

# Local government environmental governance capacity and green technology innovation

Yinling Wang<sup>a\*</sup>, Yuan Yuan<sup>b</sup>

\*1766635628@qq.com<sup>a</sup>, 1853858474@qq.com<sup>a</sup>

School of Economics and Management, Lanzhou Jiaotong University, Lanzhou, 730070, China

**Abstract.** Green technology innovation is an effective path to achieve the goal of “double carbon”, and the environmental governance is the policy premise to achieve green technology innovation. Two conclusions are drawn: firstly, government environmental governance significantly improves the level of regional green technology innovation, after multiple robustness tests, the result is still reliable. And government environmental governance is conducive to human capital accumulation, then promoting the development of green technology innovation. Secondly, regional heterogeneity’s result shows that in economically developed regions, government environmental governance has a more significant promoting regional green technology innovation.

**Keywords:** Government environmental governance; Regional green technology innovation; Human capital.

## 1 Introduction

Since the founding of New China, great changes have taken place in the spatial layout of regional economy. Before the reform and opening up, under relatively closed conditions, a series of policies supporting the development of the mainland objectively promoted balanced development among regions. Thereafter, the development trend of globalization enabled coastal areas to obtain and give play to the comparative advantages of export-oriented manufacturing industry, which has also led to changes in regional economic layout, so geographical factors are still the key factors determining the degree of regional economic agglomeration. How to narrow the gap between regions and how to realize the coordinated economic development between regions are the hot issues concerned by the society at present. Grossman and Helpman (1994) pointed out that technological innovation, as the endogenous driving force of economic growth, is the fundamental source of economic disparity between different regions<sup>[1]</sup>.

Green technology innovation is a vital way to fulfil green economic development in China, and the regional green technology enhancement has become an important link in the development of green innovation. In China, environmental governance is able to reduce environmental pollution. And it can upgrade the mass of economic development. In this process, the development path of government environment governance as well as regional green technology innovation should be clarified, and then promote environmental preservation from the perspective of green technology innovation, which is of both important theoretical value and practical significance.

## 2 Theoretical analysis and research hypothesis

Porter (1991) argued in National Competitive Advantage that strict environmental protection policies can lead to environmental technology innovation, thus generating net benefits and making enterprises more competitive, which is the famous Porter hypothesis. Strict environmental protection will increase manufacturers' costs at the very start, but as the time goes on, the "learning by doing" effect will spill over the protective effect of environmental policies, and the compensating effect of green technological innovation will offset the upward pressure of costs.

The environmental governance policies usually adopted by the government are mainly command and incentive policies. For example, the current research focus of environmental regulation is a typical command-type environmental governance policy. For one thing, it can encourage polluting enterprises to go on green technological innovation; For another thing, benefits brought by green technology innovation can compensate for the cost of pollution control. Berrone et al. (2013) found in the study that the enhancement of government regulatory pressure can significantly affect the green technology innovation of enterprises with more serious pollution and lower financing constraints<sup>[2]</sup>. Kim et al. (2021) using data from multinational companies in 29 countries, the study found that the stricter environmental regulations, the greater the influence on green patent applications by multinational companies<sup>[3]</sup>. Xu and Cui (2020) took China's Low-carbon pilot policy, which found that environmental regulation promoted enterprises' green innovation<sup>[4]</sup>. So, this paper puts forward a hypothesis:

H1: The enhancement of the government's environmental governance ability can improve the territorial green innovation.

As the core carrier of professional knowledge and technology, talent is becoming increasingly prominent in innovation (Chen et al., 2023)<sup>[5]</sup>. The more attractive areas with favorable environment are to high-quality talents, the more they can retain talents and gradually form innovative human capital. More importantly, there is a certain correlation between the health status of the labor force in a region and environment pollution. What's more, the environmental governance policy can be regarded as an investment in human capital (Greenstone and Hanna, 2014)<sup>[6]</sup>. With the continuous accumulation of human capital, the spillover effect of knowledge and technology are enhanced, the transaction efficiency is improved and the division of labor is deepened, thus promoting innovation. So, this paper puts forward a hypothesis:

H2: The higher the level of human capital, the more obvious the role of government environmental governance in promoting regional green technological innovation.

