environmental equity with fiscal decentralization as the intermediary variable, taking the government's willingness to protect the environment as a moderating variable. This paper discusses whether the government's willingness to protect the environment has an impact on the above procedures. To test the intermediary effect, this paper uses the causal stepwise regression test of Wen (2004) and bootstrap intermediary test of Chen (2013) for reference.

The model is constructed as follows:

$$\text{FAIR} = c * \text{PROT} + e_1 \quad (1)$$

$$\text{CZFQ} = a * \text{PROT} + e_2 \quad (2)$$

$$\text{FAIR} = c' * \text{PROT} + b * \text{CZFQ} + e_3 \quad (3)$$

PROT is an independent variable representing the intensity of energy conservation and environmental protection; CZFQ is an intermediary variable representing fiscal decentralization; FAIR is a dependent variable representing environmental equity; and e is a disturbance term. a , b , c and c' are coefficients that need to be estimated.

3.2 Analysis methods and procedures

This paper uses Wen's et al. (2004) stepped regression and Chen's et al. (2013) bootstrap method to test the mechanism of the influence of energy conservation and environmental protection intensity on environmental equity. The general test process of stepwise regression is (I) to test whether coefficient c is significant; if c is significant, coefficient a and coefficient b are tested in turn. (II) If both a and b are significant, coefficient c' is tested; if c' is significant, then the mediating effect is significant. If c' is nonsignificant, then the complete mediating effect is significant. (III) If a or b is not significant, the Sobel test is required. If the test is nonsignificant, the mediating effect is nonsignificant. However, Zhao et al. (2010), Chen et al. (2013), and Hayes (2009) and others have different views. They believe that even if there is no direct impact between X and Y , there can be an intermediary effect between X and Y , and this phenomenon is very common. Explicitly, to test the intermediary effect between X and Y , it is not necessary to test whether the main effect C is significant in advance. This paper agrees with this view, and according to this idea, we can conduct a comprehensive study of the relationship between X and Y . This paper analyzed the impact of green public consumption policy on environmental equity. Using the bootstrap method proposed by Chen et al. (2013) as a reference to test the intermediary effect, they proposed that the intermediary effect test process is the core of the intermediary model test based on $a \times b$.

3.3 Variable selection and data source

3.3.1 Dependent variable: environmental equity

With reference to the research results of Yan and Zhong (2012) and Wang and Qiao (2017), an environmental equity index based on GDP, ecology and population is constructed to measure environmental equity. The indexes are expressed as follows:

$$E_{\text{GDP}} = \frac{p_i/p}{\text{GDP}_i/\text{GDP}}, E_{\text{POP}} = \frac{p_i/p}{\text{POP}_i/\text{POP}}, E_S = \frac{p_i/p}{S_i/S}$$

In the formula, E_{GDP} represents the environmental equity index based on GDP, p_i represents the regional pollution discharge (wastewater discharge, exhaust gas discharge, urban domestic waste removal and transportation), p is the national pollution discharge, GDP_i represents the regional GDP, GDP is the national GDP, E_{POP} represents the environmental equity index based on population, PoP_i is the regional population, PoP is the national population, E_S represents the ecological environmental equity index, S_i is the area of regional land, and S is the area of national land. The above three indexes measure regional environmental equity. The larger the index is, the worse the environmental equity. In this study, the arithmetic mean of the three indexes is selected as a comprehensive index to measure environmental equity.

3.3.2 Independent variable

The explanatory variable of this paper is green public consumption policy. According to the above research framework, the policy system established in this paper includes

not only environmental incentive policies (energy conservation and environmental protection intensity and fiscal decentralization) but also environmental restrictive policies, that is, the government's willingness to protect the environment expressed by the proportion of local environmental tax in the GDP.

(1) Energy conservation and environmental protection intensity (PROT).

The energy conservation and environmental protection intensity is characterized by the proportion of energy conservation and environmental protection fiscal expenditure in the GDP. The expenditure of energy conservation and environmental protection involves many subprojects, such as energy development, energy conservation, and environmental protection and management, and many fields of energy conservation, environmental protection and green public consumption. The larger the proportion of expenditure on energy conservation and environmental protection in the GDP, the stronger the intensity of energy conservation and environmental protection will be.

