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Green Innovation under the Constraint of Economic Growth Targets: Evidence from Prefecture Level Cities in China

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Abstract: The demand for sustainable economic growth highlights the trade off between environmental and economic targets. From the perspective of economic growth target (*EGT*) management and green innovation (*GI*) practice, in this study, we constructed dynamic panel, spatial Dubin, quantile, and threshold models to measure the impact of *EGT* on *GI* using the panel data of 284 prefecture cities in China from 2006 to 2018. The results show that *EGT* has a negative impact on *GI*, which is characterized by dynamic, superposition, spatial, and nonlinear effects; there is remarkable heterogeneity in different regions, development stages, and urban characteristics, and the empirical conclusion is still credible under many robustness tests. We also studied the heterogeneous impact of economic growth targets with different characteristics on green innovation. This study puts forward policy implications from two perspectives: optimizing top-level design and maximizing the trade off in multi-objective accountability.

Keywords: economic growth target constraint; green innovation; environmental regulation; prefecture-level city

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1. Introduction

The rapid development of the economy over the past 40 years is not only due to an effective market but also the efforts of the government. The formulation of economic growth targets is an important starting point and power source for the government to develop the economy. Currently, the economy in China is in a new normal stage of a three-phase superposition in a shifting period of growth rate [1]; although the government continues to emphasize the coordinated relationship between economic growth and environmentally sustainable development; this does not seem to fundamentally reduce the huge pressure faced by local governments in developing the economy, and economic development indicators are still the main target of attention (Figures 1–3, left). The setting of economic growth targets generally takes precedence over the setting of other social work targets. The pressure of economic growth will lower the government's tolerance for the emission of heavy pollutants, so the motivation of enterprises to carry out green transformation will also be weakened.

Green innovation plays an important role in the long-term stable growth of a country and has been the focus of the government and academia. China's green science and technology innovation capacity has steadily improved after a long period of development; the innovation system, mechanism, and policy environment have also continuously improved (Figures 1–3, right). This has become an important strategic step for China to cope with the complex and severe international situation.

It is undoubtedly a serious challenge to achieve green development while maintaining stable economic growth. An in-depth study of the responses of local governments to the strategic adjustment of economic targets under the pressure of environmental targets can help us better understand the trade off between the two. Starting from the constraints of economic growth targets, this paper examines whether local governments neglect to invest in environmental governance, thereby hindering the growth of green technology innovation. If so, what are its specific channels and logical chains? Answering these questions will help to improve the government's goals and responsibilities in the new era and provide a scientific theoretical basis by which to achieve stable economic growth and the goals of carbon peak and carbon neutrality. Therefore, on the basis of clarifying the internal mechanism of the effect of *EGT* on *GI*, in this paper, we selected the panel data of 284 prefecture-level cities from 2006 to 2018 to empirically test the relationship. This can provide a scientific theoretical basis for improving the government's formulation of socioeconomic development targets in the new period to better realize stable economic growth and optimize the dual targets of carbon peak and carbon neutralization.

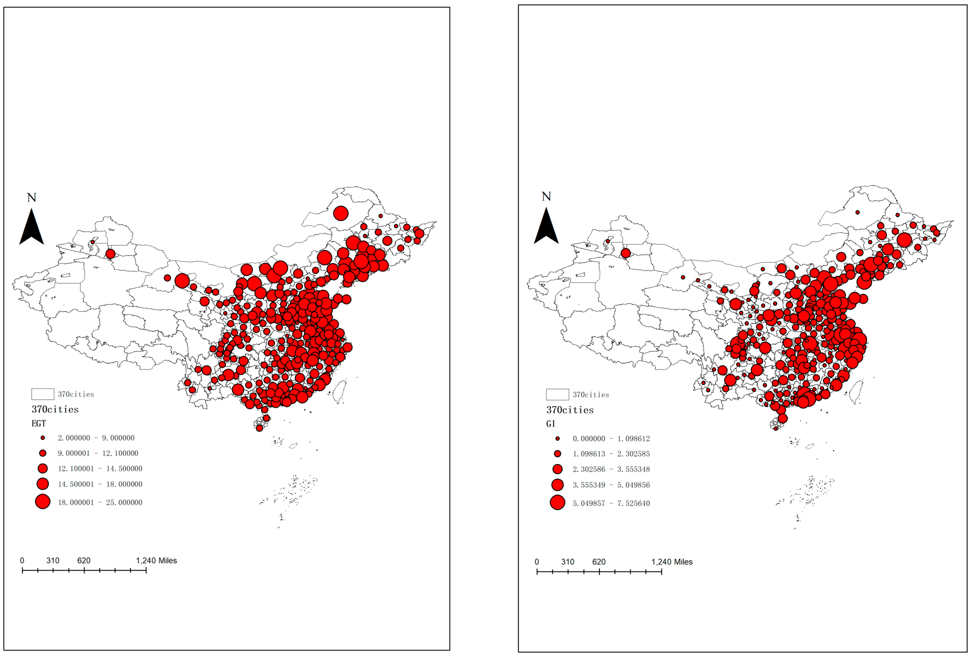

Figure 1. Spatial distribution of *EGT* and *GI* in 2006.

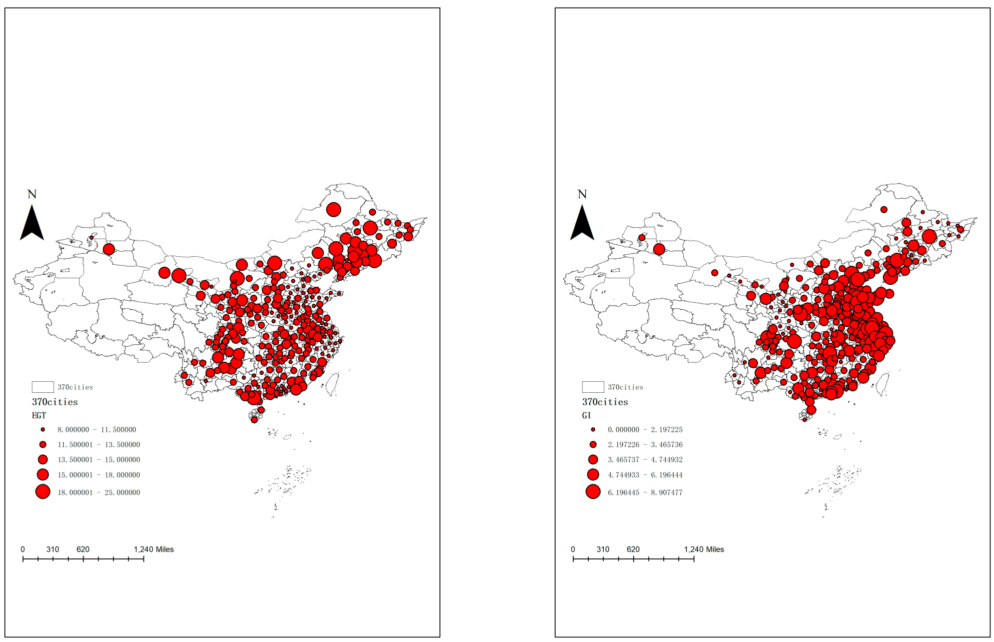

Figure 2. Spatial distribution of *EGT* and *GI* in 2012.

