Analysis on the Spatial Heterogeneity of the Interactive Impact of Green Development and Green Innovation in China

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Abstract: Green development and green innovation are the requirements and choices of scientific development. Based on the inter-provincial panel data from 2004 to 2017 in China, this paper used the PVAR model to evaluate and analyze the interactive relationship between green innovation and green development. The results show that: (1) The interaction mechanism of the two is heterogeneous in different regions. The less developed the economy is, the greater the impact of green innovation on green development. However, the support of green development to green innovation is not significant; (2) In developed areas, the impact of green innovation on green development is not significant. However, a high level of green development is conducive to the output of green innovation. This article provides policy support for the implementation of green development strategies in different regions.

1. Introduction

At present, the global environment is facing huge challenges. In order to deal with the constraints of the natural environment and solve the ecological problems in economic development, green development is gradually becoming the global sustainable development goals (SDGs) and the consensus of human development. China's practice of green development has an important impact on the world [1]. The Chinese economy has shifted from the rapid development in the past to the stage of pursuing high-quality development [2]. Scientific and technological innovation, industrial structure adjustment, and the realization of economic and social “green development” are the only way to high-quality development. From the perspective of China's development strategy, the construction of ecological civilization is also an important goal of building a beautiful China in the new era. Therefore, it is necessary to take into consider the environmental protection and resource conservation when the economy grows. The government should achieve green transformation by enriching innovative elements and developing connotations. This is a strategic exploration of great practical significance.

Green development is a new development model that realizes the harmonious coexistence of economic, social and ecological systems. The core concept of it is to achieve ecological environmental protection and governance by reducing resource consumption, and to obtain the mutual coordination of social economy, ecological environment and natural resources [3]. It aims to solve a series of ecological and environmental problems induced by the traditional economic growth model [4]. Compared with traditional innovation, the basic connotation of green innovation is roughly the same as the concepts of environment-driven innovation, ecological innovation and low-carbon innovation. They all emphasize the positive impact of technological innovation and environmental improvement on economic development, so as to achieve the goal of sustainable development [5]. The innovation input, patent authorization, achievement output and transformation in the green innovation system are all related to the regional green development. Wang Bo et al. found that the difference in the development level of various regions is the main factor affecting green innovation [6]. From the perspective of the influence mechanism, the concept of green development can create a good institutional environment for technological innovation. This will

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promote the promotion of regional technological innovation [7], and can improve innovation by optimizing the market environment and improving financing support. In addition, the optimization and upgrading of industrial structure is also an important way for green development to improve green innovation [8].

The concept of green development emphasizes the coordinated development of economy, society and environment under the constraints of resources and environment. However, every aspect of green development requires technological innovation [9]. Wang Hailong et al. pointed out that the efficiency of green innovation has a significant role in promoting green development [10]. Cao Jing et al. found that the green economy efficiency of cities in the Guangdong-Hong Kong-Macao Greater Bay Area has been significantly improved in recent years. The main influencing factors gradually transited from scale effect to innovation effect. The contribution of innovation investment in this transformation process is significant [11]. Green innovation contributes to the formation of a cluster of talents and technologies, thereby enhancing regional green total factor productivity.

Because the two influence each other and the content were similar, many existing documents have not made a strict distinction between green development and green innovation, and even used the level of green innovation to measure the green development level[12]. In order to solve this problem, Hu Angang and other scholars pointed out that it is not appropriate to confuse green development and green innovation. Green development includes the coordinated development of multiple systems such as economy, society, and environment. Although green innovation focuses on environmental impact and sustainable development, it does not deviate from the scope of technological innovation. Although green development and green innovation influence each other, they have completely different contents [3].

At present, the quantitative analysis on green innovation and green development is well developed. Many studies showed that there is a significant two-way causality between them[3,8-9]. Due to the existence of this kind of endogenous problem, it is difficult to distinguish the influence mechanism between green development and green innovation. Therefore, the basic consensus is that the two promote each other and develop together. In addition, many studies found that both green innovation and green development have their own exogenous influence paths. Such as regional R&D investment, scientific and technological talent investment, and innovation preferential policies which contributes to green innovation output [13]. Regional environmental governance, public infrastructure and other factors have a clearer causal relationship with the level of green development [14]. Although many studies have paid more attention on the relationship between green innovation and green development, they have not reached a consistent conclusion. Most of the studies only examined the one-way causal relationship between the two from a single perspective, ignoring the investigation of the synergistic effect and the two-way relationship. From the perspective of realistic policy formulation, both of them are variables of management significance. Therefore, the dynamic analysis of their coordination and interaction still needs to be further improved. This research starts with the connotation of green development and constructs a regional green development level evaluation scale based on the two core dimensions of green and development. Based on China's inter-provincial panel data from 2004 to 2017, we evaluated and analyzed the interactive relationship between green innovation and green development through the PVAR model. In order to study the issue of regional differences in the interactive effects of green development and green innovation, we made a comparison between different regions according to the level of economic and social development, and systematically judged the interactive relationship between regional green development and green innovation. This provides an important basis for the choice of green policies for regional development.