(2) Fiscal decentralization (CZFQ).

Based on the practice of He & Wang et al. (2018), the ratio of the general public energy conservation and environmental protection budget expenditure of the province in a given year to the general public energy conservation and environmental protection budget expenditure of the central government in that year was used as the index of fiscal decentralization. It is generally believed that the larger the ratio, the more rights local governments have for energy conservation and environmental protection to heavier fiscal decentralization.

(3) Willingness of the government to protect the environment (WILL).

This paper uses Qi and Hu (2013) and Li (2015) for reference to understand and define the government's willingness to protect the environment and measures the local government's willingness to protect the environment by using the proportion of local environmental-related tax revenue³ in the local GDP. The higher the proportion of environmental-related taxes in the local GDP, the more local governments prefer environmental protection, the stronger the environmental regulation, and the more capable they are to control the emission of environmental pollutants.

3.3.3 Control variables

According to research needs, this paper selects relevant indicators that may have an impact on environmental equity, including the contribution rate of the secondary industry (SECO), urbanization rate (CITY), technological progress rate (TECH) and degree of openness to the outside world (OPEN) as control variables.

³ ³ Because China does not levy independent environmental tax despite a large number of tax types and relevant policies and regulations in the tax system related to resource conservation, environmental protection, pollution prevention and control policy orientation, this paper calculates environment-related taxes including value-added tax, consumption tax, enterprise income tax, resource tax, urban land use tax, vehicle and ship tax, land occupation tax, etc.

At present, pollution mainly comes from wastewater, waste gas and solid waste, which mainly come from the industrial field. Therefore, the contribution rate of the growth of secondary industry is selected as the control variable to control the impact of industrial development on environmental pollution. With the acceleration of the urbanization process, farmers have been converted to citizens, and agricultural land has been converted to construction land. The pollutant absorption capacity of urban land is much lower than that of rural areas. The rural economy supports urban development, which increases the environmental burden of rural and urban areas. Therefore, we choose the urbanization rate to control the transfer of environmental burden caused by population and land and economic transfer to the city. Advanced technology is an important prerequisite and key means for solving the problems of new energy development and environmental pollution, and the amount of investment in technology research and development also reflects the attention paid to the research and development level of the previous generation of various countries in technology research and development to a certain extent. Furthermore, we choose the proportion of financial science and technology expenditure in GDP as the representation of technological progress to control the impact of technological progress on the environmental burden; in the current open international market, the international trade of products and services causes a certain burden on the regional environment. For a long time, China has mainly exported products that stay in the stage of "made in China," resulting in exporting energy products with low added value and importing technology products with high added value. At this stage, the higher the openness of international trade is, the more serious the burden of energy and environmental pollution in China. With the transformation of the Chinese economic structure and people's life concepts and the transformation from being made in China to being created in China, the relationship between the openness of international trade and China's burden of energy and environmental pollution has been eased. Therefore, the openness of foreign trade also has a certain impact on the Chinese environmental equity index. The proportion of export trade in total imports and exports is selected to represent the openness of foreign trade to control the impact of trade openness on energy and environmental burden.

3.3.4 Data sources

The data used in this paper come from the regional annual data of provinces of the website of the National Bureau of Statistics of China.⁴ Based on the availability of data, this paper uses 2011–2017 Chinese provincial panel data of 31 provinces for analysis. According to the level of economic development, the 31 provinces are divided into eastern, central and western regions. The eastern region includes 11 provinces (cities): Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. The central region includes 8 provinces (regions): Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan. The western region includes 12 provinces (regions): Sichuan, Chongqing, Guizhou, Yunnan, Inner Mongolia, Guangxi, Tibet, Shanxi, Gansu, Qinghai, Ningxia, and Xinjiang.

⁴ <https://data.stats.gov.cn/easyquery.htm?cn=E0103>.

