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Empirical Research on the Relationship between Education Poverty Alleviation and Rural Revitalization

—Spatial Panel Simultaneous Equation Model Based on Provincial Panel Data

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Abstract

On the basis of using entropy weight method to measure China's education poverty alleviation and rural revitalization evaluation indicators, using the panel data of 30 provinces in China (excluding Xizang, Hong Kong, Macao and Taiwan) from 2012 to 2021, a spatial panel simultaneous equation model is constructed based on adjacency matrix, geographical distance matrix and economic geographical distance matrix deeply study the interaction mechanism and spatial spillover effects between education poverty alleviation and rural revitalization through the generalized spatial three-stage least squares method (*GS3SLS*). The results indicate that there is a significant spatial spillover effect and a positive spatial correlation between education poverty alleviation and rural revitalization, and there is a significant interactive effect between the two variables, while promoting each other positively. Therefore, the government should clarify the deep relationship between education poverty alleviation and rural revitalization based on the current background, and better consolidate and expand the effective connection between the achievements of education poverty alleviation and rural revitalization.

Keywords

Education Poverty Alleviation, Rural Revitalization, Entropy Weight Method, Space Panel Simultaneous Equation Model, *GS3SLS*

1. Introduction

The two major policies of education poverty alleviation and rural revitalization,

one before and one after, interact with each other. Winning the battle against poverty is a short-term goal and an inherent requirement for building a moderately prosperous society in all respects. Implementing the rural revitalization strategy is a long-term goal and the overall lever for achieving agricultural and rural modernization. The two complement each other. Pennia (2020) [1] analyzed panel data from the five northwestern provinces using a dual logarithmic multiple linear regression model and found that education funding significantly promotes the growth of farmers' income in the five northwestern provinces. She believes that a long-term education funding investment mechanism targeting ethnic minority areas after 2020 should be established. Yan Zhonglian *et al.* (2021) [2] conducted an empirical study using a dynamic simultaneous equation system model and found that education poverty alleviation has a cumulative effect. The level of local economic development and education level promotes the positive development of local education poverty alleviation, while the level of regional urbanization has an inhibitory effect on education poverty alleviation. Dai Yan *et al.* (2021) [3] used a coupling coordination model and a multiple linear regression model to study the education poverty alleviation and rural revitalization in the eight ethnic provinces of China. They found that there is an interactive effect between the education poverty alleviation and rural revitalization systems in ethnic regions of China, and the education poverty alleviation cause significantly promotes rural revitalization in a time lag manner. In the context of rural revitalization, Liu Weiwen (2022) [4] conducted empirical research and found that the overall low level of education and insufficient human capital of the population in western agricultural and pastoral areas are important factors leading to lower income levels. Guo Wenqiang *et al.* (2022) [5] used entropy weight method and coupling coordination model to analyze the evaluation indicators of education poverty alleviation and rural revitalization in Xinjiang. The study found that the development level of education poverty alleviation and rural revitalization is increasing year by year, and empirical research shows that there is a significant interaction between the two systems. In order to scientifically evaluate the implementation effect of education poverty alleviation and rural revitalization policies, Ahai Quluo (2018) [6], Jia Jin (2018) [7], Xing Huibin (2019) [8], Mao Jinhuang (2020) [9] and others measured the education poverty alleviation indicators and rural revitalization indicators through methods such as entropy weight method and Analytic Hierarchy Process.