2. Data Sources and Research Methods

According to the research purpose, this article refers to the standard of Xiong Qiyue et al. to divide the national sample into economically developed Regions, economically developing areas and economically underdeveloped areas [15]. In order to ensure the continuity and availability of data, this paper selects the panel data of 30 provinces (autonomous regions and municipalities directly under the Central Government) from 2004 to 2017 (not included in Tibet, Hong Kong, Macao, and Taiwan) as the samples. The data comes from China Statistical Yearbook, China Environment Statistical Yearbook. The missing data are filled by fitting (linear trend method).

2.1 Data Sources and Preprocessing

The green patent data comes from the 2005-2016 China Patent Full-text Database. Compared with utility model patents and appearance design patents, invention patents are more innovative. Therefore, this article chooses invention patents as the main patent form for subsequent research. The World Intellectual Property Organization (WIPO) launched an online tool in 2010 to facilitate the retrieval of environmentally friendly technology-related patent information, the "Green List of International Patent Classifications". The search item of which divides green patents into seven types: transportation, waste management, energy conservation, alternative energy production, administrative regulatory or design aspects, agriculture or forestry, and nuclear power generation. According to the above classification criteria, the green patents were matched and identified according to the patent classification number. Furthermore, we used them as the key indicator of the green innovation level of provinces in China.

In order to exclude the influence of dimensions and numerical values on the results when evaluating green development, it is necessary to standardize the initial data. The greater the index value is, the more favorable the green development level is. The positive index was used for standardization of equation (1). The smaller the index value is, the more beneficial the green development level is. The negative index was used for standardization of equation (2).

The positive index is

$$Z_i = \frac{C_i - \min(C_i)}{\max(C_i) - \min(C_i)} \tag{1}$$

The negative index is

$$Z_i = \frac{\max(C_i) - C_i}{\max(C_i) - \min(C_i)} \tag{2}$$

where C_i and Z_i are the original value and standardized value of the *i*-th index, respectively. max (C_i) and min (C_i) are the maximum and minimum values of the *i*-th index, respectively.

In order to minimize the influence of subjective factors on the evaluation results in the process of weight determination, this paper used the coefficient of variation method of objective assignment to determine the index weight.

$$\delta_i = \frac{D_i}{\bar{Z}_i} \tag{3}$$

$$W_i = \frac{\delta_i}{\sum_{i=1}^{n} \delta_i} \tag{4}$$

where δ_i, D_i, $\overline{Z_i}$ and W_i are the coefficient of variation, mean square error, mean and weight of the ***i***-th index, respectively.

2.2 Variable Selection

The focus of this paper is to analyze the dynamic relationship between the regional green development level and green innovation capabilities. Based on the existing research literature, the selected variables and descriptions are as follows.

Table 1 Evaluation Index System of Green Development.

Object	Principle	Element	Indicator	Weight ω_j	Sign
Green development level	Economy increases	Growth efficiency	Per capita GDP (yuan/person)	0.0939	+
			Per capita disposable income of urban residents (yuan)	0.1019	+
		Growth quality	Total industrial water (100 million cubic meters)	0.0118	-
			Thermal power generation (billions of tens of millions of hours)	0.0129	-
			The added value of the tertiary industry accounts for the proportion of GDP (%)	0.0592	+
	Environment	Resourc	Industrial pollution control completed investment (ten	0.1346	-

	friendly	e consumption	thousand yuan)		
			The proportion of nature reserves in the area of jurisdiction (%)	0.0987	-
			Plantation area of the year (thousand hectares)	0.1403	-
		Ecological protection	Sulfur dioxide emissions (10,000 tons)	0.0235	+
			Total wastewater discharge (10,000 tons)	0.0121	+
			Park green area per capita (m2/person)	0.0415	+
	Society harmonious	Green life	Enrollment of ordinary colleges and universities (10,000 population)	0.0784	+
			Employed persons in urban (10,000 population)	0.0941	+
		Social development	Hospital beds (per 10,000 population)	0.0534	+
			Number of buses per 10,000 population (vehicles)	0.0436	+