Table 1 Comprehensive index of environmental equity

	2011	2012	2013	2014	2015	2016	2017
Beijing	1.710	1.689	1.645	1.511	1.537	1.755	1.967
Tianjin	3.572	3.620	3.552	3.496	3.303	2.879	3.085
Hebei	2.209	2.202	2.223	2.272	2.257	2.552	2.341
Shanxi	2.879	2.850	2.823	3.046	3.136	2.715	2.328
Neimenggu	1.839	1.929	1.956	1.918	1.934	1.654	1.798
Liaoning	1.885	1.903	1.838	2.016	2.070	2.080	2.186
Jilin	1.176	1.047	1.086	1.157	1.209	0.972	1.067
Heilongjiang	1.046	1.108	1.132	1.121	1.106	1.249	1.266
Shanghai	7.881	7.756	7.613	7.170	7.207	6.769	6.862
Jiangsu	2.285	2.228	2.185	2.175	2.145	2.474	2.533
Zhejiang	1.534	1.477	1.493	1.418	1.428	1.335	1.509
Anhui	1.374	1.391	1.343	1.396	1.383	1.297	1.376
Fujian	1.037	1.006	1.002	1.014	1.034	1.026	1.049
Jiangxi	1.189	1.166	1.178	1.162	1.246	1.271	1.230
Shandong	2.142	2.121	2.084	2.186	2.225	2.572	2.358
Henan	1.882	1.855	1.885	1.831	1.870	1.473	1.316
Hubei	1.009	0.995	0.993	1.001	1.004	0.952	0.954
Hunan	0.935	0.901	0.916	0.914	0.930	0.939	0.895
Guangdong	1.291	1.303	1.296	1.251	1.242	1.443	1.555
Guangxi	0.878	0.914	0.896	0.880	0.851	0.841	0.974
Hainan	0.582	0.632	0.628	0.608	0.631	0.706	0.792
Chongqing	1.406	1.391	1.392	1.336	1.348	1.294	1.384
Sichuan	0.695	0.664	0.658	0.661	0.671	0.741	0.778
Guizhou	1.903	1.836	1.766	1.623	1.501	1.667	1.937
Yunnan	1.009	1.008	0.989	0.909	0.902	1.177	1.027
Xizang	0.396	0.396	0.393	0.435	0.513	0.726	0.464
Shanxi	1.463	1.427	1.444	1.447	1.452	1.113	1.144
Gansu	1.277	1.223	1.218	1.267	1.342	1.132	1.242
Qinghai	1.256	1.325	1.414	1.537	1.635	1.664	1.676
Ningxia	3.653	3.659	3.719	3.448	3.495	3.348	3.408
Xinjiang	1.576	1.798	1.933	1.872	1.741	1.857	1.817

4 Results and discussions

4.1 Calculation results of environmental equity indicators

The comprehensive index of environmental equity is obtained from the arithmetic average of the environmental equity index based on GDP, population and ecology. The calculation results are shown in Table 1. Shanghai, Tianjin and Ningxia are the regions with higher environmental equity indexes. The average annual environmental equity index is above 3. The greater the environmental equity index is, the more serious the environmental burden. Tibet, Sichuan, Hainan, Guangxi and Hunan are the regions with an environmental equity index below 1, which means that the environmental burden is relatively small and tends to be more fair.