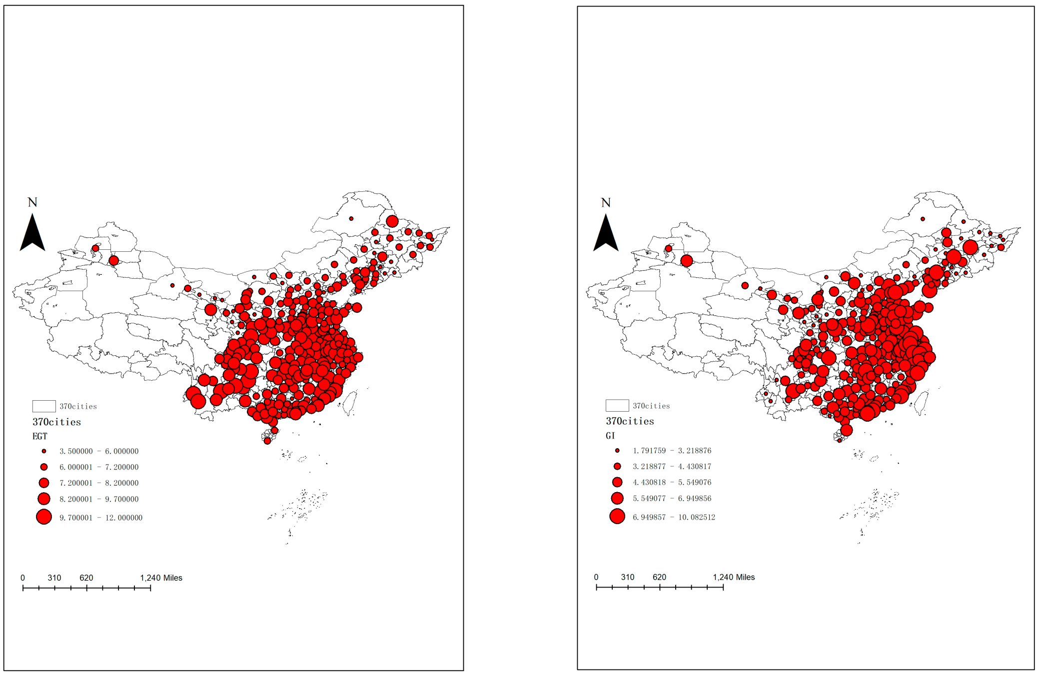

Figure 3. Spatial distribution of *EGT* and *GI* in 2018.

2. Literature Review

In periods of economic transformation, the government can be seen everywhere in the process of economic and social development, which means that the government is one of the factors that need to be focused on in the analysis of influencing factors of regional technological innovation. Among the numerous studies on governmental factors and regional technological innovation, scholars have mainly focused on fiscal and tax competition under the fiscal decentralization system or the internal relationship between economic growth targets as the core and regional technological innovation [2]. The government plays an important role in regional innovation. Governments, especially those in late developing countries, provide certain policy interventions for their own scientific and technological innovation in practice. Local governments in China have greater scope and means to influence the innovative decision making of enterprises. The adopted policies include adjusting the intensity of government regulation, formulating key industrial policies, and giving tax incentives and subsidies [3].

There is a certain contradiction between environmental protection and economic development in the short term [4,5]. Specifically, in order to achieve a higher economic growth target based on the growth target of the higher government [6], local governments usually increase infrastructure investment to achieve rapid economic growth in their jurisdictions, which leads to an extensive growth path dependency among various regions. This will inevitably have an impact on innovation activities, with the characteristics of high investment, high risk, and long cycle. The high economic growth pressure on local governments will squeeze out the green investment and total factor productivity of enterprises [7,8]. Local governments may engage in inefficient practices to achieve their growth targets, such as permissibility regarding emissions [9], negative governance [10], lax regulation [11], or overcapacity [12]. This practice not only discourages lower-level officials from protecting the environment but also indirectly provides enterprises with speculative opportunities to reduce environmental governance. When the government relaxes environmental regulations, and enterprises reduce the intensity of environmental governance, the promotion of green innovation in the industrial sector will be affected. However, the existing literature lacks an analysis of the influencing factors of regional technological innovation from the perspective of economic growth target management and rarely looks at deconstructing the internal mechanism.

Under the strong pressure of environmental targets, local governments will take the initiative to adjust their economic targets. In addition to single-goal studies, many scholars have conducted multi-target studies, especially from the perspective of the balance between economic and environmental targets, to examine the impact of local government behavior. To meet such targets, local governments encourage local enterprises (especially state-owned ones) to expand their investment and green innovation [13,14] and attract investments from nearby enterprises [15] to realize industrial transformation and upgrading [16]. However, the continuous improvement of economic growth targets may also bring about other negative effects. One study found that when local environmental assessments were strengthened, local governments, motivated by the need to meet environmental targets, and ensure economic growth, transferred polluting enterprises to border areas, which exacerbated local border contamination [17]. Another study reported that tightening controls on upstream businesses at pollution monitoring stations reduced their TFP [18]. The existing literature has demonstrated that too high economic growth targets or too strong constraints will damage local economic and energy efficiency [19], which will increase air pollution [20]. The above literature highlights the lack of research on local government behavior under the condition of balancing multiple targets from the perspective of goal setting, distinguishing the characteristics of different targets.

In fact, the impact of government behavior on enterprise innovation is often not a simple linear relationship. Xu et al. [21] found that government subsidies are an important source of funds for enterprise innovation, but they have both a leverage and a crowding-out effect. The leverage effect is the stimulation of enterprise innovation and improved innovation investment and performance, and the crowding-out effect is government subsidies crowding out private R and D investment, which is not conducive to innovation. Hao et al. [22] (2022) noted that economic growth constraints and eco-efficiency had an inverted U-shaped relationship, while Chai et al. [23] found that economic growth targets had a U-shaped relationship with sustainable development.

It can be seen that academia has initially recognized that *EGT* management is an important part of the government's economic behavior, but there are few studies focusing on *EGT* management itself and its relationship with economic growth (development). Compared with the existing literature, the marginal contributions of this study are as follows: (1) It reveals the disharmonious institutional factors between *EGT* and the development of green innovation from the perspective of *EGT* pressure faced by local governments in China so as to provide a theoretical and empirical basis to deal with the conflict between economic growth and green technological innovation. (2) In terms of data and research methods, this study put the research focus on prefecture-level cities, collected data on green innovation and *EGT* at the city level, empirically investigated the impact direction and strength of *EGT* in terms of green innovation output from the perspective of hard and soft targets, and obtained more realistic empirical conclusions. At the same time, this study also constructed dynamic panel, spatial Dubin, quantile, and threshold models to measure the dynamic, spatial, cumulative, and nonlinear effects so as to make the empirical conclusion more reliable.