At present, most scholars at home and abroad focus on theoretical research, and there is little empirical research literature on the relationship between education poverty alleviation and rural revitalization. Moreover, the current empirical research on the relationship between education poverty alleviation and rural revitalization mostly adopts the coupling coordination model, does not consider the influence of spatial effects, and does not conduct sub-regional studies on the sample data. Therefore, this paper will integrate education poverty alleviation and rural revitalization into the same research framework, use the panel data of 30 provinces in China from 2012 to 2021 to construct a spatial panel simultane-

ous equation model, and discuss the interendogenous relationship and spatial spillover effect between education poverty alleviation and rural revitalization through theoretical analysis and empirical research. The results show that from the whole regional sample, there is a significant spatial spillover effect and positive spatial correlation between education poverty alleviation and rural revitalization, and there is a significant interaction effect between the two variables, and at the same time promote each other. From the perspective of sub-regional samples, the education poverty alleviation and rural revitalization in the eastern, central and western regions and the whole regional samples are consistent, and they significantly pull each other positively. Compared with the eastern and central regions, the spatial spillover effect in the western region is more obvious, and there is obvious regional heterogeneity.

2. Data Description

2.1. Data Sources

This paper selects the data of 30 provinces in China from 2012 to 2021 (based on data availability, except Xizang) as sample observations. The data mainly comes from the "China Rural Statistical Yearbook", "China Statistical Yearbook", "China Social Statistical Yearbook", "China Education Statistical Yearbook", national data, and EPS database. The missing data is supplemented with Excel and linear interpolation method.

2.2. Calculation of Indicators for Education Poverty Alleviation and Rural Revitalization

By referring to a large number of literatures and combining the principles of data availability and scientificity, this paper uses the data of 30 provinces in China (except Xizang) from 2012 to 2021 to build an evaluation system for indicators of poverty alleviation through education and rural revitalization, and the attribute of each indicator and the weight value of each secondary indicator determined by the entropy weight method are shown in Table 1.

2.3. Variable Selection

The core explanatory variables are education poverty alleviation (*Epa*) and rural revitalization (*Rr*). To reduce the impact of subjective factors, education poverty alleviation and rural revitalization were calculated using the entropy weight method, as detailed in Table 1.

The controlling variables in the education poverty alleviation equation include education input (*Lfee*), education level (*Edl*), urbanization level (*Ur*), and local economic development level (*LnPgdp*). Among them, education poverty alleviation is expressed by the proportion of local financial education expenditure and local financial general budget expenditure; the average number of years of education = (population aged 6 and above who have not attended school * 1 + primary school population aged 6 and above * junior high school population aged 6

Table 1. Evaluation system of education poverty alleviation and rural revitalization indicators.

System	Primary Indicators	Secondary Indicators	Unit	Indicator Attribute	Weight Value
Education Poverty Alleviation System	Educational Expenditure	Educational Expenditure Per Student in Rural Kindergartens	thousand yuan	+	10.62%
		Average education expenditure for rural primary school students	thousand yuan	+	9.93%
		Average education expenditure for rural junior high school students	thousand yuan	+	6.47%
		Average education expenditure for rural high school students	thousand yuan	+	7.21%
	A Sound Education System	Number of Rural Kindergartens	place	+	7.24%
		Number of Rural Primary Schools	place	+	7.47%
		Number of Rural Junior High Schools	place	+	7.14%
		Number of Rural High Schools	place	+	5.09%
	Construction of Teacher Team	Primary School Student Teacher Ratio (number of teachers = 1)	/	−	1.57%
		Junior High School Student Teacher Ratio (number of teachers = 1)	/	−	0.06%
		Teacher to Teacher Ratio for Regular High School Students (number of teachers = 1)	/	−	2.28%
		Student Teacher Ratio in Secondary Vocational Schools (number of teachers = 1)	/	−	1.49%
		Student Teacher Ratio in Ordinary Universities (number of teachers = 1)	/	−	0.64%
	Human Capital Development	Average Number of Students Enrolled in Preschool Education Per 100,000 Population	Person	+	2.48%
		Average Number of Primary School Students Per 100,000 Population	Person	+	3.00%
		Average Number of Students Enrolled in Secondary Education Per 100,000 Population	Person	+	2.05%
		Average Number of Students Enrolled in High School Education Per 100,000 Population	Person	+	1.76%
		Average Number of Students Enrolled in Higher Education Institutions Per 100,000 Population	Person	+	2.32%
	Educational Poverty Alleviation Benefits	Per Capita Disposable Income of Rural Residents	yuan	+	3.84%
		Gross Domestic Product of Agriculture, Forestry, Animal Husbandry, and Fisheries	Billion	+	5.62%
		Consumption Level of Rural Residents	yuan	+	4.98%
		Income from Educational Expenses and Undertakings	Ten thousand yuan	+	6.72%