2.2.1 Green Development Level(G_DEV)

The concept of green development evolved from the concept of green economy, and the current research on green development evaluation has made significant progress. Based on the Green Development Index System formulated by the National Development and Reform Commission, following the principles of science, system and operability, and referring to the research of Wang Ke et al., we selected economic growth, environment and society to construct green development evaluation Index system [16]. They indicate the economic, environmental and social impact of green development (Table 1). Regarding the selection of element-level indicators, “green” and “development” can reflect the key connotation of green development. We have made adjustments in consideration of the availability of data.

2.2.2 Green Innovation Capability (G_INNO)

Green innovation is a professional innovation activity developed based on technological innovation. Many studies adopt innovation efficiency and performance indicators to measure the green innovation level. For example, the efficiency of the regional innovation network and green innovation performance in China was evaluated by the DEA method [12]. Due to the subjectivity of indicator selection, efficiency indicators cannot objectively and directly show the green innovation level. Scholars gradually used WIPO to identify the number of green patents after identifying the classification of patents, and then directly measure the green innovation level. In particular, green invention patents can better reflect the level of substantive innovation [9]. This article used the number of green patents in each province and city as a proxy variable to measure the green innovation level.

2.3 Research Methods

This study uses a panel vector autoregressive model (PVAR), which combines the advantages of panel data analysis and VAR (single-dimensional vector autoregressive) model. This can control the unobservable individual heterogeneity, and can better avoid the endogenous problem in the model. Therefore, we can accurately and effectively measure the internal correlation between variables [17]. In addition, we use the PVAR model to study the short-term dynamic correlation between green innovation and green development through impulse response, and better study the dynamic adjustment process of variables. Providing impulse response diagrams between selected variables can also visually investigate the transmission mechanism of the impact of a variable change on other variables. In addition, variance decomposition can be used to study the long-term contribution of related variables. The formula of the model is

$$Y_{i,t} = \varphi_0 + \sum_{j=1}^{p} \Phi_j Y_{i,t-j} + \alpha_i + \beta_t + \varepsilon_{i,t} \quad (5)$$

where $Y_{i,t}$ is a two-dimensional column vector containing two endogenous variables of green innovation and green development, φ_0 is the intercept term, j represents the order of lag, φ_j is the estimated matrix of the jth order of lag, α_i and β_t are the individual and time fixed effects, and $\varepsilon_{i,t}$ is the random error vector.

The estimation method of PVAR model includes three parts: generalized moment estimation (GMM) of model parameters, impulse response function (IRF) and variance decomposition of prediction error. When estimating model parameters by GMM, we considered the structural characteristics of the PVAR model. First, the time effect β_t is eliminated by the cross-sectional mean difference method of panel data. Second, we considered the correlation between the lag variable and the random disturbance term in the PVAR model. The forward mean difference method (Helmert process) proposed by Arellano and Bover (1995) was used to eliminate the individual effect α_i, so as to avoid the bias that may be caused by the commonly used mean difference method. In addition, the orthogonality between the transformed variable and the endogenous variable of lag remains unchanged, and thus has nothing to do with the random disturbance term. Third, the variable of lag is used as an instrumental variable (IV), and the GMM was used to estimate the PVAR model for the analysis of the long-term relationship between the variables of the model. Finally, on the basis of the parameter estimation of the PVAR model, the impact of the endogenous variable can be observed through the IRF on the variable itself and other endogenous variables. The variance decomposition method of forecast error was used to measure the contribution ratio of the orthogonal unit impact of each endogenous variable in the error variance that causes the endogenous variable to change. IRF and the variance decomposition of the prediction error more intuitively showed the dynamic relationship between the various variables and the magnitude of the influences.

3. Result Analysis

Based on the above-mentioned data and research methods, this research deeply analyzes the spatial heterogeneity of green development levels and green innovation capabilities, and uses models to explore the interactive effects of green development and green innovation.

3.1 Analysis on the Spatial Heterogeneity of Green Development Level

In the measurement process, the entropy method was used to determine the weight, and the comprehensive evaluation index of the green development level of provinces and cities in China are listed in Table 2.