3. Mechanism Analysis

This study analyzed the influence mechanism in detail based on tournament theory and the pollution paradise hypothesis. The social and economic development expectations of the Chinese government are summarized in the outline of the five-year plan for national economic and social development, the government's annual work report, and other economic and social development target documents. Under the constraint of economic growth targets, local governments may actively adjust their fiscal policy according to the target and induce fiscal expenditure-biased behavior. At the same time, the government's financial investment in science and education is closely related to regional green technology innovation. Local governments will be more active in designing and implementing policies to promote economic growth while matching resources and tools. These policies and instruments will bring more adequate resources to enterprises and enhance their expected economic growth potential. Enterprises are influenced by the information on local economic growth targets and corresponding economic policies and will carry out business activities more actively, and innovation activity is often an important aspect. The provision of financial subsidies increased financial support for industry–university research cooperation, the establishment of technical information exchange networks, the layout of innovation bases and innovation service platforms, and other means of support can alleviate the financing constraints and R and D risks faced by innovative projects, improve the risk–return constraint of investors, and form a diversified and interactive regional innovation system. This can provide essential basic knowledge and common technology for the R and D innovation activities of enterprises and then encourage them to increase their R and D investment.

In addition, in order to achieve economic growth targets as soon as possible, the government may allocate more financial resources to infrastructure areas that can significantly improve economic performance in the short term and pay less attention to green innovation activities that do not have a short-term growth effect, which will have a direct crowding effect on innovation expenditure [24,25]. Local governments may introduce stronger economic policies or even directly interfere in the operation of the economy and enterprises. This mode of economic control tends to undermine market forces, distort the allocation of resources, and harm economic efficiency. Under this strong intervention model, although some enterprises will obtain additional benefits, more enterprises will face greater uncertainty. Companies will rationally evaluate the message of local economic growth targets to determine their own investment in green innovation. This is because it is not the case that the higher the growth target set by the local government; the better businesses will think the future economic growth will be. When the local economic growth target exceeds a certain range, the signals transmitted by this indicator will change. Under the judgment of information transformation, rational enterprises will take more cautious decisions and actions in order to steadily endure the short-term economic uncertainty period and compress innovation activities, thus restraining green innovation performance. Therefore, when the pressure of economic growth is too high, this information will be transformed into uncertain and negative economic information, which will put pressure on market expectations, which is not conducive to micro-enterprise innovation [26]. Due to the long cycle and difficulty of basic research and common technology research and development, the investment incentive of a single enterprise in the above fields is obviously insufficient. It can be found that a higher economic growth target will lead local governments to increase their financial expenditure on infrastructure construction and reduce their expenditure on science and education, which will have a restraining effect on regional green technology innovation. Thus, this study puts forward the following theoretical hypothesis:

H1: *EGT has a negative impact on GI.*

Environmental regulation is an intervention method the government uses to realize coordinated environmental and economic development and is also an effective tool to realize green innovation [27]. In the short term, the increased intensity of environmental regulation will increase the cost of pollution control for enterprises, which will make them reduce their investment in green technologies in order to cope with operating pressure, which is not conducive to the growth of green innovation. However, from a long-term perspective, environmental regulation can promote the transformation of management concepts from passive end-to-end governance to active early stage R and D and encourage enterprises to establish a good green image in the market through product, process, and technological innovation, thereby promoting the introduction of high-end talent, the research and development of clean technologies, and the improvement of pollution control processes, in order to improve the green management level. When an enterprise builds a green brand in order to alleviate the pressure of environmental regulation and control, it also realizes its own green sustainable development because the innovation compensation brought by the offset of the cost of pollution control by the innovation income of the enterprise can achieve a win-win situation of efficiency improvement and economic growth [28].

The phenomenon of incomplete implementation of environmental regulation is universal. Whether local governments can give full play to their environmental protection advantages and perform their environmental protection functions depends on whether they can balance their own utility and public welfare maximization. Environmental regulation reflects the importance attached to environmental management. Usually, when more governance funds are invested, the government's environmental regulations will be stricter. Strong environmental regulation will drive enterprises to eliminate backward production capacity, arrange energy-saving and emission-reduction equipment, operate pollution treatment facilities, introduce green production processes, and promote green innovation. On the other hand, environmental regulation can also become a competitive tool for local governments. The economic catch up and promotion competition between local governments and the competition for liquidity factors will drive officials to pursue economic speed by destroying the ecological environment, which will hinder the promotion of green innovation. The pressure of economic growth targets can drive local governments to encourage micro-enterprises to expand production, levy lower environmental taxes and fees, reduce policy penalties for environmental violations, and reduce pollution control expenditure and green investment due to the reduced punishment cost. Under the pressure of *EGT*, local governments reduce the intensity of environmental governance and weaken the effect of environmental regulation, so as to inhibit the improvement of green innovation. This study further puts forward the following theoretical hypothesis:

H2: *Environmental regulation plays a moderating effect.*

4. Research Design

4.1. Model Setting

Based on the above theoretical analysis, we believe that higher *EGT* will have a negative impact on *GI*. In order to test the hypotheses, we used the data of prefecture cities to carry out an empirical analysis. It should be pointed out that because the innovation activity itself has a certain sustainability, that is, the innovation achievements in the current period will be affected by the early innovation foundation, and the dynamic adjustment process of innovation activities must be considered when building the model. The specific model settings are as follows:

$$GI_{i,t} = \beta_0 + \beta_1 GI_{i,t-1} + \beta_2 EGT_{i,t} + \gamma X_{i,t} + \lambda_t + \mu_i + \varepsilon_{i,t}. \quad (1)$$

In Formula (1), $GI_{i,t}$ represents the green technology innovation level of the city i in year t, and $GI_{t,t-1}$ is the corresponding green innovation level of the previous period; *EGT* is the local economic growth target, measured by the value announced in the report on the work of the local municipal government that year; X is a set of control variables, including environmental regulation (ER), industrial structure (second, terind), human capital level (lnedu), informatization level (internet), population density (lndensity), foreign direct investment (lnfdi), scale of fiscal expenditure (gov), and level of financial development (fin); λ_t, μ_i and $\varepsilon_{i,t}$ represent year fixed effect, city individual fixed effect, and error term, respectively.

4.2. Variable Selection

The explained variable is the green innovation (*GI*) level. This study uses the number of green invention patent applications to measure urban green technology innovation. This study also uses the green invention patent authorization quantity to test the robustness. In the empirical process, the two indicators are taken as natural logarithms after adding 1.

Regarding the explanatory variable, the government generally announces a specific growth target at the beginning of the year and can often achieve or even exceed the target within the year with a strong commitment. The construction of local economic growth target indicators in the existing literature mainly relied on the government's work report documents, and the value set by local governments on the economic growth target is collected to act as a proxy. In this study, we selected data from 284 cities in China from 2006 to 2018, which came from government work reports, local yearbooks, and public websites of local-level municipal governments, and drew a scatterplot of *EGT* and *GI* (Figure 4). It can be seen that the two are negatively correlated, which preliminarily validates hypothesis 1.