## 3 Research design

### 3.1 Data sources and processing

The paper's data from 30 Chinese provinces from 2009 to 2019 are taken as samples (except Tibet, Taiwan, Hong Kong and Macao), which is obtained from China Research Data Service Platform (CNRDS), China Statistical Yearbook, China Environmental Statistics Yearbook, etc. The data are mainly processed as follows: Firstly, based on CNRDS database, China Patent database matches with IPC code of International Patent, green patent information is screened,

enterprises' ability to innovate is accurately assessed, as well as the number of green patent applications of enterprises is further matched with each province by enterprise-region, and the regional green technology innovation level measured by the number of green technology innovation patent applications is finally obtained. Secondly, some missing data are supplemented by interpolation method and moving average method. Thirdly, the statistical variables related to the currency are deflated by the provincial regional GDP deflator based on 2008.

### 3.2 Model construction

In this paper, using the bidirectional fixed-effect model to verify research conclusions:

$$RIN_{it} = \alpha_0 + \alpha_1 GEG_{it} + \beta X + \phi_i + \varphi_t + \varepsilon_{it}$$

In the formula,  $i$  is a province,  $t$  is a year,  $RIN$  represents the regional green technology innovation level.  $GEG$  indicates the environmental governance efforts of local governments.  $X$  is a group of control variables that mitigate missing variable bias.  $\alpha_0$  represents the constant;  $\alpha_1$  represents the coefficient of local government environmental governance;  $\beta$  is the coefficient of the control variable;  $\phi_i$  is the individual effect,  $\varphi_t$  is the time effect, and  $\varepsilon_{it}$  is the disturbance.

①RIN. The explained variable of this study is regional green technology innovation RIN. Considering that green patent data can reflect innovation in environmental protection, pollution control and efficiency, and considering that patent application data is more stable, reliable and timely than patent grant data (Tao et al., 2021)<sup>[7]</sup>, the quality of applications can better reflect the risk of innovation. So, the research measures regional green technology innovation level by using green patent application data (Liu and Xiao, 2022)<sup>[8]</sup>.

②GEG. The explanatory variable of this study is the GEG of government environmental governance. Based on the practice of Li and Yuan (2021)<sup>[9]</sup>, it is systematically and comprehensively measured from three dimensions: environmental legislation, environmental law enforcement and environmental expenditure. The environmental legislation is represented by local environmental regulations and administrative rules. Environmental law enforcement is represented by pollution charges or environmental tax; Environmental expenditure is represented by the proportion of environmental pollution control investment in GDP.

③Control variable. Referring to existing literature, this paper selects government scale, financial development degree, economic development level, foreign direct investment and innovation environment as the control variables of this study.

### 3.3 Empirical result

①Baseline regression results. According to the benchmark model, the regression analysis of government environmental governance and regional green technology innovation is carried out. In Table 1(1), the explanatory variables are used for direct regression, and the results show that government environmental governance has a significant positive impact on the regional green technology innovation level. Then, control variables are introduced successively. The estimated coefficient of regional green technology innovation level is still remarkable. The results are

shown in the column (2) of table 1. So hypothesis H1 is validated. This indicates that after considering the possible influence of other relevant variables, the conclusion that the enhancement of the environmental governance capability can promote the territorial green technology innovation level is robust. At the same time, this also verifies Poter’s hypothesis that government environmental governance has a “leverage effect” for green innovation. In other words, government environment governance brings pressure to encourage innovation and R&D input to improve their market competitiveness. Or maybe it’s just the “crowding out effect” (Roediger Schluga,2003)<sup>[10]</sup>.

**Table 1.** Results of baseline regression

Variables	(1)	(2)	(3)
GEG	0.1579*** (0.046)	0.096** (0.041)	0.031*** (0.012)
Control	Yes	Yes	Yes
Constant	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
<i>Adj-R<sup>2</sup></i>	0.7244	0.7613	0.665
N	330	330	330

Standard errors in parentheses,\*p<0.1, \*\*p<0.05, \*\*\*p<0.01. Similarly hereinafter.