Table 2 Measurement Results Of the Green Development Level of Provinces and Cities in China from 2004-2017.

Region	Provinces	2004	2008	2012	2015	2017
Developed region	Beijing	0.263	0.323	0.360	0.453	0.484
	Tianjin	0.239	0.260	0.274	0.336	0.362
	Shanghai	0.267	0.298	0.274	0.390	0.453
	Jiangsu	0.209	0.279	0.324	0.449	0.474
	Zhejiang	0.188	0.223	0.310	0.409	0.418
	Shandong	0.293	0.366	0.409	0.489	0.520
	Guangdong	0.213	0.281	0.372	0.484	0.510
Developing region	Hebei	0.234	0.247	0.291	0.381	0.410
	Shanxi	0.213	0.262	0.301	0.328	0.387
	Liaoning	0.265	0.250	0.324	0.375	0.376
	Anhui	0.146	0.180	0.230	0.312	0.314
	Fujian	0.157	0.194	0.276	0.344	0.338
	Jiangxi	0.178	0.228	0.255	0.313	0.330
	Henan	0.223	0.288	0.290	0.373	0.430
	Hubei	0.214	0.234	0.293	0.361	0.391
	Hunan	0.232	0.205	0.300	0.362	0.379
	Guangxi	0.160	0.192	0.243	0.292	0.300
	Chongqing	0.178	0.206	0.327	0.351	0.368
	Sichuan	0.290	0.316	0.325	0.414	0.500

Underdeveloped region	Xinjiang	0.248	0.246	0.269	0.315	0.343
	Inner Mongolia	0.302	0.288	0.337	0.420	0.433
	Jilin	0.196	0.219	0.264	0.318	0.335
	Heilongjiang	0.213	0.249	0.286	0.325	0.345
	Hainan	0.137	0.160	0.201	0.245	0.263
	Guizhou	0.138	0.156	0.221	0.323	0.416
	Yunnan	0.233	0.303	0.369	0.354	0.349
	Shaanxi	0.292	0.250	0.336	0.350	0.355
	Gansu	0.264	0.230	0.296	0.348	0.387
	Qinghai	0.245	0.237	0.283	0.312	0.338
	Ningxia	0.195	0.191	0.230	0.258	0.285

3.2 Analysis on the Spatial Heterogeneity of Green Innovation

According to the "Green List of International Patent Classifications" published by the WIPO, we took the logarithm of the number of green patent grants in the specific regression based on the data distribution (Table 3).

Table 3 the Descriptive Statistics of Variables.

Variable	Name	Unit	Region	Observed value	Mean	Standard deviation	Min	Max
g_dev	Green development level	1	developed	98	0.3353	0.9064	0.1853	0.5302
			developing	182	0.2771	0.0708	0.1403	0.4999
			underdeveloped	140	0.2675	0.0699	0.1368	0.4333
g_di	Logarithmic value of the number of green patents granted	ln(number)	developed	98	6.3417	1.1974	3.4657	8.6259
			developing	182	4.7803	1.3168	1.7918	7.1397
			underdeveloped	140	3.6321	1.5578	0	6.6411

3.3 Evaluation of the Interaction between Green Development and Green Innovation

On the basis of testing the stability of the data, this study uses a panel vector autoregressive model (PVAR) to quantify and analyze the interactive relationship between green innovation and green development.

3.3.1 Stationarity Test and Selection of the Number of Lag Periods

In this study, LLC test and IPS test were used to test the stability of the data. In Table 4, the original sequence of the green development level (g_dev) and green innovation (g_di) of the three major regions cannot completely pass the LLC and IPS inspections and is non-stationary. However, it is stable after first-order difference. These two variables have a first-order single integer. Therefore, in the estimation of the PVAR model, we introduce the first-order difference of the variables into the PVAR model. Compared with the original variables, the variables after the first-order difference have not changed from an economic point of view.

Table 4 Unit Root Test Results.