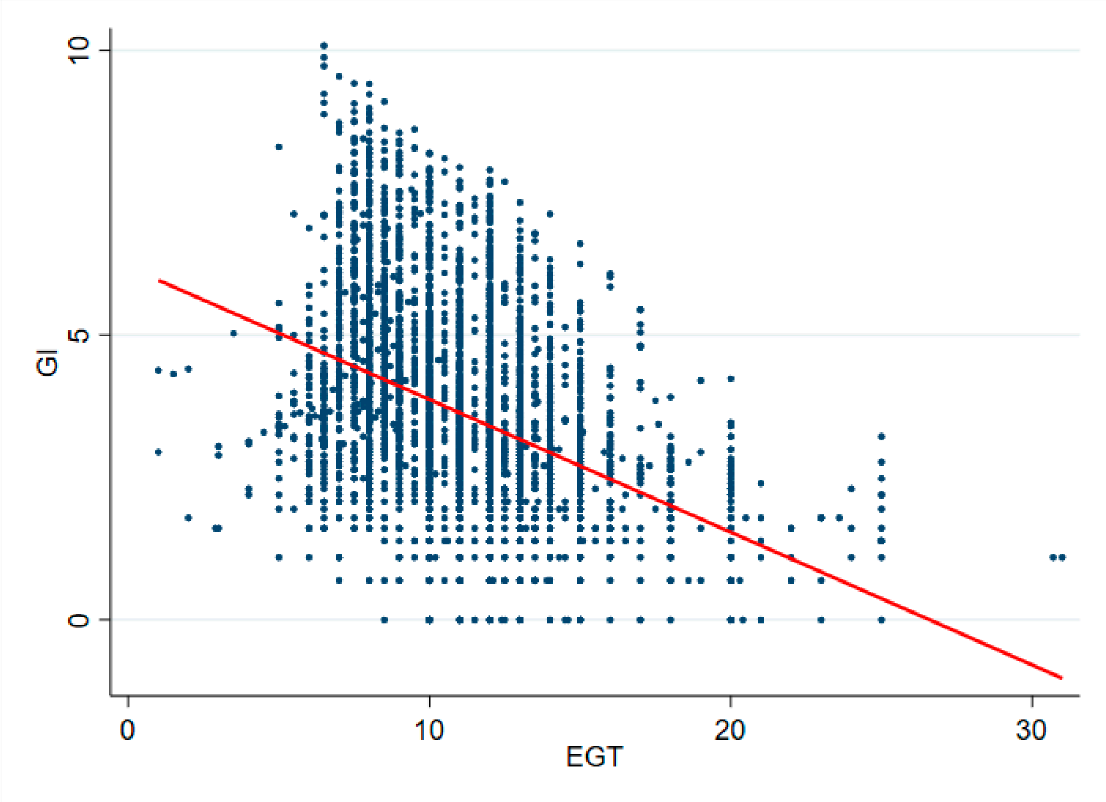

Figure 4. Scatter-plot of *EGT* and *GI*.

Regarding the control variables, in addition to local *EGT*, other factors affect urban green innovation. In order to alleviate the endogenous problems that may be caused by missing variables, we further learned from the practices of Lin and Zhou [29], Zhao et al. [30], Wu et al. [31], and Zhong et al. [32] to control other factors affecting urban green technology innovation. The specific control variable is the level of environmental regulation (ER). This study draws on Chen et al. [33] to measure ER based on the frequency of words related to environmental protection in the work reports of prefecture-level municipal governments; industrial structure (secind, terind) is measured by the proportion of the added value of the secondary and tertiary industries in GDP; the level of human capital (lnedu) is measured by the number of college students; the information level (Internet) is measured by the number of broadband access; population density (lndensity) is measured by the number of permanent residents per unit area; foreign direct investment (lnfdi) is expressed by the ratio of the actual amount of foreign capital utilized by the city to GDP; fiscal expenditure scale (gov) is expressed by the ratio of urban fiscal expenditure to GDP; and financial development level (fin), in the process of carrying out innovative activities, enterprises need financial institutions to provide financial support and alleviate financing constraints. This is measured in this study by the balance of deposits and loans of financial institutions at the end of the year.

4.3. Data Sources

In this study, cities that have undergone administrative division adjustment during the sample observation period were excluded, and a total of 284 cities were finally included as the sample for empirical analysis. It should be pointed out that although governments at all levels in China have been publishing economic growth targets for a long time, the data on urban economic growth targets before 2005 were seriously missing, so in this study, we set the sample observation period as 2006–2018. We consulted the work reports of local municipal governments on their websites or in the statistical yearbooks, and data for the other control variables were from the statistical yearbooks of Chinese cities, with missing values filled in by linear interpolation. Descriptive statistics for the main variables are reported in Table 1.

Table 1. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
GI	3692	3.607409	1.85539	0	10.08251
EGT	3692	1.11253	0.313312	0.1	3.1
ER	3692	0.659659	0.154794	0.16894	0.977741
secind	3692	0.484784	0.107380	0.1495	0.9097
terind	3692	0.383896	0.094307	0.0858	0.8098
lnedu	3692	2.220118	1.036268	0.45839	4.266567
internet	3692	0.150097	0.121673	0.019666	0.475998
lndensity	3692	3.453613	0.804985	1.789129	4.579907
lnfdi	3692	0.076951	0.249924	−0.44304	0.322343
gov	3692	2.685981	0.435584	1.892778	3.521936
fin	3692	2.130957	0.425381	1.433171	2.997429

5. Analysis of Empirical Results

5.1. Benchmark Regression

In order to examine the dynamic adjustment process of green innovation, we added a lag period of green innovation to the explanatory variables of the benchmark econometric model. As two basic dynamic panel data models, compared with difference GMM, system GMM not only estimates the difference equation and level equation at the same time but also uses the lag terms of the level variable and difference variable as instruments for the difference and level equation variables, making the estimation efficiency more efficient. Therefore, drawing on the practice of Ma and Cao [34], in this study, we used the system GMM model for empirical analysis and added the fixed effect and difference GMM models for robustness testing. The regression results are shown in Table 2.

In Table 2, column 1 gives the fixed effect regression result, column 2 gives the difference GMM regression result, column 3 gives the system GMM regression result, and column 4 gives the system GMM estimation results to investigate the moderating effect of environmental regulation. First, the Hansen test of overidentification statistic is not significant, which shows that instrumental variables are effective; AR (2) accepts the null hypothesis, which shows that the estimation method is reasonable.

