Study on the Coupling Synergetic Relationship Between Poverty Alleviation and Rural Revitalization
Based on the Comparison of Different Time Series Poverty Eradication Counties in Sichuan

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ABSTRACT

This paper takes the incidence of poverty as an evaluation index to overcome poverty. The comprehensive evaluation index system of rural revitalization is constructed from five dimensions: thriving business, pleasant living environment, social etiquette and civility, effective governance, and prosperity. Based on 10 counties (cities) in Sichuan Province, using a coupled degree model, this paper analyzes the difference and internal mechanism of the coupling degree between poverty alleviation and rural revitalization in poor counties (cities) in different periods of Sichuan. The results show that: (1) The poverty relief index and the rural revitalization index are on the rise in different time series. Among them, Guangan District and Nanbu County are in the leading position. (2) The coupling synergy between the two is on the rise, from moderate synergy in 2012 to high synergy in 2019. There are significant differences in the degree of coupling and coordination between counties (cities) in different time series. (3) The coupling synergy between poverty alleviation and rural revitalization reflects the ability of poverty-stricken counties (cities) to get rid of poverty for a long time. Thriving business is an important driving factor affecting the level of rural revitalization and its coupling and synergy. Generally speaking, the coupling synergy degree of counties (cities) which are late in getting rid of poverty lags behind, and its urgent task is to consolidate the achievements of getting rid of poverty, speed up the effective connection between the achievements of getting rid of poverty and rural revitalization, stimulate internal motivation, and promote rural development. Counties (cities) that got rid of poverty earlier are relatively leading in the degree of coupling and coordination, and their work should focus on identifying and solving shortcomings and deficiencies in rural revitalization and development, so as to make the five dimensions of rural revitalization develop in a balanced way and form a sustainable development pattern of getting rid of poverty and rural revitalization.

Keywords: *poverty alleviation, rural revitalization, coupling synergy, entropy value empowerment method*

1. INTRODUCTION AND LITERATURE REVIEW

In 2020, China won a decisive victory in the fight against poverty. Sichuan is one of the main battlefields to overcome poverty, as at 17 November 2020, 88 poverty-stricken counties (cities) in Sichuan get rid of poverty. But it's not the end. At the historic juncture of advancing towards the goal of the second century, to consolidate and expand the achievements of overcoming poverty and to realize the effective link between the achievements of overcoming poverty and the rejuvenation of the countryside, is the primary task of rural work in the 14th Five-Year Plan period. To that end, to be fully aware of the importance of the task. First, this task can effectively eliminate the risk of returning to poverty. In 2020, our province has gotten rid of poverty, but the risk of returning to poverty among those who have been lifted out of poverty and the risk of poverty among those on the edge still exists [1]. Poor households with fragile

foundations for poverty alleviation are easy to return to poverty, and marginal households are prone to poverty when they encounter risks. Second, this task can effectively solve the relative poverty. Poverty alleviation lays a solid foundation for rural revitalization. Only by realizing rural revitalization can we fundamentally solve the poverty problem [2]. Third, this task represents the smooth transfer of the focus of rural work. Both belong to the strategic "transition" and "upgrade "[3]. For the implementation of the time of succession, strategic objectives of the progressive relationship [4]. An effective link between poverty alleviation and rural revitalization lies in the of industrial development, ecological environment, institutional mechanism and grass-roots governance [5]. Fourth, this task promotes the construction of a new development pattern. In the process of effective convergence, we should keep the key technologies, innovation and development initiatives firmly in our own hands, then we will promote the construction of a new pattern of development. All in all, the two are characterized by content fusion, interaction and subject consistency, and mutually promote each other [6].

Therefore, this paper takes the incidence of poverty as the evaluation index of poverty alleviation, constructs a comprehensive evaluation index system of rural revitalization from the five dimensions of "thriving business, pleasant living environment, social etiquette and civility, effective governance and prosperity". Based on 10 different time-series poverty relief counties (cities) in Sichuan Province from 2012 to 2019, this paper analyzes the difference and internal mechanism between poverty alleviation and rural revitalization in different periods, and provides policy references for promoting the coordinated development of poverty alleviation and rural revitalization.

2. RESEARCH DESIGN

2.1. Construction of Index System

2.1.1. Construction of poverty alleviation indicators

At present, there is no unified standard for overcoming poverty. Existing research usually uses poverty population, poverty incidence, Sen index, SST index and other indicators to measure poverty. Different objects have different indicators of poverty alleviation. Through existing literature and evaluation methods, this paper uses poverty incidence to measure the evaluation indicators of poverty alleviation in poor counties (cities).

2.1.2. Construction of Rural Revitalization Index System

In this paper, referring to Liao Wenmei et al. [3] and Wang Guoli et al. [7], the index system of rural

revitalization is constructed from five first-class indicators: thriving business, pleasant living environment, social etiquette and civility, effective governance and prosperity. The score of each indicator indicates the relative position of each county (city).

