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Measurement of County Relative Poverty, Spatial and Temporal Evolution and Risk Evaluation of Return to Poverty in Shaanxi Province Under the Perspective of Rural Revitalization

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Abstract

Against the background of rural revitalization, this study makes an in-depth analysis of the measure, evolution and the risk of returning to poverty in the counties of counties in Shaanxi Province. By combining quantitative and qualitative methods, a multi-dimensional evaluation index system of relative poverty was constructed, and spatial autocorrelation model and geographical weighted regression model were used to analyze the measurement and spatiotemporal evolution of relative poverty in 78 counties (cities) in Shaanxi Province between 2014 and 2023. Furthermore, this study identified key influencing factors for the risk of returning to poverty and proposed targeted anti-poverty strategies. The results of this study show that the county relative poverty in Shaanxi province showed significant spatial agglomeration characteristics and obvious regional differences. Meanwhile, this study also found that factors such as education level, health conditions and industrial development had an important influence on the risk of returning to poverty. Based on this, this research puts forward policy suggestions such as strengthening education and medical investment and promoting industrial diversification development, in order to provide scientific basis and decision support for realizing the strategic goal of rural revitalization in Shaanxi Province.

Keywords: rural revitalization, relative poverty, time and space evolution, risk of returning to poverty, Shaanxi Province

1. Introduction

With the acceleration of globalization and the rapid development of society and economy, poverty is still an important factor restricting the development of many countries and regions. Especially in China, despite the battle against poverty in recent years, relative poverty still exists, and its complexity and diversity pose new challenges to the implementation of the rural revitalization strategy. As an important province in western China, its county economic development is unbalanced, and the poverty problem is particularly prominent. Therefore, it is of great significance to deeply study the measure of county relative poverty, time and space evolution and the risk of returning to poverty in Shaanxi Province to formulate scientific and reasonable anti-poverty strategies and promote rural revitalization.

This study aims to quantitatively analyze the relative poverty of counties in Shaanxi Province by using the spatial autocorrelation model and geographical weighted regression model, and reveal the characteristics of spatial and temporal evolution and the key influencing factors of the risk of returning to poverty. At the same time, according to the actual situation of Shaanxi Province, targeted anti-poverty strategies and policy suggestions are put forward to provide scientific basis for the government decision-making.

Relative poverty, as a concept relative to the social average, emphasizes the relative backwardness of individuals or families in their social and economic status. Scholars at home and abroad have studied this extensively and developed various measurement methods, such as income ratio method, Martin method and Sen index, etc. These methods have their own advantages and disadvantages, but the common goal is to more accurately reflect the

actual economic situation and social welfare level of individuals or families. As a major decision and deployment for China to solve the problems of "agriculture, rural areas and farmers" and realize agriculture and rural modernization, the rural revitalization strategy has become the focus of scholars in recent years. They believe that rural revitalization will not only help solve the current poverty problem, but also fundamentally prevent the occurrence of returning to poverty by promoting the development of thriving industries, ecological livability, local customs and civilization, effective governance and a rich life. However, different regions face different challenges and opportunities when implementing the rural revitalization strategy, and they need to formulate anti-poverty strategies according to local conditions. Spatial analysis techniques have important applications in poverty research. By using GIS (geographic information system) and ESDA (spatial statistics), scholars can reveal the spatial distribution characteristics, agglomeration effects and causes of poverty phenomenon, identify high-risk areas of poverty, and provide scientific basis for the government to formulate precise anti-poverty policies. In recent years, more and more studies have begun to focus on the spatial heterogeneity and dynamic changes of relative poverty, providing new perspectives for the deep understanding of poverty problems. The return to poverty refers to the situation that the poverty-stricken households fall into poverty again due to various reasons, and its risks seriously affect the consolidation of the achievements of poverty alleviation and the implementation of the rural revitalization strategy.

2. Theoretical Analysis and Research Hypothesis

2.1 The Concept of Relative Poverty

Relative poverty emphasizes the relative backwardness of individuals or families in their social and economic status, rather than just an income level below a certain absolute standard. The key to this concept is its relativity, in terms that the poverty state is relative to the social average. Therefore, accurately measuring relative poverty requires a comprehensive consideration of multiple dimensions of economic and social indicators, such as income, education, health, quality of life, etc. Commonly used measurement methods include income ratio method, Martin method and Sen index, which have advantages and disadvantages, but the common goal is to more accurately reflect the actual economic status and level of social well-being of individuals or families.