Continued

Rural Revitalization System	Industrial Prosperity	Total Power of Agricultural Machinery	Million Kilowatts	+	8.79%
		Yield Per Unit Area of Autumn Grain Crops	Kg/Ha	+	4.11%
		Gross Domestic Product of Agriculture, Forestry, Animal Husbandry, and Fisheries	Billion	+	7.28%
		Added Value of Agriculture, Forestry, Animal Husbandry, and Fshery	Billion	+	7.12%
	Ecological Livability	Popularity Rate of Sanitary Toilets	%	+	1.99%
		The Intensity of Fertilizer Use in Agricultural Production	Kg/Ha	−	1.35%
		Popularity Rate of Village Water Supply	%	+	2.46%
		The Proportion of Road Area within the Willage	%	+	4.59%
	Rural Civilization	The Average Number of Adoptions at the End of the Year in Rural Poverty Alleviation and Support Institutions	Person/Number	−	3.71%
		The average number of times rural residents watch art groups perform in the countryside per person	order	+	12.95%
		Proportion of per capita consumption expenditure on education, culture, and entertainment among rural residents	%	+	2.75%
		Proportion of full-time teachers in rural areas	%	+	0.59%
	Effective Governance	Average minimum living security standard for rural residents	Yuan/person	+	7.28%
		The proportion of hardened road surfaces in administrative villages	%	+	0.66%
		Proportion of Party Members in Village Committees	%	+	3.11%
		Ratio of Party Branch Secretary and Village Committee Director	%	+	7.61%
		Comparison of income levels between urban and rural residents (rural residents = 1)	/	−	1.35%
	Live in Affluence	Retail sales of consumer goods in rural areas	Billion	+	13.06%
		Proportion of per capita expenditure on food, tobacco, and alcohol among rural residents	%	+	3.95%
		Average number of household cars owned by rural residents at the end of the year per hundred households	Vehicle	+	5.29%

and above * population of junior high school aged 6 and above * population of 9 + high school population aged 6 and over 6 years old * population of high school aged 6 and above * population of 12 + population aged 6 and above of college and above * 16)/total population sampled; The level of urbanization is expressed by the ratio of the number of permanent urban residents at the end of the year to

the total permanent population of the region. The level of local economic development is expressed logarithmicly by per capita GDP. Pennia [1] showed that education investment has achieved remarkable results in education poverty alleviation, and Yan Zhonglian [2] concluded through empirical research that education level and local economic development level promote the process of education poverty alleviation, and urbanization level inhibits education poverty alleviation development.

The controlling variables in the rural revitalization equation include wage level (*LnWl*), human capital (*Hc*), cultural construction (*Pclh*), and the total fixed asset investment of rural households (*LnGd*). The wage level is a logarithmic treatment of the average wages of employees in private units in agriculture, forestry, animal husbandry and fishery towns; Human capital is the ratio of the number of self-employed people in rural areas to the number of rural population; The per capita possession of public library collections is expressed by the per capita public library holdings of the region; The total fixed asset investment of rural farmers is expressed by the logarithmic total fixed asset investment of rural farmers in the region. Qu Yanchun *et al.* [10] believe that the rural revitalization strategy should further promote the structural reform of agricultural supply side and increase farmers' wage income. Zhao Dandan *et al.* [11] based on dynamic panel data of 31 provinces in China prove that human capital has a promoting effect on rural revitalization. Rural style civilization occupies a core position in the rural revitalization strategy, cultural construction is an important measure to improve spiritual civilization, rural farmers' fixed asset investment is of great significance to rural economic development, therefore, it is of great significance to study the effect of per capita library collection and rural farmers' fixed asset investment on rural revitalization. The clear definition and calculation method of variables are shown in **Table 2**, and the descriptive statistics of variables are shown in **Table 3**. It can be seen from **Table 3** that the mean value of rural revitalization is 0.28304, the standard deviation is 0.08216, the maximum value is 0.53631, the minimum value is 0.12879, and there is a certain distance between the maximum value and the minimum value, indicating that there are regional differences in rural revitalization in various provinces in China. The mean value of education poverty alleviation was 0.23888, the standard deviation was 0.06542, the maximum value was 0.44659, and the minimum value was 0.10192.