2.1.2.1. *Exponential formation*

The specific method is: set the maximum and minimum score of the index in the base year (2012) as 1 and 0 respectively for a single index, and determine its score between 0 and 1 according to the index value of each county (city) to form a single index corresponding to the index. A dimension index is synthesized by several indexes belonging to the same dimension according to a certain weight, and finally a total index is synthesized by several dimension indexes according to a certain weight. The method of calculating index score is as follows [8]:

Positive indicators:

$$\lambda_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \quad (1)$$

Negative indicators:

$$\lambda_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)} \quad (2)$$

x_{ij} is the original data of the jth index in the ith county (city), $\max(x_j)$ is the largest value, $\min(x_j)$ is the smallest value and λ_{ij} is the index score of the jth index in the ith county (city). After the above treatment, each score is positively related to poverty alleviation and rural revitalization level, that is, the higher the score, the higher the level of poverty alleviation and rural revitalization. On the contrary, the lower.

2.1.2.2. *Weight calculation*

In this paper, Shannon's entropy method is used to calculate the index weight. As an objective weighting method, it measures the index weight according to the original data of each index, avoids random errors, and can deal with the information overlap of multiple index variables. The calculation formula and specific steps of entropy method are as follows [9].

The first step is the standardization of index data: all kinds of index values obtained by formula (1) and formula (2) are λ_{ij}, forming an index matrix $(\lambda_{ij})_{m \times n}$, where m represents the number of sample counties (cities) and n represents the number of evaluation indexes.

Secondly, calculate the index value proportion P_{ij} of the ith county (city) under the jth index:

$$P_{ij} = \frac{\lambda_{ij}}{\sum_{i=1}^{m} \lambda_{ij}} \quad (3)$$

In the third step, calculate the entropy e_j of the jth index:

$$e_j = -\frac{1}{lnm} \sum_{i=1}^{m} P_{ij} lnP_{ij} \tag{4}$$

The fourth step is to calculate the weight ω_j of each index. The calculation formula is:

$$\omega_j = \frac{(1-e_j)}{\sum_{j=1}^{n}(1-e_j)} \tag{5}$$

Among them, $(1-e_j)$ is the utility value of the first index. The larger $(1-e_j)$ is, the more important the index is. The calculation results are shown in Table 1.

The fifth step is to calculate the index u_{ij} of each county (city) in different years.

$$u_{ij} = \sum_{i=1}^{n} \omega_j \times \lambda_{ij} \tag{6}$$

2.2. Construction of Coupling Collaborative Model of Poverty Alleviation and Rural Revitalization

2.2.1. Coupling degree model

In order to study the relationship between poverty alleviation and rural revitalization, this paper uses the capacity coupling coefficient model in physics to obtain the coupling degree function of the interaction between poverty alleviation and rural revitalization:

$$C = \frac{2\sqrt{U_1 \times U_2}}{U_1 + U_2} \tag{7}$$

C indicates the coupling degree of interaction between poverty alleviation and rural revitalization, which reflects the strength of interaction coupling between them. U_1 and U_2 are evaluation functions of the development level of poverty alleviation and rural revitalization, respectively. The coupling degree $C \in (0, 1)$, the closer to 1, the better the interactive coupling state between the two.

2.2.2. Collaborative degree model

In order to judge the coupling synergy degree of poverty alleviation and rural revitalization more accurately, this paper also introduces the synergy degree model:

$$D = \sqrt{C \times T} \qquad \text{among it, } T = \alpha U_1 + \beta U_2 \tag{8}$$

D is the synergy between poverty alleviation and rural revitalization, T is the comprehensive development level of poverty alleviation and rural revitalization system, α and β represent the importance of the two systems, and $\alpha + \beta = 1$. Assuming that poverty alleviation and rural revitalization are equally important, take $\alpha = \beta = 0.5$. Drawing lessons from previous research results [10], this paper divides the degree of synergy into four types. When $D \in [0, 0.4)$, it shows low synergy. When $D \in [0.4, 0.6)$, it showed moderate synergy. When $D \in [0.6, 0.8)$, it is highly synergistic. When $D \in [0.8, 1.0)$, it shows extreme synergy.

2.3. Data sources

In order to compare the differences of coupling synergy between rural revitalization and poverty alleviation in poverty-stricken counties (cities) in Sichuan Province, the counties (cities) with different poverty alleviation time sequences were selected as the research objects, including Guangan District and Nanbu county, which were lifted out of poverty in 2017; Langzhong City and Yilong County, which were lifted out of poverty in 2018; Pingwu County and Qingchuan County, which were lifted out of poverty in 2019; Rangtang County, Tongjiang County, Pingshan county and Xuyong county, which were lifted out of poverty in 2020. The data sources of this paper are Sichuan Statistical Yearbook, poverty-stricken counties (cities) Statistical Yearbook, local government annual bulletin and field survey data of some counties (cities).