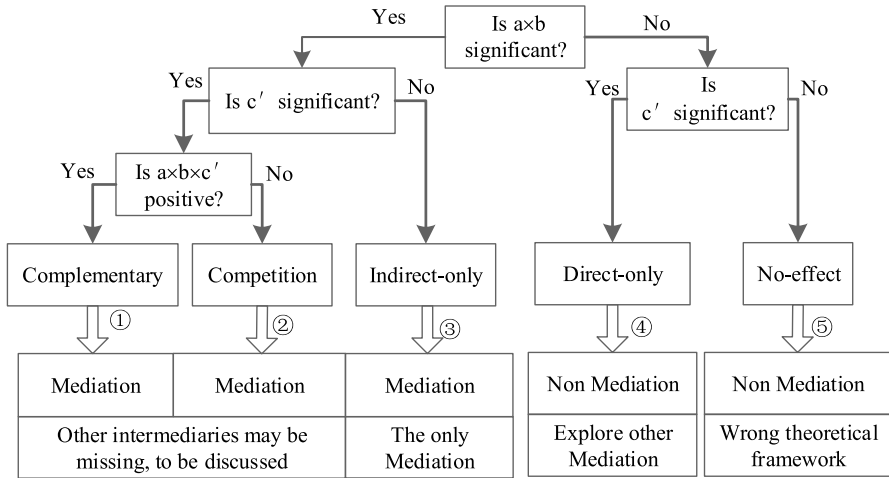


Fig. 2 Mediation effect test and analysis procedure

Table 2 Stepwise regression results of the effect of green public consumption policy on environmental equity

Dependent variable	(1) FAIR	(2) CZFQ	(3) FAIR
PROT	- 0.001 (0.062)	- 0.178** (0.078)	- 0.043 (0.068)
CZFQ	- 0.234*** (0.054)	-	- 0.233*** (0.054)
WILL	0.094* (0.054)	-	0.108*** (0.055)
WILL*PROT	-	-	- 0.056
SECO	0.237*** (0.065)	0.154* (0.081)	0.232*** (0.065)
CITY	0.520*** (0.084)	0.181* (0.106)	0.541*** (0.085)
TECH	0.354*** (0.078)	0.045 (0.099)	0.342*** (0.078)
OPEN	0.099 (0.063)	- 0.109 (0.078)	0.113* (0.064)
Constant	0 (0.05)	0 (0.064)	- 0.013 (0.051)
R ²	0.475	0.140	0.481

The values in brackets are the standard error, and *, **, and ***represent significance at the 10%, 5%, and 1% levels, respectively

Table 3 The impact of energy conservation, environmental protection intensity and fiscal decentralization on environmental equity

	Coeff	BootSE	BootLLCI	BootULCI
Total effect	0.039	0.064	- 0.087	0.165
Direct effect	- 0.001	0.062	- 0.123	0.121
Mediation effect	0.04	0.018	0.011	0.082

4.2 Analysis of the results of the impact of green consumption policy on environmental equity

4.2.1 Stepwise regression results

The results of stepwise regression and the intermediary effect are shown in Tables 2 and 3. The results show that $a \times b$ is significant but that c' is not. It can be seen that fiscal decentralization is the only intermediary for the intensity of the effect of energy conservation and environmental protection on environmental equity, and the intermediary effect is established, as shown in path ③ in Fig. 2. It can be seen that in China as a whole, the intensity of energy conservation and environmental protection cannot directly and significantly affect environmental equity. However, the intensity of energy conservation and environmental protection significantly affects the environmental equity index through fiscal decentralization. The overall effect is 0.039, the direct effect is -0.001 , and the intermediary effect is 0.040, which is significant. In view of the definition of the environmental equity index, this result indicates that for the regions with more fiscal decentralization, the greater the intensity of environmental protection expenditure is, the stronger the degree of regional environmental inequality. The possible reasons are as follows: first, financial decentralization aggravates the Matthew effect of regional and rural environmental burdens. With industrial gradient transfer, many high-pollution enterprises have transferred from the original economically developed areas to the less developed areas at the expense of the environments of the less developed areas. In addition, urban land is limited, and urban solid waste and other pollutants are generally transported to rural areas for landfill storage or treatment, which aggravates environmental pollution in rural areas. Due to the relative concentration of the urban population and policies, energy conservation and environmental protection spending are mostly used for urban pollution prevention and control spending, while less developed areas and vast rural areas are often ignored. From the results of the control variables, in the China as a whole, the government's willingness to protect the environment, the contribution rate of secondary industry, the urbanization rate, the rate of technological progress, and the openness of foreign trade all aggravate the regional environmental burden to varying degrees, resulting in environmental injustice.

This paper tests the moderating effect of the government's willingness to protect the environment on the intensity of energy conservation and environmental equity, but no significant results are obtained. However, the government's willingness to protect the environment affects environmental equity at a significance level of 10%. Considering that the effects of the willingness of local governments to protect the environment may affect or offset each other, it is necessary to further analyze the regional differences in the impact of energy conservation and environmental protection intensity on environmental equity to explore the differences in green energy consumption policies affecting environmental equity between developed regions.