Terms	Test method	Developed region		Developing region		Underdeveloped region	
		t	*p*	*t*	*p*	*t*	*p*
g_dev	LLC	1.8561	0.0317	3.0237	0.0012	4.4815	0.0000
	IPS	0.2721	0.6072	0.0985	0.5392	2.5694	0.0051
g_di	LLC	6.0899	0.0000	5.4112	0.0000	7.3436	0.0000
	IPS	3.0957	0.0010	1.0155	0.1549	3.0503	0.0011
dg_dev	LLC	8.1350	0.0000	11.0838	0.0000	11.8728	0.0000
	IPS	4.7625	0.0000	6.3397	0.0000	8.7303	0.0000
dg_di	LLC	5.8130	0.0000	13.6410	0.0000	16.7796	0.0000
	IPS	2.9119	0.0018	8.4667	0.0000	11.3711	0.0000

Note: H0: There is a unit root, *, **, *** indicate rejection of H0 at 10%, 5%, and 1% significance levels, respectively.

According to the criteria of AIC, BIC, and HQIC, the samples of the three economic zones were discriminated. The results showed that the best lag period of the three economic regions was 1.

3.3.2 Pvar Model Estimation

GMM on the PVAR model was performed through Stata15.0. Before estimation, the forward mean difference method (Helmert) process was used to eliminate time effects and fixed effects to avoid coefficient estimation bias. The results are listed in Table 5.

Table 5 Gmm Statistical Results of Pvar Model.

Region	Developed region		Developing region		Underdeveloped region	
variable	Green innovation	Green development	Green innovation	Green development	Green innovation	Green development
L.h_gi	0.551***	-0.00251	0.827***	0.0133**	0.798***	0.0210**
	(3.055)	(-0.0877)	(8.023)	(2.098)	(5.061)	(2.294)
L.h_g_dev	0.567*	0.903***	0.519	0.666***	1.215	0.532***
	(1.672)	(2.702)	(0.307)	(6.158)	(0.471)	(3.46)
Observations	84	84	156	156	120	120

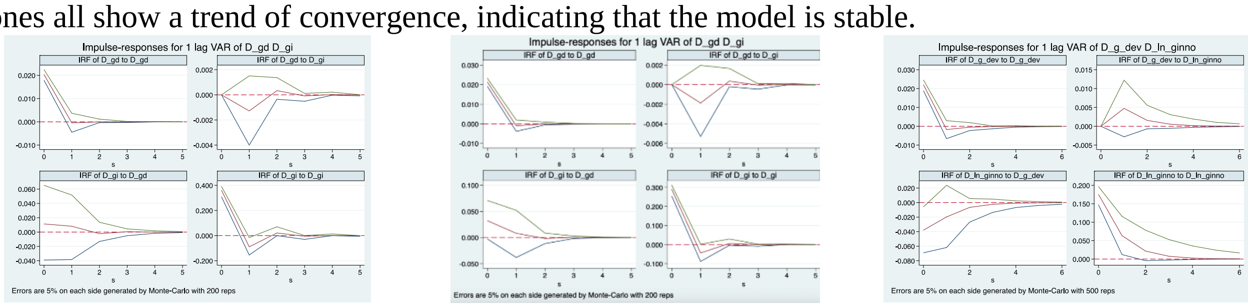
Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The impact coefficient of green innovation in the economically developed regions 1-lag behind on green innovation is 0.55, which is significant at the 1% confidence level. However, green development is not significantly affected by green innovation. One reason is that the industrial structure of economically developed regions is more reasonable. After the heavy-polluting industries were transferred to the underdeveloped areas, the transformation of purely green patented technology in developed areas had no significant impact on regional social development. In addition, the level of green development with 1-lag of developed regions has a significant impact on green development and green innovation. First, it shows that green development in developed regions has entered a benign development model. Second, it also shows that the green innovation capabilities of developed regions are strongly supported by the social environment.

The impact coefficients of green innovation in economically developing regions and economically underdeveloped regions with 1-lag were 0.013 and 0.021 respectively. They were both significant at the 1% confidence level. This shows that green innovation had a positive effect on its green development. When green innovation was used as the dependent variable, the effect of green development was not significant. This shows that in underdeveloped regions, the green development level was low. There was no strong support for green innovation, and the relationship between the two to promote each other has not yet formed.

3.3.3 Impulse Response Analysis

To further analyze the response mechanism of green innovation and green development, the impulse response trajectories of the three major economic zones were obtained through 500 Monte Carlo simulations. This can demonstrate the dynamic interactive impact of green innovation and green development. It can be found that the impulse response graphs of the three major economic zones all show a trend of convergence, indicating that the model is stable.



(a) Developed region (b) Developing region (c) Underdeveloped region

Fig.1 Pvar Model Impulse Response Diagram.