3. EMPIRICAL RESULTS

3.1. Description of poverty alleviation and rural revitalization level

3.1.1. Description of the poverty index

According Table 1 and the calculation of relative index method, the poverty alleviation and rural revitalization indexes of 10 counties (cities) in Sichuan Province from 2012 to 2019 are obtained, as shown in Figure 1. Generally speaking, the poverty alleviation index is on the rise. The poverty alleviation index increased by 0.2811 from 0.5928 in 2012 to 0.8739 in 2019. In the past eight years, the highest average index was 0.9511 in Nanbu county, followed by Guangan District and Langzhong City, and the lowest was Tongjiang County. On the whole, the change trend of poverty-stricken counties (cities) in each time series is basically the same, but the poverty-stricken counties (cities) with earlier time series have higher index.

Table 1. Index system setting and average weight of coupling system of poverty alleviation and rural revitalization.

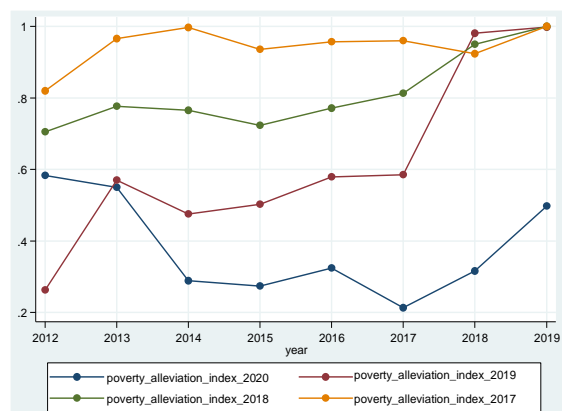| system	first level indicator	weight	secondary indicators	character	average weight
Poverty alleviation	Poverty reduction level	1.0000	Incidence of poverty/%	−	1.0000
Rural revitalization	Thriving business	0.3685	Per capita GDP/yuan	+	0.2657
			Per unit area yield of grain(kg/m^2)	+	0.1031
			Tourist arrivals/10000	+	0.4982
			Total mechanical power per mu	+	0.1330
	Pleasant living environment	0.1714	forest area per capita(m^2/person)	+	0.2698
			Number of beds for 10000 people	+	0.1963
			Per capita highway mileage/m	+	0.5339
	Social etiquette and civility	0.1105	Number of full-time teachers	+	0.3732
			Enrolment rate of school-age children	+	0.1742
			Junior high school entrance rate	+	0.2257
			Senior high school entrance rate	+	0.2269
	Effective governance	0.1034	Coverage rate of urban and rural endowment insurance	+	0.4994
			Minimum living security rate in urban and rural area	+	0.5006
	Prosperity	0.2462	Urban-rural income ratio	−	0.3753
			Rural per capita consumption	+	0.2457
			Rural per capita electricity consumption	+	0.1179
			Per capita household savings	+	0.2611

Figure 1 Poverty alleviation index of poverty alleviation counties in different time series in Sichuan Province from 2012 to 2019.

3.1.2. Description of Rural Revitalization Index

From 2012 to 2019, the average index of rural revitalization in 10 counties (cities) showed an upward trend, from 0.5180 in 2012 to 0.5884 in 2019. The rural revitalization level of Guangan District is at the leading level, its index reached 0.8748 in 2019, followed by Langzhong City and Nanbu county. However, Rangtang County is relatively backward, only 0.1609 in 2019. Except for some counties (cities), the growth trend of

rural revitalization level in all counties (cities) is relatively synchronous. The indexes of 10 counties (cities) are classified into 4 categories according to the time series of poverty alleviation, which are shown in Figure 2. Generally speaking, the counties (cities) that got rid of poverty earlier showed a strong development trend in all dimensions of rural revitalization. However, in the counties (cities) that got rid of poverty later, the level of rural revitalization lags behind.
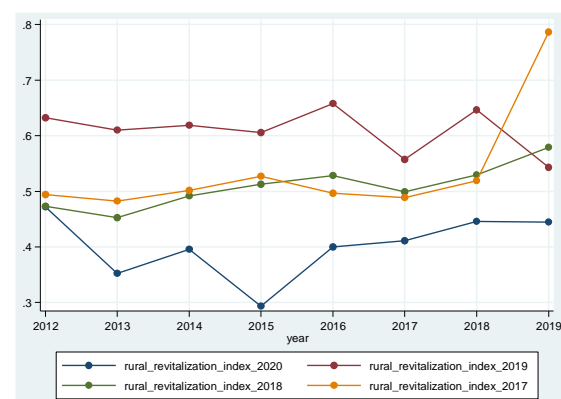

Figure 2 Rural revitalization index of poverty-stricken counties in different time series in Sichuan Province from 2012 to 2019.