At the same time, the regression coefficient of each green innovation lag by one period is significantly positive, which shows that innovation activities have obvious dynamic evolution characteristics; this further provides strong support for the application of the dynamic panel data model. The variable coefficient of local economic growth constraint is obviously negative, which shows that higher economic growth targets set by local governments will have a negative effect on green innovation ability. Thus, hypothesis 1 proposed above is preliminarily verified. Considering the moderating effect of environmental regulation, the higher the level of environmental regulation, the higher the economic growth constraint and the greener technology innovation. One possible explanation is that under the central government's strong constraints on the management of energy conservation and emission reduction by local governments, the development of clean technology innovation, the cultivation of human capital, and the introduction of advanced management experience through increased investment in environmental protection by prefectural-level cities in order to achieve the expected growth targets, through the diffusion of environmental protection knowledge, green technology spillover, green equipment sharing, leading to long-term low levels of energy utilization, production technology efficiency, and low efficiency of factor resource allocation of competitive vulnerable industries and enterprises, so as to improve green innovation.

Table 2. Benchmark regression results.

	(1)	(2)	(3)	(4)
	FE	DIFF-GMM	SYS-GMM	SYS-GMM
	Explained Variable: *GI*			
L.GI		0.785 *** (0.108)	0.165 *** (0.020)	0.125 *** (0.028)
EGT	−0.404 *** (0.098)	−0.351 ** (0.173)	−0.651 *** (0.226)	−1.050 *** (0.265)
ER	1.359 *** (0.176)	0.751 (0.487)	0.964 *** (0.351)	0.206 (0.469)
EGR*ER				7.682 *** (1.555)
secind	2.644 *** (0.381)	−6.327 * (3.232)	2.199 * (1.214)	3.030 ** (1.486)
terind	2.751 *** (0.288)	−6.473 ** (3.032)	0.393 (1.095)	1.233 (1.162)
lnedu	0.211 ** (0.089)	0.237 (0.476)	0.770 *** (0.199)	0.643 *** (0.226)
internet	3.599 *** (0.335)	4.170 *** (1.509)	6.558 *** (0.598)	8.298 *** (0.841)
lndensity	0.630 *** (0.131)	1.168 (1.062)	1.148 *** (0.200)	0.867 *** (0.225)
lnfdi	1.095 *** (0.058)	−0.0732 (0.108)	0.228 *** (0.057)	0.218 *** (0.077)
gov	0.200 *** (0.046)	0.269 *** (0.059)	0.389 *** (0.043)	0.0881 (0.063)
fin	−0.0447 (0.070)	−0.0458 (0.125)	0.171 ** (0.087)	0.334 *** (0.119)
_cons	−8.299 *** (1.056)		−8.991 *** −2.838	−8.667 *** (3.160)
N	3692	3124	3408	3408
R-sq	0.704			
AR (1)		0.000	0.000	0.000
AR (2)		0.128	0.575	0.289
Hensen		0.509	0.731	0.235

Note: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.2. Robustness Check

The results of benchmark regression show that there is a significant negative relationship between local economic growth targets and the level of green innovation. However, other factors may interfere with the estimation results, so we carried out robustness tests from three aspects, and the results are shown in Table 3. First, we changed the method of measuring the explained variable. In the benchmark model, we used the data of green patent applications, which may not fully reflect the changing trend of technological innovation. Therefore, we used the number of green patent authorizations as a newly explained variable for estimation, and the results are shown in column 1. Second, we considered the impact of green patent cycles. Considering the complexity of green patent applications, the difficulty of innovative technology, and the long R and D cycle, and referring to the practice of He and Tian [35], we used the number of patents in T + 1 and T + 2 years to measure the cumulative effect of green technology innovation and re-evaluated this model. The results are shown in column 2. Third, the existing studies mainly discuss the problem of innovation within a non-spatial framework and ignore spatial interaction. However, green technology innovation has the characteristics of broad coverage, strong liquidity, and a long retention period, and there is a spatial disequilibrium distribution. Therefore, we further used the spatial Dubin model for empirical analysis [34]; column 3 gives the estimation result under the adjacent matrix, and column 4 gives the estimation result under the economic weight matrix. Based on the empirical results, the changes in coefficients, and the significance of green innovation after replacing the core variables and considering that the cumulative and spatial effects of green innovation have no substantial impact on the above conclusions, the empirical results of this study are still robust.

Table 3. Robustness test results.

	(1)	(2)	(3)	(4)
	Replacing Variable	**Cumulative Effect**	**Spatial Effect**	
			Explained Variable: *GI*	
L.GI	0.231 *** (0.015)			
EGT	−0.624 *** (0.158)	−0.388 *** (0.101)	−0.0385 *** (0.008)	−0.0091 (0.007)
ER	0.894 *** (0.261)	1.377 *** (0.183)	0.359 *** (0.136)	0.422 *** (0.136)
secind	1.167 * (0.637)	2.763 *** (0.387)	0.654 *** (0.135)	0.567 *** (0.128)
terind	0.0467 (0.629)	2.850 *** (0.303)	1.466 *** (0.149)	1.309 *** (0.143)
lnedu	1.002 *** (0.203)	0.272 *** (0.093)	0.463 *** (0.021)	0.461 *** (0.021)
internet	5.607 *** (0.488)	3.597 *** (0.330)	1.664 *** (0.234)	1.331 *** (0.219)
lndensity	0.382 ** (0.163)	0.705 *** (0.136)	0.524 *** (0.032)	0.623 *** (0.023)
lnfdi	0.129 *** (0.046)	1.467 *** (0.058)	0.0517 *** (0.010)	0.0527 *** (0.010)
gov	0.193 *** (0.032)	0.204 *** (0.046)	−0.654 *** (0.060)	−0.434 *** (0.061)
fin	0.180 ** (0.073)	−0.161 ** (0.074)	0.558 *** (0.059)	0.437 *** (0.056)
_cons	−4.015 *** (1.482)	−8.309 *** (1.107)		
AR (1)	0.000			
AR (2)	0.625			
Hensen	0.946			
Spatial				
rho			0.566 *** (0.093)	−0.0117 (0.033)
Variance				
sigma2_e			0.806 *** (0.019)	0.829 *** (0.019)
N	3408	3692	3692	3692
R-sq		0.754	0.007	0.707

Note: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5.3. Characteristics of Economic Growth Target Constraints

In this study, we used the modal words used by government reports announcing the growth targets of prefecture-level cities as the identifying variables [36], including "above", "over", "ensure", etc. If the value is 1, otherwise 0, the economic growth target is regarded as soft constraint by using the mood words of "left and right", "up and down", and "between". The total word frequency was taken as a proxy variable of economic growth constraints. The results are shown in column 1 of Table 4. The effects of tough and soft constraints on innovation were considered, and the results are shown in columns 2 and 3 of Table 4, respectively.

Table 4. Economic target constraint characteristics.