(1)The impact of green development on green innovation. In Figure 1, the response value of green innovation in economically developed region to its green development is greater than zero.

Except for the second and fourth periods, the response value of the economically developing region is also greater than zero. However, the response value of green innovation to green development in economically underdeveloped regions is around 0, and the response was not significant. The green development level of the three major economic zones on their green innovation is in the order of developing regions, developed regions, and underdeveloped regions. This is consistent with the moment estimation result. In addition, it should be noted that the response value of green innovation in the latter two regions is still relatively small, and the economically underdeveloped regions also showed negative values. This indicates that the green development of the two major economic regions has not yet formed a support mechanism for their green innovation. Therefore, green innovation needs to be further emphasized.

(2)The impact of green innovation on green development. In Figure 1, in economically developed regions, the response of green development to green innovation within the forecast period is greater than zero. It shows that its green innovation has a continuous positive impact on green development. The response value of the first phase of green development in economically developing regions is 0.5%. However, the response value of economically underdeveloped areas is around 0 The green innovation has a weak impact on green development. This shows that the transformation mechanism of its scientific research results is not perfect, and the influences of scientific and technological innovation are no significant. Therefore, it cannot significantly promote its green development. In conclusion, green innovation in economically developed regions has a strong role in promoting its green development, followed by economically developing regions, and the degree of response of economically underdeveloped regions needs to be improved.

3.3.4 Variance Decomposition

In order to further quantify the interaction between green innovation and green development, and to evaluate the degree of interaction between the two, this paper conducts variance decomposition on the basis of PVAR moment estimation and impulse response analysis. After 500 Monte Carlo simulations, the variance decomposition between green innovation and green development is shown in Table 6.

Table 6 Variance Decomposition Table.

Varibles	period	Developed region		Developing region		Underdeveloped region	
		D_gd	D_gi	D_gd	D_gi	D_gd	D_gi
D_gd	1	1	0	1	0	1	0
D_gi	1	0.044	0.956	0.012	0.988	0.001	0.999
D_gd	2	0.955	0.045	0.992	0.008	0.996	0.004
D_gi	2	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	3	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	3	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	4	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	4	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	5	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	5	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	6	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	6	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	7	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	7	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	8	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	8	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	9	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	9	0.05	0.95	0.013	0.987	0.001	0.999
D_gd	10	0.95	0.05	0.992	0.008	0.996	0.004
D_gi	10	0.05	0.95	0.013	0.987	0.001	0.999

It can be seen from Table 7, the impact of green development on green innovation was greatest in economically developed regions (7.5%), followed by economically developing regions (2.5%), and least in economically underdeveloped regions (0.2%). The impact of green innovation on green development was greatest in economically underdeveloped regions (20%), followed by economically less developed regions (7%), and least in economically developed regions (0.3%). Although there are regional differences in the mutual influence of green innovation and green development in various regions, the contribution rate of both green development and green innovation to itself exceeds 80%. Therefore, the two are still more dependent on their own development, and the degree of mutual influence needs to be further strengthened.

4. Conclusion

By constructing a PVAR model, this paper analyzes the coupling and interaction of green innovation and green development in China's provinces and regions (except Tibet) from 2004 to 2017. Since the beginning of the new century, the level of green innovation and green development has been greatly improved, and the capacity for sustainable development has been significantly enhanced. However, green innovation and green development in various regions still significantly depend on themselves, and the interaction between green innovation and green development needs to be strengthened. Green innovation in economically underdeveloped regions has a more significant effect on their green development. The promotion of green innovation by green development in economically developed regions is more significant than that in other regions. The effective interaction between green innovation and green development in different regions needs to be further improved.

Local governments must adhere to the principle of adapting measures to local conditions in policy formulation and implementation. Improving the green development level, economically developed areas should further utilize their advantages in capital, talents and industrial agglomeration. In addition, local governments should further strengthen the expansion and utilization of green innovation and increase the utilization rate of green technological innovation. The economically developing regions need to further optimize the industrial structure. The economically developing regions must support and guide green innovation activities, increase investment in education, research and development, and improve its green technology innovation. Economically underdeveloped regions must further improve the construction of infrastructure, such as transportation and communications, build a livable environment, attract high-quality talents, and promote the green development and green innovation. From the perspective of the country as a whole, it is necessary to strengthen exchanges and cooperation between regions, pay attention to the differentiation of strategies, and form a virtuous circle of coordinated promotion and mutual promotion of green development and green innovation.

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