4.2.2 Analysis of the Differences among Eastern, Central and Western China

- (1) Direct and mediating effects of energy conservation and environmental protection intensity on environmental equity.

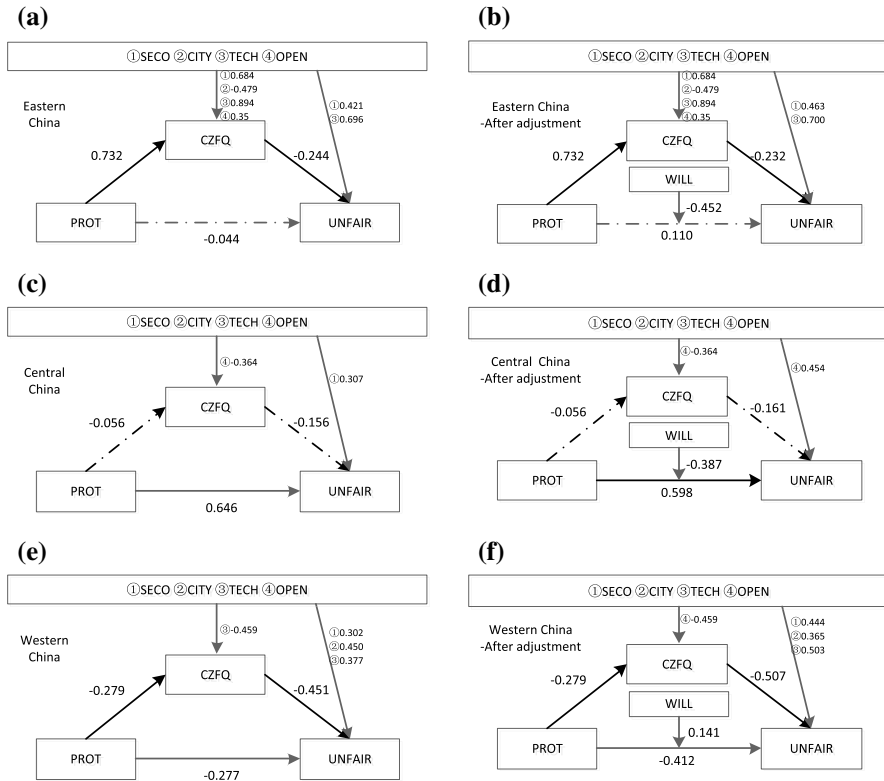


Fig. 3 **a** Eastern China. **b** Eastern China (after adjustment). **c** Central China. **d** Central China (after adjustment). **e** Western China. **f** Western China (after adjustment). Notes: the dotted line indicates a lack of significant effect, the solid line indicates a significant effect, the number is the influence coefficient, the symbol indicates the direction of influence, and UNFAIR indicates environmental inequity

The results of the subregional study are shown in Tables 4 and 5 and Fig. 3a–f. From the perspective of the total effect, there are two trends in the impact of energy conservation and environmental protection intensity on environmental equity in eastern and western China. The intensity of energy conservation and environmental protection in eastern and western China has a negative impact on environmental inequality, but the impact is nonsignificant. The intensity of energy conservation and environmental protection in central China has a significant positive impact on environmental inequality. This shows that the effect of energy conservation and environmental protection in eastern and western China is better than that in central China.

From the perspective of the direct effect, the intensity of energy conservation and environmental protection in eastern China has a nonsignificant impact on environmental equity, while the intensity of energy conservation and environmental protection in central China has a significant positive impact on environmental inequality, increasing environmental inequality, with an impact coefficient of 0.636. Increasing the intensity of energy conservation and environmental protection in western China will help alleviate environmental injustice, with an impact coefficient of -0.277 .