2.4. Stability Inspection

To avoid false regression or correlation, and to make the research results more effective and reliable, panel data stationarity tests were conducted on all variables in the article. According to the method of unit root test for panel data given by Chen Qiang [12], this article uses four methods, LLC, IPS, ADF-Fisher, and Breitung, to conduct panel unit root tests. The test results are shown in **Table 4**, and it is believed that the variables in this article are stationary, which can further establish a spatial panel simultaneous equation model for analysis.

Table 2. Variable definition and calculation method.

Variable	Variable Name	Variable Symbol	Processing Method
Core Explanatory Variables	Education Poverty Alleviation	*Epa*	The entropy weight method can be used to calculate
	Rural Revitalization	*Rr*	The entropy weight method can be used to calculate
Control Variable	Educational Investment	*Lfee*	Education Expenditure of Local Finance/General Budget Expenditure of Local Finance
	Salary Level	*LnWl*	The Logarithm of the Average Salary of Urban Private Sector Employees in Agriculture, Forestry, Animal Husbandry, and Fisheries
	Urbanization Level	*Ur*	Number of Urban Permanent Residents at the end of the Year in the Region/Total Number of Permanent Residents in the Region
	Education Level	*Edl*	Average Years of Education of the Sampled Population in the Region
	Human Capital	*Hc*	Number of Rural Self-employed Personnel/Rural Population
	Local Economic Development Level	*LnPgdp*	Log of per capita Gross Domestic Product
	Per Capita Library Holdings	*Pclh*	Per Capita Possession of Public Library Collections in the Region
	Total Fixed Assets Investment of Rural Households	*LnGd*	Log of the Total Fixed Assets Investment of Rural Households in the Region

Table 3. Descriptive statistics for variables.

Variable Name	Variable Symbol	Mean Value	Standard Deviation	Minimum Value	Maximum Value	Observations
Rural Revitalization	*Rr*	0.28304	0.08216	0.12879	0.53631	300
Education Poverty Alleviation	*Epa*	0.23888	0.06542	0.10192	0.44659	300
Educational Investment	*Lfee*	0.16360	0.02656	0.09895	0.22217	300
Human Capital	*Hc*	0.08371	0.06370	0.00737	0.36421	300
Wage Level	*LnWl*	10.34813	0.28855	9.63991	11.16287	300
Urbanization Level	*Ur*	0.60232	0.11814	0.36298	0.89583	300
Education Level	*Edl*	9.36937	0.89004	7.68000	12.82000	300
Local Economic Development Level	*LnPgdp*	10.87100	0.43504	9.84940	12.14167	300
Per Capita Library Holdings	*Pclh*	0.75307	0.53679	0.24000	3.32000	300
Total Fixed Assets Investment of Rural Households	*LnGd*	5.40045	1.14519	1.09192	6.90132	300

Table 4. Panel unit root test.

