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Analysis of Spatial Spillover Effect of Poverty Reduction Effect of Green Development in Hunan Province

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Abstract: Green poverty reduction and development are the tasks and challenges that China highly concerned. Based on the perspective of spatial spillover effect, this paper studied the spatial spillover effect of green development in Hunan Province, selected relevant indicators such as green development in various regions of Hunan Province from 2010 to 2020, used the spatial panel model to investigate whether there is a spatial spillover effect of poverty reduction effect of green development, then put forward targeted policy recommendations according to this results. The research showed that the impact of green development on poverty reduction has a spatial spillover effect, and the spatial distribution is uneven. The economic development gap, education level difference, government support imbalance and urbanization gap in adjacent areas will inhibit the effect of poverty reduction. Therefore, we should deeply explore the relationship between green development and poverty reduction, and build a reasonable assessment system for green development and poverty reduction. At the same time, the coverage and inclination of government policy support should be raised in poor areas. Paying attention to narrowing regional development differences and promoting regional coordinated development are also important.

Keywords: Green poverty reduction, spatial spillover effect, Hunan Province.

1. Introduction

Green development and poverty reduction have risen to the height of national strategies. With the rapid development of China's economy, environmental and resource problems have become increasingly prominent. The concept of "green water and green mountains are golden mountains and silver mountains" has become increasingly popular. Since the 18th National Congress of the Communist Party of China, China has elevated green development to the national strategy, established green development as one of the five development concepts, and carried out a series of sustainable and fundamental work to promote green development. In the critical period of green development, exploring the relationship between green development and poverty alleviation, and clarifying the role of green development in poverty alleviation in China are conducive to providing important reference for promoting the formulation of relevant policies in China, such as reducing poverty through green development and eliminating poverty, and effectively promoting the poverty reduction effect of green development. Studying the impact of green development mode on poverty alleviation is also of great significance for various regions to choose appropriate development mode and promote poverty alleviation.

Scholars at home and abroad rarely pay direct attention to the spatial spillovers of poverty reduction effects of green development, focusing on the spatial spillovers of poverty reduction effects such as research investment and financial expenditure. First of all, domestic and foreign scholars have confirmed that there is a relationship between research investment, financial expenditure and poverty reduction. For example, Caminada and Kees (2009) [1] studied the relationship between financial revenue and poverty reduction, and found out different types of financial revenue have inconsistent poverty reduction effects, and social expenditure has good poverty reduction effects. Chen Ming et al (2016)[2] used the three-stage DEA method to calculate the poverty reduction efficiency of agricultural science and technology in China's provinces. The calculation results show that the overall efficiency of poverty reduction in China's agricultural science and technology is not high, and there is much room for improvement in both pure technical efficiency and scale efficiency. The external environmental factors and internal management factors of agricultural science and technology investment directly affect the poverty reduction efficiency. Cai Wenbo et al. (2018) [3] focused on whether education expenditure can reduce poverty, and discussed the relationship between them from the perspective of spatial panel and nonlinear respectively. Li Shengji (2014) [4] focused on rural poverty, theoretically deduced the relationship between rural poverty and poverty reduction, and empirically analyzed the effect of fiscal expenditure on rural poverty reduction. Zhuang Tianhui (2016) [5] and others explored the spatial relationship between fiscal expenditure on supporting agriculture and farmers' income increase, and used spatial measurement methods to measure the spatial relationship between fiscal expenditure on supporting agriculture and farmers' income increase in Sichuan Province among cities and prefectures. However, most of these studies are based on homogeneity, which is inconsistent with the actual situation of provincial differences in scientific research investment and financial expenditure. Therefore, domestic and foreign scholars have studied the spatial spillover of poverty reduction effects of research investment and financial expenditure based on the assumption of spatial heterogeneity. For example, Shen Neng (2012) [6] focused on the relationship between rural research investment and poverty reduction, and discussed the spatial spillover effects of rural research investment based on the assumption of spatial heterogeneity. The research shows that the poverty reduction effect of agricultural research investment is obvious, but the difference is significant in different regions; The poverty reduction effect of agricultural scientific research investment is characterized by spatial spillover, which explains the spatial imbalance between the intensity of agricultural scientific research investment and the incidence of poverty. Deng Hongliang (2015) [7] analyzed the current situation and convergence of educational financial expenditure and poverty incidence in Jiangxi Province, and found that the intensity of educational financial expenditure and poverty incidence have obvious spatial dependence and agglomeration, and the spatial spillover effect of educational financial expenditure and poverty incidence is significant.