Table 4 Results of regional differences in the impact of green public consumption policy on environmental equity

Dependent variable	(1)				(2)				(3)			
	FAIR				CZFQ				FAIR			
	Eastern China	Central China	Western China	Western China	Eastern China	Central China	Western China	Western China	Eastern China	Central China	Central China	Western China
PROT	-0.222* (0.131)	0.646*** (0.218)	-0.151 (0.110)	-0.279** (0.107)	0.732*** (0.134)	-0.056 (0.222)	-0.279** (0.107)	-0.044 (0.153)	0.638*** (0.217)	-0.156 (0.130)	-0.277*** (0.104)	
CZFQ	-	-	-	-	-	-	-	-0.244** (0.113)	-0.156 (0.130)	-0.451*** (0.110)		
SECO	0.255 (0.192)	0.290** (0.1423)	0.277 (0.112)	0.055 (0.110)	0.684*** (0.196)	0.109 (0.145)	0.055 (0.110)	0.421** (0.203)	0.307** (0.143)	0.302*** (0.102)		
CITY	0.270 (0.211)	-0.111 (0.182)	0.444 (0.111)	-0.007 (0.109)	-0.479** (0.215)	-0.071 (0.185)	-0.007 (0.109)	0.153 (0.213)	-0.122 (0.181)	0.441*** (0.100)		
TECH	0.478** (0.235)	-0.104 (0.131)	0.584 (0.130)	-0.459*** (0.127)	0.894*** (0.240)	-0.143 (0.134)	-0.459*** (0.127)	0.696*** (0.251)	-0.126 (0.132)	0.377*** (0.128)		
OPEN	-0.077 (0.155)	0.357* (0.199)	0.089 (0.106)	-0.076 (0.104)	0.35** (0.158)	-0.364* (0.202)	-0.076 (0.104)	0.008 (0.156)	0.300 (0.204)	0.054 (0.096)		
CONSTANT	0.087	0 (0.119)	0 (0.085)	0 (0.084)	0 (0.089)	0 (0.121)	0 (0.084)	0 (0.085)	0 (0.118)	0 (0.077)		
R ²	0.452	0.186	0.475	0.498	0.429	0.159	0.498	0.486	0.207	0.577		

The values in brackets are the standard error, and *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively

Table 5 Overall, direct and indirect effects of energy saving and environmental protection intensity on environmental equity

		Coeff	BootSE	BootLLCI	BootULCI
Total effect	Eastern China	- 0.22	0.13	- 0.48	0.04
	Central China	0.65	0.22	0.21	1.08
	Western China	- 0.15	0.11	- 0.37	0.07
Direct effect	Eastern China	- 0.04	0.15	- 0.35	0.26
	Central China	0.64	0.22	0.20	1.07
	Western China	- 0.28	0.10	- 0.48	- 0.07
Mediation effect	Eastern China	- 0.18	0.07	- 0.33	- 0.03
	Central China	0.01	0.05	- 0.05	0.15
	Western China	0.13	0.07	0.03	0.31

From the perspective of the mediation effect, the intensity of energy conservation and environmental protection in eastern China has a nonsignificant direct impact on environmental equity, but it indirectly affects environmental equity through fiscal decentralization, which is the only intermediary effect of energy conservation and environmental protection on environmental equity. Fiscal decentralization in eastern China has an indirect impact on the intensity of energy conservation and environmental protection, and the higher the fiscal decentralization in the eastern region is, the greater the expenditure on energy conservation and environmental protection will help alleviate environmental injustice and promote environmental equity in eastern China. As shown in Fig. 3a and Table 5, the intensity of energy conservation and environmental protection in the central region has a significant direct impact on environmental equity, and increasing the intensity of energy conservation and environmental protection aggravates the phenomenon of environmental inequality, with an impact coefficient of 0.646. Fiscal decentralization does not play an intermediary role, as shown in Fig. 3c. In western China, the intensity of energy conservation and environmental protection has a direct and indirect impact on environmental equity, in which fiscal decentralization plays a role, as shown in Fig. 3e. The intermediary effect accounts for 83.3% of the total effect.⁵ Increasing the financial decentralization of western China can enhance the intensity of energy conservation and environmental protection and promote the direct effect on environmental equity. Thus, incentive policies can help internalize the positive externality of environmental consumption behavior, enhance the positive spillover of environmental consumption behavior, and promote environmental equity.