	(1)	(2)	(3)
	Soft and Tough	**Tough**	**Soft**
	Explained Variable: *GI*		
L.GI	0.0323 ***	0.0171 ***	−0.0053
	(0.011)	(0.005)	(0.009)
EGT	−1.352 ***	−3.020 ***	1.324 ***
	(0.196)	(0.397)	(0.138)
ER	−0.253 ***	−0.448 ***	−0.213 ***
	(0.026)	(0.030)	(0.019)
secind	−1.233 **	0.24	0.141
	(0.542)	(0.333)	(0.335)
terind	3.365 ***	6.089 ***	4.797 ***
	(0.821)	(0.428)	(0.465)
lnedu	2.255 ***	1.897 ***	1.876 ***
	(0.183)	(0.125)	(0.115)
internet	−1.397 ***	−1.168 ***	−2.483 ***
	(0.485)	(0.322)	(0.293)
lndensity	−0.196	−0.0698	0.133
	(0.162)	(0.099)	(0.087)
lnfdi	0.912 ***	1.134 ***	1.025 ***
	(0.099)	(0.069)	(0.080)
gov	0.0751	0.304 ***	0.213 ***
	(0.090)	(0.045)	(0.066)
fin	−0.757 ***	−0.715 ***	−0.641 ***
	(0.112)	(0.079)	(0.085)
_cons	−1.847	−7.746 ***	−6.660 ***
	(1.926)	(1.076)	(1.101)
N	3407	3407	3407
AR (1)	0.000	0.000	0.000
AR (2)	0.248	0.315	0.206
Hensen	0.260	0.365	0.756

Note: Standard errors in parentheses; ** $p < 0.05$, *** $p < 0.01$.

The results show that when considering both soft and tough constraints, the impact on green innovation is significantly negative, which is consistent with the benchmark regression conclusion of this study. When the government adopts tough constraints to set *EGTs*, the effect on green innovation is significantly negative; when the government adopts soft constraints to set the targets, the impact on innovation is significantly positive. One possible explanation is that the constraint intensity is directly related to the attitude of local governments toward economic growth targets. By putting pressure on departments at all levels, tough constraints force governments at all levels to distort the allocation of factors in order to ensure they meet the economic growth goal, resulting in resource mismatch.

5.4. Heterogeneity Test

5.4.1. Regional Heterogeneity Test

China has a vast territory with great differences in resource endowments and economic and social development levels. Due to the great differences in the basis of economic development among regions, local governments, under the constraints of economic growth targets, face different pressures to maintain growth, and green innovation will also be different due to the resource endowment, factor market, and innovation activities of the region. In this study, the samples were divided into eastern, central, and western regions to investigate the heterogeneity of the effect of economic growth targets on green innovation. The test results of regional heterogeneity are reported in columns 1–3 of Table 5.

Table 5. Results of heterogeneity test.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Eastern	**Central**	**Western**	**2006–2011**	**2012–2018**	**Resource-Based City**	**Non-Resource-Based City**
	Explained Variable: *GI*						
L.GI	0.132 ***	0.581 ***	0.360 ***	0.132 ***	0.347 ***	0.435 ***	0.242 ***
	(0.031)	(0.024)	(0.034)	(0.029)	(0.024)	(0.028)	(0.026)
EGT	−0.0366 **	−0.0156 **	−0.0740 ***	−0.0213 **	−0.0387 ***	−0.0763 ***	−0.118 ***
	(0.016)	(0.007)	(0.019)	(0.008)	(0.008)	(0.015)	(0.015)
ER	1.260 ***	0.742 ***	0.245	1.104 ***	0.528 ***	2.616 ***	0.804 **
	(0.394)	(0.166)	(0.510)	(0.193)	(0.155)	(0.398)	(0.354)
secind	2.473 ***	1.963 ***	2.438 ***	1.798 ***	0.885 ***	1.120 ***	2.919 ***
	(0.607)	(0.290)	(0.560)	(0.417)	(0.277)	(0.386)	(0.306)
terind	4.446 ***	1.458 ***	4.628 ***	1.706 ***	1.336 ***	1.435 ***	1.255 ***
	(0.947)	(0.256)	(0.616)	(0.385)	(0.247)	(0.454)	(0.439)
lnedu	0.371 ***	−0.0334	0.514 ***	0.0539	0.00608	0.421 ***	0.698 ***
	(0.059)	(0.060)	(0.114)	(0.063)	(0.067)	(0.111)	(0.070)
internet	3.175 ***	2.046 ***	−0.474	0.811 ***	1.074 ***	−1.320 **	4.012 ***
	(0.608)	(0.307)	(0.654)	(0.293)	(0.222)	(0.543)	(0.479)
lndensity	0.819 ***	−0.0013	1.117 ***	0.0336	0.466 **	0.740 ***	0.253 ***
	(0.114)	(0.112)	(0.122)	(0.104)	(0.193)	(0.083)	(0.069)
lnfdi	0.338 ***	0.265 ***	1.133 ***	0.326 ***	1.995 ***	0.451 ***	0.477 ***
	(0.079)	(0.091)	(0.145)	(0.061)	(0.335)	(0.111)	(0.080)
gov	0.104	0.0999 *	0.190 **	0.740 ***	−0.028	0.177 **	0.163 ***
	(0.083)	(0.053)	(0.091)	(0.126)	(0.034)	(0.071)	(0.060)
fin	0.033	0.0344	−1.051 ***	−0.318 ***	0.068	−0.466 ***	−0.0122
	(0.085)	(0.068)	(0.150)	(0.059)	(0.103)	(0.106)	(0.090)
_cons	−11.80 ***	−4.223 ***	−9.653 ***	−4.458 ***	−2.706 ***	−5.187 ***	−6.042 ***
	(1.756)	(0.865)	(1.674)	(1.157)	(1.031)	(1.086)	(0.967)
N	1212	1200	996	1420	1704	1368	2040
AR (1)	0	0	0	0.004	0.004	0	0
AR (2)	0.794	0.592	0.146	0.771	0.137	0.613	0.21
Hensen	0.212	0.664	0.759	0.237	0.407	0.205	0.993

Note: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The empirical results show that the inhibitory effect in the western region is significantly higher than in the central and eastern regions. A possible explanation lies in the fact that the eastern region, which has a better economic base, has slowed down its growth targets as a result of the strategic adjustment of the central–inland-oriented economic policy. In order to narrow the development gap with the eastern region, other regions, which have a relatively poor economic development foundation, have continued to increase their economic growth targets, which has led to greater pressure on the governments in the central and western regions to maintain growth, thus has intensified the crowding out of investment in green innovation.

5.4.2. Time Heterogeneity Test

Since 2012, the economic policy of the new government has put more emphasis on the principle of high-quality development, and the concept of central development has also changed from economic construction to scientific development. Therefore, local governments will adjust their economic development patterns in time and allocate more energy and resources to activities that can promote the sustainable development of cities, such as green innovation. In order to test whether the change in the development concept had a heterogeneous impact on the intrinsic relationship between economic growth targets and the level of urban technological innovation, using 2012 as the boundary, this study analyzed the different impacts of economic growth constraints on green innovation in different periods. The results are given in columns 4 and 5 of Table 5.