From the perspective of the spatial spillover effect of green development on poverty reduction, there is no literature to discuss the spatial spillover effect of green development on poverty reduction. At the same time, due to the spatial imbalance of green development in various regions, it is particularly important to study the poverty reduction effect of green development on the basis of spatial correlation.

2. Spatial Spillover Effects of Green Poverty Reduction in Hunan Province

2.1 Spatial Measurement Model Setting

China has a vast territory. There are significant regional differences in both the internal resources and environment of the region and the economic and social development, which leads to regional differences between regional green development and poverty. At the same time, as green development is a concept of systematic development, and poverty also has obvious open characteristics, the poverty reduction effect of green development also has a certain spatial dependence. Therefore, this paper analyzed the effect of green development on poverty reduction from the perspective of spatial spillover and put forward the following research assumptions:

Hypothesis 1: The poverty reduction effect of green development in Hunan Province has spatial correlation.

Hypothesis 2: The poverty reduction effect of green development in Hunan Province has a spatial spillover effect.

2.2 Spatial Auto-correlation

From the perspective of geography, spatial auto-correlation showed that things and phenomena in different regions have spatial attribute relationships of interdependence, mutual restriction, mutual influence and interaction (Wang Zhouwei, Cui Baisheng, Zhang Yuanqing, 2017) [8]. The three forms of auto-correlation are positive correlation, negative correlation and non-correlation. Positive correlation shows that there are similar attributes between adjacent regions, also known as spatial dependence; The negative correlation reflects the large difference of attributes between adjacent regions, which is also called spatial heterogeneity; Negative correlation means that the spatial effect cannot be identified, and the observation value changes randomly in space. The measurement of spatial correlation is usually tested by Moran's I index. The formula for calculating Moran's I index is as follows:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})^2} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \quad (1)$$

Where， n is the total number of regions in the study area，and w_{ij} is the spatial weight；When area i and aera j are adjacent， $w_{ij} = 1$；When area i and area j are not adjacent， $w_{ij} = 0$； x_i an x_j are attributes of region i and region j respectively； $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$ ， is the average value of the attribute； $S^2 = \frac{1}{n}\sum_i (x_i - \bar{x})^2$ ， is the variance of the attribute.

Moran's I index can be regarded as the correlation coefficient between the observed value and its lag. The space of variable x_i is the average value of x_i in domain j ， which is defined as：

$$x_{i,-1} = \sum_j w_{ij} x_{ij} / \sum_j w_{ij} \quad (2)$$

Therefore, the value of Moran's I index is generally between -1 and 1. If it is greater than 0, it indicates positive correlation. If it is close to 1, it indicates that similar attributes are clustered together; Less than 0 indicates negative correlation, and values close to - 1 indicate that different attributes are clustered together. If Moran's I index is close to 0, it means that the attributes are randomly distributed or there is no spatial auto-correlation.

3. Analysis of Test Results

3.1 Spatial Auto-correlation Test

In order to more intuitively compare and analyze the spillovers of poverty reduction effects of green development in different years, this paper used GeoDa software to calculate the Moran's I index of green development and poverty level in each region. According to the Moran's I calculation method, Table 1 gives the test results of the Moran's I distribution of green development and poverty in Hunan Province from 2010 to 2020. It can be seen from the table that the Moran's I index of the green development level of each province from 2010 to 2020 is positive, and the value is increasing, most of them have passed the significance test, and the Moran's I index of the poverty level is positive, and all of them have passed the significance test, which shows that the green development and poverty situation in each region of Hunan Province from 2010 to 2020 have a stronger spatial positive correlation in geography, which means the spatial distribution of green development and poverty in China's provinces is not independent of each other.