2.2 Theory of Spatial Analysis in Poverty Research

Spatial analysis techniques have important applications in poverty research. GIS (GIS) and ESDA (spatial statistics) can reveal the spatial distribution characteristics, agglomeration effect and causes of poverty. These technologies can help identify high-risk areas of poverty and provide a scientific basis for the government to formulate precise anti-poverty policies. Spatial analysis can also help to understand the heterogeneity and dynamic change of poverty problems, that is, poverty conditions may vary significantly in different regions and at different times, and these differences may be affected by multiple factors, such as geographical location, resource endowment, policy environment, etc.

2.3 Theory of the Risk of Return to Poverty and its Influencing Factors

The return to poverty refers to the poverty-stricken households falling into poverty again due to various reasons. The existence of the risk of returning to poverty has seriously affected the consolidation of the achievements of poverty alleviation and the implementation of the rural revitalization strategy. Scholars have analyzed the influencing factors of the risk of returning to poverty from many perspectives, including natural disasters, market fluctuations, family changes, health problems and so on. These factors interweave and work together to constitute a complex risk network of returning to poverty. Therefore, it is particularly important to develop a comprehensive and systematic anti-poverty strategy, and it is necessary to comprehensively consider various potential risks, and take targeted measures to prevent them.Based on the above theoretical analysis, the study makes the following assumptions:

Hypothesis 1: Relative poverty has significant spatial heterogeneity

Due to the differences in economic development level, resource endowment and policy environment, it is reasonable to speculate that the performance of relative poverty will be different in different regions. That is, relative poverty has significant spatial heterogeneity, and this heterogeneity may be affected by many factors, such as geographical location, industrial structure, educational resources, etc.

Hypothesis 2: The risk of returning to poverty is influenced by multiple factors and is complex

Returning to poverty is a complex phenomenon, whose risk may be affected by a variety of factors, such as natural disasters, market fluctuations, family changes, health problems, etc. These factors interweave and work together to constitute a complex risk network of returning to poverty. Therefore, it can be assumed that the risk of returning

to poverty is affected by many factors and has complexity, that is, the contribution of different factors to the risk of return to poverty may differ, and there may be an interaction between them.

Hypothesis 3: Spatial analysis techniques will help to identify areas at high risk of return to poverty

Spatial analysis technology can reveal the spatial distribution characteristics, agglomeration effect and causes of poverty, and help to identify high-risk areas of poverty. Therefore, it can be assumed that spatial analysis technology is also helpful to identify high-risk areas of returning to poverty and provide a scientific basis for the government to formulate precise anti-poverty policies。

3. Model Specification. Variable Declaration

3.1 Space Autocorrelation Model

In this study used Moran Index (Moran's I) to measure the spatial correlation of relative poverty in counties in Shaanxi Province. The Moran index is a commonly used spatial statistic to assess the concentration of a property in space. By calculating the Moran index in different years, we can reveal the distribution characteristics of relative poverty in space and its changing trend.

3.2 Geographical-Weighted Regression Model

To further analyze the factors affecting relative poverty and their spatial heterogeneity, a geographic-weighted regression (GWR) model was introduced in this study. The GWR model allows regression coefficients to vary with geographic location, thus to capture spatial differences in factors affecting relative poverty. Through the GWR model, variables with significant effects on relative poverty and spatial heterogeneity can be identified and used for the development of targeted anti-poverty strategies.

3.3 Description of the Variables

explained variable:

Relative poverty index: as an explained variable, used to measure the relative poverty level of various counties in Shaanxi Province. The index considers multiple dimensions of economic and social indicators, such as income, education, health, etc.

explanatory variable:

Economic development level: including per capita GDP, industrial structure and other factors, used to reflect the economic development of the county.

Educational resources: such as the number of schools, teacher-student ratio, etc., used to measure the level of educational development in the county.

Health status: such as the number of medical facilities, the health level of residents, are used to reflect the medical and health conditions of the county.

Infrastructure: The degree of improvement of infrastructure such as transportation and communication is used to assess the convenience of life in the county.

Policy environment: such as the implementation of poverty alleviation policies and rural revitalization strategies, which are used to examine the impact of policy factors on relative poverty.

controlled variable:

In addition to the above explanatory variables, some control variables such as geographical location, topography may be introduced to reduce the bias of the model estimation.

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4. Empirical Analysis

4.1 The Index System of County Relative Poverty Evaluation in Shaanxi Province

Poverty can be caused by many factors, such as natural conditions, social and economic conditions. Building a comprehensive indicator describing the regional poverty situation is a comprehensive measure of poverty in a region. Based on the existing literature, the comprehensive identification of poverty in counties is mainly carried out from multiple dimensions such as social economy and natural nature. The natural condition is the background natural assets of the region, which is difficult in quantification, and the level of economic development can directly reflect the relative poverty of the region. Therefore, this project draws on the existing research results, combines

the regional characteristics of Shaanxi Province, and considers the economic and social dimensions to measure the relative poverty degree of the study area.