Variable Symbol	Statistic				Inspection Results
	LLC	*IPS*	*ADF-Fisher*	*Breitung*	
Rr	−10.8125***	−2.5347***	145.4044***	−0.8183	Stable
Epa	−11.8084***	3.2097	128.6291***	6.0757	Stable
Lfee	−11.8255***	−4.2414***	154.6152***	−2.1690**	Stable
LnWl	−3.9794***	−0.9381	170.8831***	1.6529	Stable
Ur	−5.5142***	−0.4108	142.2440***	1.4532	Stable
Edl	−9.1632***	−4.6862***	194.5160***	−2.3760***	Stable
Hc	−9.5367***	−5.5111**	105.7017***	−3.6828***	Stable
LnPgdp	−6.8425***	0.5294	165.2573***	2.4876	Stable
Pclh	−2.2025**	−2.5015***	126.4438***	1.3265	Stable
LnGd	−11.1234***	−5.2955***	74.8609*	−1.9666**	Stable

Note: ***, **, and * respectively indicate significance at the 1%, 5%, and 10% significance levels, the same below.

3. Construction and Estimation of 2-Space Weight Matrix and Model

3.1. Construction of Spatial Weight Matrix

The purpose of this study is to explore the interactive effect between education poverty alleviation and rural revitalization. In order to make the research results more robust and reliable, three different spatial weight matrices are constructed to achieve the research purpose. The first type is the adjacency space weight matrix (W_1). Based on the adjacency concept of spatial weight matrix, this article selects the queen adjacency weight matrix. If two adjacent provinces *i* and *j* have a common edge or vertex, it is adjacency, with a value of 1, otherwise it is 0. The second type is the geographic distance spatial weight matrix (W_2). Using the reciprocal form of distance $W_2 = 1/d_{ij}$, d_{ij} is calculated from the longitude and latitude of provinces *i* and *j*. The third type is the Economic Geographic Distance Weight Matrix (W_3). The reciprocal of the absolute value of the difference between the GDP of two provinces in 2019 during the sample period and the product of the geographical distance spatial weight matrix W_2 are used.

3.2. Spatial Correlation Test between Education Poverty Alleviation and Rural Revitalization

Using the adjacency space weight matrix, the education poverty alleviation and rural revitalization in 30 provinces of China from 2012 to 2021 were calculated using Moran index statistics, as shown in Table 5. The results show that the global Moran index of rural revitalization (*Rr*) is greater than 0, and all of them pass the spatial correlation test at a significance level of at least 5%, indicating

Table 5. Results of the Moran' *I* index statistic test for *Rr* and *Epa*.

Year	*Rr*		*Epa*	
	Moran's *I*	*z* Value	Moran's *I*	*z* Value
2012	0.156***	2.295	0.054	1.280
2013	0.144***	2.645	0.069*	1.504
2014	0.102**	2.029	0.062*	1.410
2015	0.106**	2.096	0.084**	1.731
2016	0.125**	2.341	0.109**	2.076
2017	0.120**	2.248	0.101**	1.956
2018	0.143***	2.549	0.113**	2.126
2019	0.159***	2.772	0.124**	2.275
2020	0.148***	2.261	0.096**	1.878
2021	0.147***	2.607	0.000	0.497
2012-2021	0.300***	11.473	0.296***	11.295

that there is a significant positive spatial correlation in rural revitalization; Except for the global Moran index of education poverty alleviation (*Epa*) in 2021, which is equal to 0 and there is no spatial autocorrelation, the global Moran index of all other years is greater than 0, basically passing the 10% significance level test, indicating that there is also a positive spatial autocorrelation in education poverty alleviation.

3.3. Setting and Estimation of Spatial Panel Simultaneous Equation Models

Introducing spatial effects into the simultaneous equation system, while considering the interactive impact between education poverty alleviation and rural revitalization, a spatial panel simultaneous equation model is established to model the interactive effect, spatial spillover effect, and mechanism between the two. The expression is as follows:

$$\begin{cases} Epa_{it} = \alpha_0 + \alpha_1 W_{ij} Epa_{it} + \alpha_2 Rr_{it} + \alpha_3 W_{ij} Rr_{it} + \sum_{k=1}^{k_1} \alpha_k A_{k,it} + \varepsilon_{it} & (1) \\ Rr_{it} = \beta_0 + \beta_1 W_{ij} Rr_{it} + \beta_2 Epa_{it} + \beta_3 W_{ij} Epa_{it} + \sum_{k=1}^{k_2} \beta_k B_{k,it} + \tau_{it} & (2) \end{cases}$$

Equation (1) is the education poverty alleviation equation, Equation (2) is the rural revitalization equation, where *i* and *t* represent the region and year, Epa_{it} represents the education poverty alleviation in the *t*-th year of region *i*, Rr_{it} represents the rural revitalization in the *t*-th year of region *i*, and *e* and *t* are random perturbation terms. $A_{k,it}$ is the control variable group that affects education poverty alleviation, and $B_{k,it}$ is the control variable group that affects rural revitalization.