According to the empirical results, the regression coefficient is higher for the second stage than the first stage, indicating that the inhibitory effect of economic growth constraints on green innovation in the second stage is more obvious, which seems to be different from intuition. The explanation is that although higher-level governments put more emphasis on transforming the economic development model from factor driven to innovation driven, the path dependence on extensive economic growth will make lower-level governments tend to ignore the important role of regional innovation performance when formulating economic growth objectives for their jurisdictions, which will have a relatively large negative effect on the level of urban technological innovation. Therefore, the path of green, low-carbon, and high-quality development still needs to be continuously followed.

5.4.3. Heterogeneity of Natural Resource Endowments

China is rich in natural resources, which are widely distributed, forming a number of resource-based cities with natural resource exploitation and processing as the leading industry. The question we are concerned about is whether the impact of economic growth goals on green innovation is different among cities with different natural resource endowments. Therefore, based on the practice of Ma and Cao [34], we divided the sample into resource-based and non-resource-based cities. The empirical results are shown in columns 6 and 7 of Table 5.

The regression results show that economic growth targets have a more severe inhibitory effect on technological innovation ability in non-resource-based cities than resource-based cities. This may be because there are more active green R and D and innovation activities in non-resource-based cities. There are higher requirements for green technology content for mining and processing under environmental pressure; as a result, there is a higher demand for high-end talent in resource-based cities, which in turn improves the level of human capital in cities and is conducive to the development of R and D and innovation activities, thus, further improving the living space, resulting in the continuous development of green innovation.

6. Further Analysis

6.1. Quantile Regression Test

This study further used a panel quantile regression model to analyze whether the decision mechanism of green technology innovation is different for cities with different green technology innovations. It should be noted that traditional OLS regression can only examine the impact of explanatory variables on the conditional expectation of explained variables; that is, we can only draw a conclusion for cities in China. However, there may be strong spatial heterogeneity in China's green innovation, and the impact of economic growth constraints on green innovation may vary greatly among cities. Compared to traditional OLS regression, quantile regression allows the regression coefficient to change with the quantiles of dependent variables and can investigate the impact of economic growth constraints on different levels of green innovation output in cities (quantiles of different innovation outputs). In addition, because quantile regression uses full samples, it can avoid the truncation problem of grouped OLS regression and has the advantages of being less susceptible to extreme values and having more robust coefficient estimators. The specific form of the model is as follows:

$$Quant_{\tau}(Y_{i,t}X_{i,t}) = \beta(\tau)X_{i,t} + \mu_i(\tau) + \varepsilon_{i,t}. \quad (2)$$

The conditional quantile of the explanatory variable is to the left of the equation, τ is the quantile $[\tau \in (0,1)]$, $\beta(\tau)$ is the regression coefficient at τ quantile, and the other variables are the same as Equation (1); the regression results are shown in Table 6.

Table 6. Results of quantile regression test.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q10	**Q20**	**Q30**	**Q40**	**Q50**	**Q60**	**Q70**	**Q80**	**Q90**
	Explained Variable: *GI*								
EGT	−0.581 ***	−0.646 ***	−0.525 ***	−0.466 ***	−0.408 ***	−0.357 ***	−0.301 ***	−0.219 **	−0.310 ***
	(0.117)	(0.101)	(0.086)	(0.084)	(0.072)	(0.09)	(0.09)	(0.10)	(0.09)
ER	1.013 ***	1.301 ***	1.149 ***	1.031 ***	1.062 ***	1.117 ***	1.195 ***	1.425 ***	1.502 ***
	(0.239)	(0.218)	(0.190)	(0.186)	(0.156)	(0.16)	(0.16)	(0.17)	(0.18)
secind	0.928 ***	1.189 ***	1.281 ***	1.325 ***	1.276 ***	1.251 ***	1.053 ***	0.869 ***	0.958 ***
	(0.226)	(0.184)	(0.180)	(0.158)	(0.153)	(0.17)	(0.18)	(0.19)	(0.22)
terind	2.020 ***	2.250 ***	2.059 ***	2.122 ***	2.124 ***	2.074 ***	2.024 ***	1.695 ***	1.741 ***
	(0.295)	(0.199)	(0.195)	(0.170)	(0.171)	(0.21)	(0.19)	(0.20)	(0.23)
lnedu	0.513 ***	0.474 ***	0.480 ***	0.460 ***	0.463 ***	0.478 ***	0.503 ***	0.539 ***	0.514 ***
	(0.039)	(0.032)	(0.028)	(0.026)	(0.024)	(0.03)	(0.03)	(0.03)	(0.03)
internet	2.256 ***	2.412 ***	2.934 ***	3.470 ***	3.736 ***	4.207 ***	4.291 ***	4.545 ***	4.422 ***
	(0.343)	(0.309)	(0.315)	(0.312)	(0.311)	(0.36)	(0.34)	(0.34)	(0.39)
lndensity	0.567 ***	0.596 ***	0.567 ***	0.595 ***	0.577 ***	0.590 ***	0.592 ***	0.631 ***	0.583 ***
	(0.042)	(0.036)	(0.033)	(0.027)	(0.030)	(0.03)	(0.03)	(0.03)	(0.04)
lnfdi	1.140 ***	1.165 ***	1.202 ***	1.130 ***	1.091 ***	1.070 ***	1.096 ***	1.102 ***	1.219 ***
	(0.145)	(0.105)	(0.106)	(0.111)	(0.101)	(0.09)	(0.11)	(0.11)	(0.10)
gov	−0.328 ***	−0.260 ***	−0.260 ***	−0.191 ***	−0.156 ***	−0.0433	0.0338	0.158 **	0.256 ***
	(0.093)	(0.067)	(0.060)	(0.052)	(0.056)	(0.06)	(0.06)	(0.08)	(0.08)
fin	−0.174	−0.147 **	−0.0393	−0.0564	−0.0209	−0.0193	−0.0039	0.0616	0.139 *
	(0.109)	(0.066)	(0.054)	(0.053)	(0.052)	(0.06)	(0.07)	(0.08)	(0.08)
_cons	−4.010 ***	−4.669***	−4.500 ***	−4.679 ***	−4.623 ***	−4.821 ***	−4.625 ***	−4.583 ***	−4.557 ***
	(0.768)	(0.563)	(0.542)	(0.434)	(0.441)	(0.51)	(0.48)	(0.51)	(0.61)
N	3692	3692	3692	3692	3692	3692	3692	3692	3692

Note: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

According to Table 6, the regression results at all quantile levels are similar to those at the national level, and the impact is significant at all quantile levels, with increases in local *EGT* inhibiting green innovation. From the range of impact, the smaller the degree of green innovation, the greater the impact of economic growth constraints on green innovation, that is, the more obvious the crowding-out effect. One possible explanation could be that high levels of innovation in green technology reduce waste and energy consumption by making more efficient use of natural resources. Green growth is achieved through the allocation of resources and the provision of value-created opportunities. Green innovation is expected by enterprises and local governments to reap the corresponding economic benefits, and it is also hoped to reduce environmental pollution. The impact of economic growth constraints on green innovation will be relatively small. When the level of development of green innovation is relatively low, it is still in the early investment process. Under the inertia of local governments, they will strengthen themselves and even lock in the original growth path, at which time the restraining effect of economic growth constraints on green innovation will be more obvious. Therefore, the government's environmental regulation policies and green R and D subsidies to encourage green innovation activities, breaking through the existing mechanisms and fixed patterns, is an important way to continue to promote green innovation breakthroughs and upgrades.