3.2. *Analysis of Coupling Synergistic Relationship between Poverty Alleviation and Rural Revitalization*

According to the coupling coordination model formula (8), the coupling coordination degree of poverty alleviation and rural revitalization of 10 counties (cities) in Sichuan Province from 2012 to 2019 can be obtained, as shown in Figure 3. The coupling synergy between poverty alleviation and rural revitalization in 10 counties (cities) of Sichuan Province increased from 0.4606 in 2012 to 0.7899 in 2019, showing an overall upward trend. Among them, Guangan District has a leading growth in the degree of coupling synergy, from 0.6218 in 2012 to 0.9827 in 2019, indicating that Guangan District has well completed the effective connection between poverty alleviation and rural revitalization. However, the relative backwardness of Rangtang County is mainly caused by the relative lag of rural revitalization.

From the perspective of poverty-stricken counties (cities) in different time series, there is a significant difference in the degree of coupling synergy between them. Counties (cities) that got rid of poverty earlier have been in the leading position in terms of coupling and synergy. Counties (cities) that got rid of poverty later have relatively low coupling synergy, mainly because the development speed of rural revitalization does not match the development speed of poverty alleviation, rural revitalization lags behind.
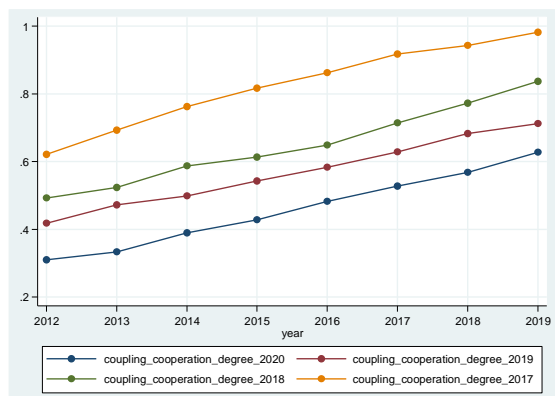

Figure 3 Coupling synergy between poverty alleviation and rural revitalization in poverty-stricken counties in different time series in Sichuan Province from 2012 to 2019.

4. CONCLUSION

4.1. *Research conclusion*

In this paper, 10 poverty-stricken counties (cities) in Sichuan Province are taken as study areas. Based on the index system of poverty alleviation and rural revitalization and combined with the coupling synergy model, the difference characteristics of poverty alleviation counties (cities) in different time series are analyzed, and some preliminary research conclusions are drawn.

(1) The poverty alleviation and rural revitalization index of all counties (cities) are on the rise as a whole. Guangan District and Nanbu county are in the leading position. There are great differences in rural revitalization index of poverty-stricken counties (cities) in different time series, among which, thriving business is an important reason for the differences in rural revitalization of poverty-stricken counties (cities) in different time series, while prosperity has become the equilibrium point for the common development of rural revitalization of poverty-stricken counties (cities).

(2) The coupling synergy between poverty alleviation and rural revitalization in all counties (cities) is steadily increasing, and Guangan District is at the leading level. The coupling synergy degree of poverty-stricken counties (cities) in different time series is obviously different. The earlier the poverty-stricken time series, the higher the coupling synergy degree.

(3) The coupling synergy between poverty alleviation and rural revitalization reflects the ability of poverty-stricken counties (cities) to get rid of poverty for a long time. Poverty alleviation lays the foundation for rural revitalization in industry, education and ecology, and promotes the development of rural revitalization. The balanced development of rural revitalization in all dimensions can consolidate and the achievements of poverty alleviation and promote the all-round development of rural areas. Thriving business is an important driving factor that affects the rural revitalization level of poverty-stricken counties (cities) and the differentiation of their coupling synergy.

4.2. *Research recommendations*

There are obvious differences in poverty alleviation, rural revitalization index and coupling synergy of poverty-stricken counties (cities) in different time series. Scientifically clarifying the coupling and synergy between poverty alleviation and rural revitalization will help to see problems in development, fill shortcomings and deficiencies, and seek benign interaction and resonant development between the two. Generally speaking, the coupling synergy degree of counties (cities) that are late in getting rid of poverty lags behind, and its urgent task is to consolidate the achievements of getting rid of poverty, speed up the effective connection between the achievements of getting rid of poverty and rural revitalization, stimulate internal motivation, and promote rural development. Counties (cities) that got rid of poverty earlier are relatively leading in the degree of coupling and coordination, and their work should focus on identifying and solving shortcomings and deficiencies in rural revitalization and development, so as to make the five dimensions of rural revitalization develop in a

balanced way and form a sustainable development pattern of getting rid of poverty and rural revitalization.

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