3.4. Empirical Results and Analysis

In order to conduct in-depth research on the interactive relationship and spatial spillover effects between education poverty alleviation and rural revitalization, this article adopts three different spatial weight matrices and estimates the spatial panel simultaneous equation model using the generalized spatial three-stage least squares method proposed by Kelejian and Prucha (2004) [13]. The detailed results are shown in Table 6. It can be seen that the rural revitalization equation

Table 6. Space panel simultaneous equation model estimation results.

Variable	W_1		W_2		W_3	
	Rr	*Epa*	*Rr*	*Epa*	*Rr*	*Epa*
Rr		0.61524***		0.31655***		0.25692***
		(0.04637)		(0.05168)		(0.06147)
W · Rr	0.09739***	0.11531***	32.18975***	32.36254***	0.50530***	0.61754***
	(0.01105)	(0.02373)	(6.61773)	(9.25901）	(0.09654)	(0.09033)
Epa	0.63354***		0.25567***		0.20731***	
	(0.08438)		(0.09451)		(0.08875)	
W · Epa	−0.11124***	−0.13477***	−29.68343***	−36.14663***	0.03519	−0.37750***
	(0.01326)	(0.02373)	(8.27852)	(11.12129)	(0.10499)	(0.09466)
Hc	0.14187***		0.18887***		0.12090***	
	(0.04090)		(0.04761）		(0.04438)	
LnGd	0.02350***		0.03867***		0.03201***	
	(0.00462)		(0.00521)		(0.00450)	
Pclh	0.03369***		0.04554***		0.03000***	
	(0.00884)		(0.00851)		(0.00821)	
LnWl	0.03708***		0.05981***		0.04198***	
	(0.01021)		(0.01154)		(0.01198)	
LnPgdp		0.04443***		0.09952***		0.07868***
		(0.01357)		(0.01522)		(0.01476)
Ur		−0.21878***		−0.40111***		−0.31095***
		(0.05393)		(0.05742)		(0.05485)
Lfee		0.29566***		0.44422***		0.42824***
		(0.09136)		(0.10265)		(0.09439)
Edl		0.01099***		0.00641		−0.00340
		(0.12014)		(0.00499)		(0.00505)
_cons	−0.42976***	−0.44642***	−0.72289***	−0.84174***	−0.55173***	−0.61948***
	(0.10624)	(0.12014)	(0.12174)	(0.12954)	(0.11852)	(0.12889)
R^2	0.9944	0.9794	0.9937	0.9661	0.9810	0.9798

and education poverty alleviation equation are all greater than 0.95 under three different weight matrices. At the same time, the estimated values of the coefficients of the variables have hardly changed, proving that the equation fits well and the empirical results of the model are relatively robust and reliable. Next, a detailed discussion will be conducted based on the economic geographical distance weight matrix.