②Mechanism test results. In this paper, selecting the quality of students in colleges and universities to measure the level of human capital (mc), as a theoretical mechanism for environmental governance to affect regional green technology innovation. Table 1 (3) gives the estimated results of the test process of human capital effect of government environmental governance. From the results, it can be seen that government environmental governance has a positive and significant effect on local human capital at 1%, indicating that government environmental governance has a promoting effect on human capital accumulation. With the increase of government environmental governance intensity, regional environmental quality will improve accordingly, which makes this region more able to attract and retain talents compared with other regions, gradually form innovative human capital, and further promote the enhancement of regional green technology innovation level. Hypothesis H2 has been verified.

### 3.4 Robustness test

To ensure the accuracy of the conclusion that the governments’ s environmental attention affects green innovation, model replacement method, variable replacement, and excluding samples of directly under the central government were used to conduct robustness test. The result indicates that the baseline results are robust. Firstly, the bidirectional fixed effect model is replaced by GMM dynamic model to test and verify the baseline results. The results of the replacement model are shown in column (1) of Table 2. In the benchmark regression, the innovation level of green technology is directly measured by the number of patent applications for green invention. To ensure the empirical test results and solve the right-bias distribution problem of green invention patent application data, the natural logarithm is taken after adding 1 to the data. The result in column(2) of Table 2 indicates that the conclusion of baseline regression is robust. Considering the unique political status of municipalities, their level of policy support

is different from that of other provinces. To this end, samples of municipalities directly under the central government (Beijing, Shanghai, Tianjin, Chongqing) are excluded and panel data of other provinces are tested. As shown in the regression results in column (3) of Table 2, the conclusion of baseline regression is robust.

**Table 2.** Robustness test results

	(1)	(2)	(3)
	GMM model	Replace the explained variable	Delete some research samples
L.RIN	0.6455*** (0.0452)		
GEG	0.0998** (0.0443)	0.0900* (0.0524)	0.1059* (0.0596)
Control	Yes	Yes	Yes
Constant	Yes	Yes	Yes
Province FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
<i>Adj-R</i> <sup>2</sup>	0.8954	0.8292	0.8171
<i>N</i>	300	330	286

### 3.5 Regional heterogeneity analysis

At present, there are diversity in the degree of economic growth between regions in our country, and the influence of local government governance for green innovation is bound to be different. Therefore, in order to explore whether geographical location affects this effect, 30 provinces in China were divided into four groups according to regional development policies and relevant documents, and the relationship between government environmental governance ability in different regions and regional green technology innovation was investigated. The results in table 3 indicate that only the environmental governance ability of the government in the eastern region has a remarkable result on regional technology innovation. In the central, western and northeast of China, the government environmental governance ability don't have no significant effect on regional green technology innovation. Compared with developed areas, residents' income level is lower in economically underdeveloped areas. Local governments focus on economic development, ignoring the needs of green development, and enterprises are not encouraged in green technological innovation. Therefore, the results of regional heterogeneity test show that the more economically developed areas, the greater the role of government environmental governance in promoting regional green technology innovation.

**Table 3.** Heterogeneity test results of four major economic regions

	East	Central	West	Northeast
GEG	0.4019** (0.1633)	-0.0653 (0.1477)	0.0106 (0.0832)	-0.0555 (0.1635)
Control	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes
<i>Adj-R<sup>2</sup></i>	0.7202	0.6586	0.4617	0.9127
<i>N</i>	110	66	121	33

## 4 Conclusion

Based on the panel data of 30 provinces (municipalities and districts) in China from 2009 to 2019, this paper systematically investigates the impact of local government environmental governance on regional green technology innovation by comprehensive use of fixed effect model, system GMM model and other measurement methods. The findings are as follows: Firstly, government environmental governance significantly improves the level of regional green technology innovation. After a series of robustness tests, the result is proved to be reliable. At the same time, government environmental governance is conducive to the accumulation of human capital, and thus brings the human foundation for green technology innovation. Secondly, regional heterogeneity analysis shows that the more economically developed areas, the more significant the character of government environmental governance in promoting regional green technological innovation.

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