Table 1 Moran's I Index of Green Development and Poverty Level in Hunan Province

Year	Green development		Poverty level	
	Moran's I	Z value	Moran's I	Z value
2010	0.074	0.982	0.5	4.79
2011	0.093	1.161	0.474	4.561
2012	0.056	0.824	0.442	4.282
2013	0.048	0.754	0.566	5.345
2014	0.123	1.478	0.533	5.055
2015	0.136	1.6	0.568	5.355
2016	0.165	1.87	0.482	4.61
2017	0.146	1.7	0.527	4.97
2018	0.15	2.03	0.52	4.97
2019	0.19	2.1	0.4	3.94
2020	0.184	2.06	0.36	3.58

3.2 Estimation Results of Spatial Panel Model

Accurate model setting is the premise to ensure the authenticity and reliability of empirical results. The spatial auto-correlation test results show that dependent variables and independent variables have significant spatial auto-correlation, which means that poverty alleviation and green development have spatial dependence. Therefore, a spatial panel model is constructed. In combination with reality, this paper first considered the use of spatial Dubin model, and then verified whether the model is used correctly through testing. The commonly used inspection steps are proposed by Elhorst. It is mainly to verify whether the common panel model, SLM model, SDM model or SEM model is selected by comparing the significance of LM lag, Robust LM lag, LM error and Robust LM error.

First, determined whether to use ordinary panel model or spatial panel model through LM test and Robust LM test. The results obtained by using matlab software are shown in Table 2

Table 2 LM and Robust LM Inspection Results of Panel Data

Inspection index	T statistic	P-value
LM lag	2.4473	0.100
Robust LM lag	13.21	0.000
LM error	0.0038	0.930
Robust LM error	10.65	0.001

It can be seen from Table 2 that the statistics of LM lag, Robust LM lag, LM error and Robust LM error t are 2.4473, 13.21, 0.0038 and 10.65 respectively, and the P values are 0.110, 0.000, 0.930 and 0.001 respectively, which means Robust LM is significant at the significance level of 1%, and has passed the SLM model and SEM model at the same time. This paper further judges whether SDM model should be selected through Wald test, and the test results are shown in Table 3.

Table 3 Wald Test Results of Spatial Panel Data

Wald Test	Wald Statistic	P-value
Wald spatial lag	52.959	0.000
Wald spatial lag	58.020	0.000

Table 3 shows that the Wald statistic of Wald spatial lag and Wald spatial error is 52.959 and 58.020, the P value is 0, that is, the Wald test of SLM and SEM is significant at the 1% significant level, so the spatial Dubin model is the most appropriate choice. The spatial Dubin model has the advantages that other models do not have: (1) It can distinguish between direct effects and indirect effects. Direct effect refers to the impact of green development on poverty reduction in the region, while indirect effect refers to the impact of green development in surrounding regions on poverty reduction in the region. (2) The total spatial effects of different orders are analyzed. (3) Estimate reasonable model parameters. The introduction of spatial lag term in the model can avoid the endogenous problems in traditional econometric models and obtain more scientific models. In general, the spatial Dubin model is used in the empirical analysis. At the same time, in order to compare SLM, SEM and SDM to determine the optimal model, this paper estimated the three models respectively. Finally, this paper selected the spatial panel Dubin model with fixed time and space as the main analysis model.