The equation for rural revitalization in Table 6 shows that the estimated coefficient of the spatial lag term for rural revitalization ($W \cdot Rr$) is 0.5053, which is significant at the 1% level, indicating that there is a significant spatial spillover effect in rural revitalization, that is, the implementation effect of rural revitalization will be positively driven by neighboring areas with good economic performance. The estimated coefficient of poverty alleviation through education (*Epa*) is 0.20731, which positively promotes rural revitalization at a significance level of 1%. Compared with the lagged term of education poverty alleviation in the adjacency matrix and geographic matrix, the lagged term of education poverty alleviation has a significant promoting effect on rural revitalization and has a less significant inhibitory effect. The estimated coefficient of human capital (*Hc*) is 0.1209, which significantly promotes the positive development of rural revitalization policies at the 1% level. The estimated coefficient of the total fixed assets investment of rural households (*LnGd*) is 0.03201, which promotes rural revitalization at the significance level of 1%, meaning that increasing the total fixed asset of rural households will play a good role in promoting rural revitalization. The per capita possession of public library collections (*Pclh*) is estimated to significantly promote rural revitalization and development at the 1% level with a coefficient of 0.03. The estimated coefficient of wage level (*LnWl*) is 0.04198, which significantly promotes rural revitalization at a level of 1%. It can be seen that an increase in the average wage level of urban private sector employees in agriculture, forestry, animal husbandry, and fisheries can improve people's livelihoods and promote rural economic development.

The equation for poverty alleviation through education in Table 6 shows that the estimated coefficient of rural revitalization is 0.25692, which is significant at the 1% level, indicating that the implementation of rural revitalization strategy also has a positive impact on education poverty alleviation policies. The estimated coefficient of the spatial lag term in rural revitalization is 0.61754, which improves the effectiveness of education poverty alleviation at a significance level of 1%. The spatial lag of education poverty alleviation significantly inhibits the implementation of education poverty alleviation at a level of 1%, possibly because surrounding economically underdeveloped cities will reduce the support for education poverty alleviation in economically prosperous areas. The coefficient sign of the local economic development level (*LnPgdp*) is positive, and the estimated coefficient of 0.07868 significantly promotes education poverty alleviation. The level of urbanization (*Ur*) has a negative impact on education poverty alleviation at a level of 1%. The regression coefficient of education investment (*Lfee*) is 0.42824, which promotes the effectiveness of education poverty allevia-

tion at a significance level of 1%. This means that increasing the proportion of local financial education expenditure in local general budget expenditure will have a significant positive promoting effect on education and poverty alleviation. The impact of education level (*Edl*) on education poverty alleviation is not significant, but in the context of adjacency spatial weight matrix, education level has a positive promoting effect on education poverty alleviation at a significance level of 1%.

Table 7. Robustness test results.

Variables	*3SLS*		*GS2SLS*		*GS3SLS*	
	Rr	*Epa*	*Rr*	*Epa*	*Rr*	*Epa*
Rr		0.42861***		0.36881***		0.25692***
		(0.06373)		(0.04213)		(0.06147)
W · Rr			0.54024***		0.50530***	0.61754***
			(0.07071)		(0.09654)	(0.09033)
Epa	0.50103***		0.31518***		0.20731***	
	(0.11905)		(0.06177)		(0.08875)	
W · Epa				0.24418**	0.03519	−0.37750***
				(0.10365)	(0.10499)	(0.09466)
Hc	0.18178***		0.13708***		0.12090***	
	(0.04274)		(0.04331)		(0.04438)	
LnGd	0.03067***		0.02639***		0.03201***	
	(0.00624)		(0.00386)		(0.00450)	
Pclh	0.04578***		0.02097***		0.03000***	
	(0.01041)		(0.00781)		(0.00821)	
LnWl	0.06923***		0.03059***		0.04198***	
	(0.01398)		(0.01064)		(0.01198)	
LnPgdp		0.08702***		0.07229***		0.07868***
		(0.01605)		(0.01656)		(0.01476)
Ur		−0.34318***		−0.37291***		−0.31095***
		(0.05753)		(0.05909)		(0.05485)
Lfee		0.49771***		0.46360***		0.42824***
		(0.10057)		(0.10008)		(0.09439)
Edl		0.01298***		0.01509***		−0.00340
		(0.00436)		(0.00507)		(0.00505)
_cons	−0.76834***	−0.82473***	−0.42523***	−0.70117***	−0.55173***	−0.61948***
	(0.14714)	(0.14628)	(0.10554)	(0.14029)	(0.11852)	(0.12889)
R^2	0.6784	0.6689	0.9816	0.9755	0.9810	0.9798

4. Robustness Test

According to Table 6, the empirical analysis results obtained through different spatial weight matrices in this article are already relatively robust. Next, three different estimation methods, 3*SLS*, *GS*2*SLS*, and *GS*3*SLS*, will be used to retest the robustness of the model. Among them, *GS*2*SLS* and *GS*3*SLS* both use economic geographical distance spatial weight matrices, and the detailed results are shown in Table 7.