Observing the effect of control variables on environmental equity, the results show that the contribution rate of secondary industry in eastern, central and western China has a significant and positive impact on environmental inequality, which means that the more the industry develops, the more serious the regional environmental pollution burden and the greater the environmental inequality coefficient. This conclusion is particularly obvious in eastern and western China, with a significant impact, but the significance in eastern China is lower. The possible reason is that in the process of industrial transfer from eastern to western China, the environmental burden of the western region increases.

⁵ ①The calculation process of some intermediaries in the western region is as follows: $0.126/0.151 = 0.833$.

Table 6 Bootstrap test results of the effect of energy savings and environmental protection intensity on environmental equity

Dependent variable	Coeff	BootMean	BootSE	BootLLCI	BootULCI
CZFQ					
Constant	0.000	0.004	0.064	- 0.120	0.133
PROT	- 0.172	- 0.179	0.061	- 0.301	- 0.061
WILL	0.056	0.052	0.059	- 0.063	0.168
SECO	0.147	0.150	0.076	- 0.006	0.294
CITY	0.174	0.178	0.098	- 0.013	0.377
TECH	0.051	0.045	0.098	- 0.146	0.246
OPEN	- 0.095	- 0.093	0.060	- 0.209	0.027
FAIR					
Constant	0.000	0.003	0.050	- 0.093	0.102
PROT	- 0.001	0.005	0.050	- 0.089	0.112
WILL	- 0.234	- 0.225	0.063	- 0.351	- 0.104
SECO	0.094	0.096	0.036	0.029	0.171
CITY	0.237	0.234	0.054	0.131	0.344
TECH	0.520	0.515	0.079	0.366	0.674
OPEN	0.354	0.357	0.111	0.147	0.583
Constant	0.099	0.095	0.053	- 0.006	0.200

Urbanization: According to the empirical analysis results, the process of urbanization in western China has intensified environmental inequality, and the degree of urbanization has a significant positive impact on environmental inequality. In the process of development and economic development in western China, the expansion of cities to rural areas has coopted a large amount of rural land, and a large number of farmers have become citizens. It reduces the absorption capacity of land to the environment and aggravates the environmental pollution of the city.

Technological progress: Technological progress in eastern and western China has not alleviated the phenomenon of environmental inequality but has rather largely increased this inequality. The possible reason is that technological progress is more applicable to economic development than to environmental pollution control. Technological progress aggravates environmental pollution in the process of promoting economic growth.

Openness to foreign trade has a nonsignificant impact on environmental inequality.

- (2) The regulatory effect of government willingness to protect the environment on the impact of energy conservation and environmental protection intensity on environmental equity.

The effect of the government's willingness to regulate the intensity of energy conservation and environmental protection on environmental equity varies in eastern, central and western China. The willingness of governments to conserve energy and protect the environment in eastern and central China plays a negative role in the direct influence

of the intensity of energy conservation and environmental protection on environmental equity. The increase in the government's willingness for energy conservation and environmental protection restrains the promotion effect of energy conservation and environmental protection intensity on environmental injustice in eastern China, as shown in Fig. 2b and d, with adjustment coefficients of -0.452 and -0.387 , respectively; the willingness of governments to protect the environment in western China has a negative effect on the intensity of energy conservation, and environmental protection has a positive effect on promoting environmental equity. In general, the government's willingness to protect the environment is conducive to reducing environmental burden and promoting environmental equity. This conclusion verifies that the use of restrictive policies to internalize the negative externalities of environmental consumption behavior is conducive to eliminating the negative externalities of environmental consumption and promoting the realization of environmental equity.

4.3 Bootstrap test of mediation effect

Using the bootstrap test method, at the 95% confidence level, the number of self-samplings was 5000, and the results are shown in Table 6. The results show that the intensity of energy conservation and environmental protection has a significant impact on fiscal decentralization, and fiscal decentralization has a significant impact on environmental equity. Thus, the mechanism by which energy conservation and environmental protection intensity affect environmental equity is energy conservation and environmental protection intensity \rightarrow fiscal decentralization \rightarrow environmental equity. The conclusion of the intermediary effect is established and further verifies the above discussion of the mediating effect.