6.2. Threshold Feature Analysis

6.2.1. Model Setting and Panel Threshold Effect Test

This study used the threshold effect model proposed by Hansen [37] to further explore the impact of economic growth constraints on green innovation in prefecture-level cities under different levels of environmental regulation. It uses exogenous grouping to test nonlinear relationships in order to avoid the artificial division of growth intervals and the estimation error caused by endogenous problems in the past. The specific form is as follows:

$$\begin{array}{l} GI_{i,t} = \beta_0 + \beta_1 EGT_{i,t} \cdot I(\mathrm{ER} < \gamma_1) + \beta_2 EGT_{i,t} \cdot I(\gamma_1 < \mathrm{ER} < \gamma_2) \\ +\beta_3 EGT_{i,t} \cdot I(\mathrm{ER} > \gamma_2) + \varsigma X_{i,t} + \lambda_t + \mu_i + \varepsilon_{i,t} \end{array}, \quad (3)$$

where γ_1 and γ_2 are the threshold values, and there are three intervals, and in each interval, there is a certain heterogeneity in the effect of economic growth constraints on green innovation; $I(\cdot)$ is the indicator function; and the other variables are the same as Equation (1). Based on bootstrapping 400 samples in the threshold panel model, this study tested the significance of the threshold effect with environmental regulation as the threshold variable under the hypothesis of no threshold effect. As can be seen in Table 7, the threshold model has a double threshold effect but fails to pass the triple threshold significance test.

Table 7. Panel threshold effect test (BS = 400).

Threshold	**RSS**	**MSE**	**Fstat**	**Prob**	**Crit10**	**Crit5**	**Crit1**
Single	1228.86	0.334	80.87	0.000	26.9023	32.7533	42.6929
Double	1216.71	0.3307	36.75	0.0075	18.6139	22.0356	28.5263
Triple	1209.42	0.3287	22.17	0.76	51.2487	57.3365	68.799

6.2.2. Model Estimation and Analysis of Results

The regression results with environmental regulation as the threshold variable (Table 8) show that there is a significant threshold effect of the impact of economic growth constraints on China's green innovation. When the degree of ER is less than 0.5673, the level of green innovation decreases by 0.551% for each unit of economic growth constraint. The results show that the constraint of economic growth significantly inhibits green technology innovation in China, and the regression coefficient decreases when the degree of ER is between 0.5673 and 0.7572. The results show that the negative effect of economic growth constraint on green technology is restrained by the increasing degree of ER, and when the environmental regulation degree is more than 0.7572, the negative effect of *EGT* on *GI* is greatly restrained by the increasing degree of ER. This empirical conclusion further verifies hypothesis 2.

Table 8. Threshold model regression results.

	(1)
	Threshold Variable: ER
	Explained Variable: *GI*
secind	2.727 ***
	(0.183)
terind	2.927 ***
	(0.172)
lnedu	0.246 ***
	(0.043)
internet	3.787 ***
	(0.170)

Table 8. *Cont.*

	(1)
	Threshold Variable: ER
	Explained Variable: *GI*
lndensity	0.688 ***
	(0.096)
lnfdi	1.122 ***
	(0.056)
gov	0.176 ***
	(0.040)
fin	−0.063
	(0.047)
EGT (ER < 0.5673)	−0.551 ***
	(0.050)
EGT (0.5673 < ER < 0.7572)	−0.410 ***
	(0.054)
EGT (ER > 0.7572)	−0.180 ***
	(0.061)
_cons	−7.978 ***
	(0.607)
N	3692
R-sq	0.701

Note: Standard errors in parentheses; *** $p < 0.01$.

7. Discussion

Starting from the management of economic growth constraints in prefecture-level cities, this study deeply analyzed the impact of economic growth constraints on green innovation. First, the empirical results show that economic growth constraints significantly inhibit green innovation, and this impact is still robust after replacing the core variables and considering the cumulative and spatial effects. Second, the negative effects are significantly heterogeneous in different regions, development periods, and resource endowment structures. Third, this study used the quantile model to investigate the nonlinear effect of economic growth constraints on green innovation, analyzed the threshold effect based on environmental regulation, and examined the characteristics of the impact from different dimensions. Finally, based on the above empirical conclusions, this study puts forward the following policy suggestions:

Top-level target planning and design should be further optimized. On the one hand, it is necessary to integrate the indicators of innovation, environment, and people's well being into the relevant planning of economic development and to designate planning targets in order to improve the quality of economic development based on multiple perspectives. On the other hand, it is necessary to set up a mechanism of regional coordinated development based on the national chess game, give full play to the complementary advantages among regions, and realize coordinated regional development. Government agencies at all levels should try to adopt a "soft constraint" approach to setting economic growth targets and set reasonable economic growth ranges. This could give the process of government planning and setting more space, and then more attention can be paid to innovative and green development. Enterprises are the most dynamic actors in economic activities, and they should also be the subjects of innovation, information transmitted by local governments, and the policies formulated, and more attention should be paid to how enterprises respond to such information and policies. The future direction should be to build an effective mechanism to promote green innovation for the whole society, which is enterprise- and market-oriented and can give full play to the government's function.

In target allocation, performance evaluation, and standardized assessment of the government target responsibility system, we need to consider the trade off between multiple targets. When the assessment of environmental targets and other social targets is strengthened, it is necessary to consider the adjustment of economic objectives in order to better coordinate the realization of multi-target tasks. Second, we need to truly implement the high-quality development goal of a green and low-carbon circular development economic system in the government target responsibility system and further strengthen the importance of relevant assessment indicators, such as the environment and people's livelihoods, in the official assessment system, so as to continuously improve people's sense of gain. Third, environmental governance needs to be coordinated with upgrading of the industrial structure. At the same time, we should set appropriate, feasible, clear, and mandatory hard constraint targets for pollution reduction and environmental optimization and match the means of promoting the implementation of responsibilities and the completion of targets, such as rewards for meeting the standards and punishments for failing to meet the standards, so as to encourage local governments to adjust the focus and action direction of target management to environmental governance.

8. Conclusions

From the perspective of economic growth target constraints, this study examined the impact of *EGT* on *GI*, which provides a new rationality for the phenomenon of high economic growth and low innovation in China and also provides a certain policy enlightenment in terms of the government's future green development with the management of *EGT*. There are still two specific deficiencies in this study. First, this study used patent data, which have the advantages of availability and consistency, to measure regional technological innovation capability, but these data cannot describe innovation quality and efficiency well and may lead to the overestimation of the level of regional technological innovation. A future research direction will be to measure the quality and efficiency of green innovation with more objective and accurate indicators. In addition, under the target responsibility system, another aspect of future research will be to examine the impact of the epidemic on corporate behavior, including corporate social responsibility and organizational and marketing models.

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