Using the three-stage least squares method (3*SLS*) to test the panel simultaneous equation model of education poverty alleviation and rural revitalization without adding space, the R^2 of the rural revitalization equation and education poverty alleviation equation are 0.6784 and 0.6689, respectively; The R^2 obtained by testing the two using the generalized space three stage least squares (*GS*2*SLS*) method is 0.9816 and 0.9755, respectively; The empirical results obtained using the generalized space three stage least squares (*GS*3*SLS*) method show that the R^2 of both are 0.9810 and 0.9798, respectively; Compared to the first two methods, the goodness of fit of the generalized space three stage least squares method is relatively higher. From the table, it can be seen that the coefficient symbols and significance of the estimation results of the three methods have mostly not changed. Therefore, it is believed that the estimation results of the spatial panel simultaneous equation model constructed in this paper using the *GS*3*SLS* method are robust.

5. Conclusions and Enlightenment

This article uses panel data from 30 provinces in China from 2012 to 2021 to construct a spatial panel simultaneous equation model under three different spatial weight matrices, exploring the interaction effect and spatial spillover effect between the two endogenous variables of education poverty alleviation and rural revitalization. Empirical research has found that there is a significant endogeneity relationship between education poverty alleviation and rural revitalization. After considering three different spatial weights, education poverty alleviation and rural revitalization promote each other at a significance level of 1%. The spatial lag term of education poverty alleviation significantly inhibits the development of education poverty alleviation and rural revitalization, while the spatial lag term of rural revitalization positively promotes the development of education poverty alleviation and rural revitalization to varying degrees.

Based on the above conclusions and combined with the current development of education poverty alleviation policies and rural revitalization strategies in China, the following inspirations are drawn:

Firstly, promote coordinated regional development and narrow regional disparities. Spatial positive autocorrelation and positive spatial spillover effects can effectively promote the benefits of education poverty alleviation and rural revitalization among provinces, thereby improving the endogenous poverty alleviation ability of the impoverished population and revitalizing rural economy, industry,

culture, ecology, etc. Each region should tailor its policies to local conditions, taking into account its economic and regional conditions, and formulate and introduce policies that are more in line with its own region. It should learn from the excellent methods and methods of other regions to contribute to preventing the return of impoverished individuals in the region after poverty alleviation. At the same time, it should lay a solid foundation for the effective connection between poverty alleviation and rural revitalization.

Secondly, continue to improve the education system and establish a sound education assistance system. In the fight against poverty, priority should be given to poverty alleviation through education. The poverty alleviation method has changed from the past "blood transfusion" to the current "hematopoietic". At this stage, the rural preschool education system should continue to be improved, and public kindergartens should be vigorously developed to enable eligible children from impoverished families to receive preschool education nearby; strengthen vocational education for rural populations, thereby enhancing their vocational skills, expanding employment opportunities, and enhancing their ability to overcome economic poverty. The investment in education funds plays a crucial role in the effective implementation of education poverty alleviation policies. Priority should be given to increasing the investment in education funds in poverty-stricken areas, optimizing and improving education and teaching conditions, and narrowing the gap in education levels between urban and rural areas.

Thirdly, increase the reserve of rural human capital. The government reserves a group of outstanding backbone through talent introduction or education and training, develops suitable rural industries through independent innovation and learning exchange, improves the economic level of rural areas, and achieves the goal of revitalizing rural areas, providing more innovative ways and methods to solve the "three rural" problems.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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