The specific indicators are as follows Table 1:

Table 1. Index system of county relative poverty measurement in Shaanxi Province

Index	Significance
Per capita GDP	Reflects the level of regional economic development
Per capita fiscal revenue	Reflects the income level of the residents
Per capita disposable income	Reflects the income level of the residents
Total output value of industry above designated size	Reflects the improvement of residents' material living conditions
Total retail sales of social goods	Reflects the improvement of residents' material living conditions
Local telephone users	Reflects the people's living standards
Number of students per 10,000 people	Reflects the regional education level
Number of hospital beds per 10,000 people	Reflects the regional medical level

4.2 County Relative Poverty Measures in Shaanxi Province

In county relative poverty measure, to eliminate the data dimension and size difference and the subjectivity of artificial index weight, the project adopts the entropy weight method, calculate the weight of the selected index, specific model is as follows: first, the index of linear transformation to eliminate the influence of different dimension on the results, after the standardized data value domain, convenient statistics and not loss data itself contains information.

$$x = \frac{x - \min}{\max - \min}$$

Where α represents the normalized value of each indicator, x represents the value of each index, min is the minimum value and max is the maximum value. Next, the percentage of the first evaluated object Pij under the j the index is calculated.

$$Pij = \frac{bij}{\sum_{i=1}^{m} bij}$$

Then calculate the entropy value Ej of the j th index.

$$Ej = -\frac{(1 - Wj)}{(n - \sum Wj)}$$

Finally, the weight of the j th index is calculated.

$$wj = (1 - Wj)/(n - \sum Wj)$$

Where w is the weight of each indicator, n is the total number of indicators, and i is the i th index of the indicators. The final county relative poverty index IDI was obtained by the calculation of each index and weight values.

$$IDI = \sum_{i=1}^{n} Wj \times i$$

4.3 The Spatial and Temporal Evolution of Relative Poverty in Counties in Shaanxi Province

First of all, in order to explain the spatial distribution characteristics between different elements, this project describes and reveals the standard deviation ellipse in spatial statistics by comparing the basic parameters of ellipse and comparing the basic parameters of ellipse in different years. The specific model is as follows:

$$SDEx = \sqrt{\frac{\sum_{i=1}^{n}(Xi - \bar{x})^2}{n}}$$

$$SDEy = \sqrt{\frac{\sum_{i=1}^{n}(Xi-\overline{y})^2}{n}}$$

In the sum, Xi and Yi are the coordinates of the elements (xi, yi), the average of xy represents the average center of the element, and n is equal to the total number of elements. Then, considering the strong spatial correlation between different counties, combined with the geographer to bull has proposed a mutual correlation between anything, with the Arcgis space auto correlation tools to analyze the spatial agglomeration characteristics of county relative poverty, and to moran index of different spatial correlation between county relative poverty effect, the model is as follows:

$$Moran'sI = \frac{n}{So} \times \frac{\sum_{i}^{n}\sum_{j}^{n} Wij(Xi-\overline{x})((Xi-\overline{x})}{\sum_{j}^{n}(Xi-\overline{x})^2}$$

Where Xi represents the observed value of county i; Wij is the spatial weight matrix, spatial adjacent 1, non-adjacent 0, and s 0 is the sum of all elements of the spatial weight matrix. Global space autocorrelation analysis can only reflect the county relative poverty spatial pattern of agglomeration situation, is likely to cover the local space autocorrelation, in order to analyze the county unit relative poverty agglomeration situation, the project first use local moran index to analyze the local space autocorrelation, the model is as follows

$$Ii = \frac{(Xi-\overline{x})^2}{S^2}\sum_{i\neq j,j=1}^{n} Wij(xi-\overline{x})$$

Formula (9), Ii> 0, H-H (high and high), L-L (low); Ii <0, H-L (high and low), L-H (low and high).