3.3 Decomposition of Spatial Spillover Effect

Table 4 Decomposition of direct effect and spillover effect of spatial Dubin model

Target layer	System layer	Indicator layer	Direct effect		Indirect effect		Total effect	
			Coefficient	T-value	Coefficient	T-value	Coefficient	T-value
Green poverty reduction indicator system	Green development indicators（G）	Park green area per capita	0.0084	1.693	0.0031	0.337	0.0011	1.0015
		Greening coverage rate of built-up area	0.0054	5.585	0.0016	0.083	0.052	2.06
		Sewage treatment rate	0.018	2.8	0.057	3.92	0.077	4.8
		Density of drainage pipe	-0.0448	-1.42	0.0121	1.162	0.0072	0.576
	Agricultural development indicators（A）	Crop sown area	0.07	0.483	0.148	0.466	0.076	0.215
		Total output value of agriculture, forestry, animal	0.012	1.62	0.062	2.643	0.065	3.2

	husbandry and fishery						
	grain yield	0.013	0.262	0.226	1.736	0.209	1.414
	Aquatic product output	0.018	1.82	0.072	2.843	0.085	3.31

The above analysis shows that the impact of green development on poverty reduction has a spatial spillover effect. To further analyze the spatial impact of green development on poverty reduction, the spatial effect of the spatial Dubin model is decomposed to obtain the direct and indirect impacts of various variables to describe the spatial interaction. The direct effect is the local effect, indicating the impact of local green development on local poverty reduction, and the indirect effect is the spillover effect, indicating the impact of local green development on poverty reduction in adjacent areas. As shown in Table 5, the direct and indirect effect coefficients of green development are 0.0084 and 0.0031 respectively, and the variables are significant at the level of 1%, indicating that the impact of green development on poverty reduction is characterized by the coexistence of local effects and spillover effects. While the direct effect coefficient of green coverage in built-up areas is 0.054, and the indirect effect coefficient is 0.0016. The two coefficients have passed the significance test at the same time, indicating that every 1% increase in green coverage in built-up areas can reduce the poverty level of the region by 0.54%, and also make the green development level of adjacent areas increase by 0.16%. As the local green development can help solve the poverty in this region to a certain extent. However, the economic development of some regions may be at the expense of the development of neighboring regions, resulting in the "beggar thy neighbor" effect.

4. Conclusion

This paper analyzed the effect of green development on poverty reduction in Hunan Province in the sight of spatial spillover. From the perspective of spatial spillover, the impact of green development on poverty reduction has a spatial spillover effect, and the spatial distribution is uneven. The economic development gap, education level difference, policy support imbalance and urbanization gap in adjacent regions will inhibit the effect of poverty reduction. Combining the main conclusions of theoretical derivation, status analysis and empirical results, this paper proposed the following policy implications:

First, we should deeply explore the internal relationship between green development and poverty reduction, and build a green development and poverty reduction assessment system suitable for China's national conditions. At present, China's development has entered a new stage in which we should not only comprehensively promote green development but also continuously tackle poverty alleviation. Both the academia and the government should consider green development and poverty reduction based on traditional economic theories and more from the perspective of the characteristics of the national development stage. In the new development situation, the academic community can pay more attention to the research on the relationship between regional green development and poverty, such as multi-dimensional consideration of rural poverty level from the perspective of livelihood capital, and exploration of green poverty reduction path, to adapt to the complex analysis framework and decision-making mode at this stage, and provide theoretical basis for the practical departments to issue relevant poverty reduction policies. Relevant departments should strengthen practice, specifically implement the policy of green development, improve the poverty reduction evaluation system, improve the effect of green poverty reduction, and provide a long-term driving force for poverty reduction.

Second, we should increase the coverage and preference of government policy support in poor areas. In the process of promoting regional green development, we should actively promote the reform of rural systems, optimize the structure of financial support for agriculture, especially improve the level of financial support for agriculture in poor areas, further improve infrastructure construction, and strengthen education investment, so as to further strengthen the promotion effect of financial support for agriculture on poverty reduction. At the same time, through further improving the income distribution policy and the education poverty alleviation policy, we will reduce the income gap between urban and rural areas and regions and improve the income level of farmers.

Third, attaching importance to narrowing regional development differences and promoting regional coordinated development. The negative external effects brought by the imbalance of regional green development and the spatial differentiation of poverty reduction effects are difficult to eliminate in a short period of time. The practice department should strengthen the construction of institutional mechanisms, market environment, civilization and other aspects while increasing the efforts to promote green development and poverty reduction policies, so as to ensure the reduction of regional development differences.

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