5 Research conclusions and policy implications

5.1 Research conclusion

- (1) Throughout the country, fiscal decentralization is the only intermediary variable that affects environmental equity. The intensity of energy conservation and environmental protection has an impact on fiscal decentralization and on environmental equity. Energy conservation and environmental protection investment are often targeted at pollution control in developed areas, while energy development in underdeveloped areas intensifies the Matthew effect of environmental burden.
- (2) The mechanism of the fiscal decentralization effect on energy conservation and environmental protection varies. In eastern China, the intensity of energy conservation and environmental protection indirectly affects environmental equity through fiscal decentralization, while in central China, fiscal decentralization has no intermediary effect on the intensity of energy conservation and environmental protection. In western China, fiscal decentralization has a positive intermediary effect on the intensity of energy conservation, and environmental protection affects environmental equity by 83.3%. Specifically, increasing fiscal decentralization in the western region may not enhance the environmental equity effect of energy conservation and environmental protection expenditures.
- (3) The government's willingness to protect the environment plays a regulatory role in the direct impact of energy conservation and environmental protection intensity on envi-

ronmental equity in eastern, central and western China, restrains the effect of energy conservation and environmental protection intensity on environmental inequality, and promotes the effect of energy conservation and environmental protection intensity on environmental equity. The overall direction of action is the same. Strengthening the government's willingness to protect the environment will contribute to regional environmental equity.

5.2 Practice implications

Enterprises and the public should strengthen their awareness of and actual environmental protection:

Enterprises should invest more funds in the field of environmental protection through the development of new energy and new technology, reduce costs by improving pollution control technology and production technology, and stimulate enterprise innovation and improve production efficiency to offset the regulatory cost, obtain an innovation compensation effect, and establish environmental standards before competitors and international market to increase profits. The "currency voting" and "first mover advantage" of the market will bring an absolute competitive advantage.

The public should enhance its awareness of environmental protection through education and publicity, popularizing scientific knowledge of environmental protection, and guiding the public to enhance their awareness of environmental protection and conservation and consciously practice a green life. We should implement responsible environmental protection, establish a responsibility system for environmental protection officials, and promote the implementation of environmental protection at all levels.

5.3 Policy implications

Green development is a complex and interactive regional system (Li & Du, 2019) that includes natural, economic, social and other subsystems. The environmental burden caused by environmental pollution in individual regions and countries is global. Therefore, we should establish a set of energy or environment measurement indicators and evaluation standards for the pollution caused by producing countries (regions) rather than consuming countries (regions); tax high emission countries, regions and enterprises; and internalize the negative externalities of the environment by means of constraints. To promote the development of new energy or reduce the energy consumption of global industries, tax incentives, technology supply or financing incentives should be provided through incentive means to internalize the positive externality of the environment. The externality of environmental production and consumption can be eliminated by means of internalization, and market failure in the field of the environment can be alleviated. Neighboring countries should establish pollution emission trading systems to clarify the regional responsibility the division of pollution output.

We should establish a multilevel system of environmental governance, implement the regional officer responsibility system for environmental protection, and implement the main body of environmental responsibility. The central government should establish a set of index systems covering economic development and environmental governance to evaluate the performance of local governments, improve the awareness of the environmental protection of local governments, and implement high-quality development strategies.

We should establish special funds for environmental governance and ensure that special funds for resources and environmental taxes are dedicated to resource development and environmental governance. Taking resources and environmental taxes should be avoided as the main means of fiscal revenue or should be used other fields of nonenergy conservation, environmental protection and governance. At the same time, more environmental financial power should be decentralized to local governments to ensure their environmental protection capacities.

6 Discussion of limitations and the scope of future research

Green public consumption policy is the key policy by which the government promotes economic development and environmental equity. Limited by space, this paper does not discuss the effect of green public consumption policy from the perspective of economic development. Regional development requires not only environmental friendliness but also economic development, which means high-quality economic development. Therefore, for the study of the effect of environmental policy, we think that future research should focus on how global environmental policy can be formulated, achieving a win-win situation between environmental protection and economic development, and achieving high-quality economic development.

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