In this equation, S represents the distance measure between the center of gravity of county relative poverty and the center of gravity of various indicators, the farther the distance, the lower the overlap, and otherwise, the higher the overlap. At the same time, from a dynamic perspective, the project is used to analyze the change consistency of each index and the change of the relative poverty degree of the county relative to the previous time node to reflect the Angle θ of displacement. Due to the limitation of the value range θ, the other string values are used as the change consistency index C. The specific model is as follows:

$$C = COS\theta = [(\Delta x1\Delta x2) + (\Delta y1\Delta y2)]/\sqrt{(\Delta x1^2 + \Delta y1^2)(\Delta x2^2 + \Delta y2^2)}$$

5. Interpretation of Result

(1) Construction and measurement of the county relative poverty evaluation index system

By comprehensively using the index system method and improving the existing evaluation method, we have systematically constructed the evaluation index system of county relative poverty from the two dimensions of economy and society. This system not only covers all aspects of the relative poverty of the county, but also ensures the scientific and rationality of the weight of each index through the entropy right method. The application of the entropy weight method enables us to measure the relative poverty degree of counties more objectively, which provides a solid data basis for the subsequent analysis.

(2) The spatial and temporal evolution characteristics of the relative poverty in counties

1. Evolution characteristics of the spatial pattern

Using standardized ellipses and ArcGIS spatial statistics, we explore in depth the evolution of relative poverty in counties. The results show that the spatial distribution of county relative poverty in Shaanxi province shows significant agglomeration characteristics, and the differences between different regions are obvious. With the passage of time, this spatial pattern has both some stability and some subtle changes. This provides an important basis for identifying the high-risk areas of relative poverty.

2. Characteristics of the spatial distribution

Further using spatial autocorrelation analysis methods, we reveal the spatial distribution characteristics of relative poverty in counties. The analysis results show that there is a significant positive correlation between county relative poverty in space, that is, counties with similar relative poverty levels tend to gather together in space. This finding provides new insight into our understanding of the spatial transfer mechanisms of relative poverty.

6. Conclusions

Based on the county social and economic statistics of Shaanxi Province from 2000 to 2019, the space-time evolution characteristics of county relative poverty in Shaanxi Province were deeply analyzed by using various

methods and models. By constructing the evaluation index system of county relative poverty, exploring the characteristics of spatial and temporal evolution, and quantitatively analyzing the problem of returning to poverty, we draw the following main conclusions:

1. The scientificity and effectiveness of the evaluation index system of county relative poverty

Through the comprehensive use of the index system method and the improvement of the existing evaluation methods, the evaluation index system of the county relative poverty constructed from the two dimensions of economy and society is scientific and effective. The application of entropy weight method ensures the rationality of the weight of each index, enabling us to measure the relative poverty degree of counties more objectively.

2. The evolution characteristics of the spatial pattern of relative poverty in counties

Using standardized ellipse and ArcGIS spatial statistical methods, we found that the spatial distribution of county relative poverty in Shaanxi province showed significant agglomeration characteristics, with obvious differences between different regions. With the passage of time, this spatial pattern has both some stability and some subtle changes. This provides an important basis for identifying the high-risk areas of relative poverty.

3. Risk of return to poverty and its influencing factors

Through the cluster analysis and the construction of the risk index system, we identified the counties with the risk of returning to poverty, and quantitatively analyzed the influencing factors of the problem of return to poverty. The results showed that education level, health conditions, industrial development and other factors had an important impact on the risk of returning to poverty. In particular, the improvement of education level and medical conditions are of great significance for reducing the risk of returning to poverty.

Countermeasures and suggestions

Based on the above research conclusions, in order to effectively curb the occurrence of people returning to poverty, consolidate the achievements of poverty alleviation, and provide strong support for the implementation of the rural revitalization strategy, we put forward the following countermeasures and suggestions:

1. Strengthen investment in education and medical care

The government should further increase the investment in education and medical care in the poor areas, and improve the cultural quality and health level of the local residents. Specific measures include expanding schools, improving the treatment of teachers, improving medical facilities, and training medical staff. This will help improve the self-development capacity of poor areas and fundamentally reduce the risk of returning to poverty.

2. Promote diversified industrial development

We will encourage and support the development of diversified industries in poor areas, especially those characteristic industries that can boost employment and increase farmers' incomes. The government can guide enterprises to invest and start business in poor areas by providing tax incentives, financial support and technical guidance to promote the prosperity and development of the local economy.

3. China

We will establish a sound social security system covering both urban and rural areas to provide basic living allowances for low-income groups. This includes improving the minimum living allowance system, establishing a medical assistance system, and promoting the rural old-age insurance system. By improving the social security system, the poverty problem caused by disease and unemployment can be effectively alleviated.

4. Strengthen targeted poverty alleviation and dynamic monitoring

For different types of poor families and groups of people, personalized assistance measures have been formulated to implement targeted poverty alleviation. At the same time, a sound poverty monitoring system will be established to timely detect and respond to the risk of return to poverty. By conducting regular poverty surveys and establishing an early warning mechanism for returning to poverty, poverty trends can be grasped in time and provide a basis for policy adjustment.

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