

# Research on Measuring the Development Level of Rural Revitalization in China Based on Entropy Weighted TOPSIS Model Analysis

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**Abstract:** In the report to the Nineteenth National Congress, General Secretary Xi Jinping proposed the concept of “rural revitalization” for the first time, and pointed out the general requirements of “Thriving businesses, Pleasant living environment, Social etiquette and civility, Effective governance, and Prosperity”. Comprehensively promoting rural revitalization is of great significance in achieving coordinated development of urban and rural areas, promoting economic development, and narrowing the gap between urban and rural areas. This paper establishes a rural revitalization evaluation index system based on the development status of rural revitalization in China from 2012 to 2021, and evaluates the overall level and development trend of rural revitalization in China by using the entropy weight TOPSIS model.

**Keywords:** Rural Revitalization; Indicator System; Entropy Weight TOPSIS Model

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## 1. Preface

### 1.1 Research background

The strategy of rural revitalization is another major strategy proposed after the innovation-driven strategy, the strategy of developing the country through science and education, the strategy of strengthening the country through talents, and the strategy of civil-military integration. General Secretary Xi Jinping stressed that the strategy of rural revitalization is to promote the “five major revitalizations” of the countryside, and that stronger measures are needed to implement the rural revitalization strategy. Examining the level of rural revitalization, formulating rural development strategies, and implementing guarantees for rural revitalization are all important aspects to be examined in the evaluation of rural revitalization<sup>[1]</sup>.

### 1.2 Research status

Currently, all domestic studies use the twenty-word general requirements for rural revitalization to construct the indicator system. In the study of assessment methods, many scholars use hierarchical analysis method and expert survey method to screen the required indicators, and determine the weights of the indicators through expert scoring method and Delphi, etc., but these methods inevitably carry a certain degree of subjectivity.

This paper takes the twenty-word general requirements of rural revitalization as the first-level indicators, and then selects four second-level indicators from each first-level indicator, and adopts the entropy-weighted TOPSIS model to evaluate the comprehensive index of rural revitalization and the degree of fit of each first-level indicator in the period of 2012-2021, and the conclusions are more objective and accurate.

## 2. Rural Revitalization Evaluation Indicator System and Evaluation Method

### 2.1 Construction of Evaluation Indicator System

The Strategic Plan for Rural Revitalization (2018-2022)<sup>[2]</sup> puts forward the general requirements of “prosperous industries, ecological livability, rural civilization, effective governance and wealthy life”. Based on the principles of scientific, comparability and systematicity, this paper takes the general requirements of rural revitalization as the first-level indicators, combines the development of countryside in China, and draws on the second-level indicators in the study of rural revitalization in China by Xu Xue and Wang Yongyu<sup>[3]</sup>, Lu Haixia and Fei Shaojin<sup>[3]</sup> to construct 20 second-level indicators, and establishes an indicator system that is suitable for the current situation of rural development.

**Table 1 Rural Revitalization Index System**

Level 1 indicators	Level 2 indicators
Thriving businesses	Labour productivity (%)
	Total power of agricultural machinery (billion watts)
	Rural per capita grain output (kg)
	Gross output value of agriculture, forestry, fishery and animal husbandry (billion yuan)
Pleasant living environment	Rural fertilizer application (pure) (tonnes)
	Rural sanitary toilet penetration rate (%)
	Beds in medical and health institutions per 1, 000 population (units)
	Percentage of administrative villages with centralized water supply (%)
Social etiquette and civility	Proportion of heads of households of rural residents who have not attended school (%)
	Per capita expenditure on education, culture and entertainment by rural residents (yuan)
	Number of colour TVs per 100 rural residents (units)
	Internet penetration rate in rural areas (%)
Effective governance	Ratio of consumption level of urban and rural residents
	Number of village committees (number)
	Ratio of income level of urban and rural residents
	Rural minimum living standard (yuan/person-yuan)
Prosperity	Per capita disposable income of rural residents (yuan)
	Number of household cars per 100 rural households (cars)
	Rural residents' per capita consumption expenditure (yuan)
	Engel's coefficient for rural residents (%)

**2.2 Evaluation methodology**

**2.2.1 Data standardization**

Considering that the units of the indicators are not uniform and that the indicators are first standardized before being calculated.

For positive indicators:

$$x'_{ij} = \frac{X_{ij} - \min(X_{1j}, \dots, X_{nj})}{\max(X_{1j}, \dots, X_{nj}) - \min(X_{1j}, \dots, X_{nj})} \#(2.1)$$

For negative indicators:

$$x'_{ij} = \frac{\min(X_{1j}, \dots, X_{nj}) - X_{ij}}{\max(X_{1j}, \dots, X_{nj}) - \min(X_{1j}, \dots, X_{nj})} \#(2.2)$$

$x'_{ij}$  is the value of the jth indicator in year i after processing. (i=1, 2, 3, ..., n; j=1, 2, 3, ..., m)

**2.2.2 Entropy Weight TOPSIS Model**

The entropy weight TOPSIS method<sup>[5]</sup> is an improvement of the traditional TOPSIS method, which is a more objective evaluation model.

Step 1, the data is shifted  $B_{ij}$  and the normalization matrix  $C_{ij}$  is calculated:

$$B_{ij} = XA'_{ij} + Y \#(2.3)$$

$$C_{ij} = \frac{B_{ij}}{\sum_{j=1}^{10} B_{ij}} \#(2.4)$$

Step 2, calculate the entropy value  $D_i$  and weight  $E_i$ :

$$D_i = - \frac{\sum_{j=1}^{10} (C_{ij} \times \ln C_{ij})}{\ln 10} \#(2.5)$$

$$E_i = \frac{1 - D_i}{\sum_{i=1}^n (1 - D_i)} \#(2.6)$$

Step 3, calculate the comprehensive score of the development level of rural revitalization in each district:

$$F_{ij} = \sum_{i=1}^n C_{ij} \times E_i \#(2.7)$$

Step 4, calculate the weighted normative decision matrix G:

$$G = G_{ij} = G_{ij} \times E_i \quad \#(2.8)$$

Step 5, calculate the positive ideal solution  $G_j^+$  and the negative ideal  $G_j^-$ :

$$G_j^+ = \begin{cases} \max G_{ij}, j \in j^+ \\ \min G_{ij}, j \in j^- \end{cases} \quad \#(2.9)$$

$$G_j^- = \begin{cases} \min G_{ij}, j \in j^+ \\ \max G_{ij}, j \in j^- \end{cases} \quad \#(2.10)$$

Step 6, calculate the separation of evaluation indexes and positive and negative ideal solutions:

$$H_i^+ = \sqrt{\sum_{j=1}^n (G_{ij} - G_j^+)^2} \quad \#(2.11)$$

$$H_i^- = \sqrt{\sum_{j=1}^n (G_{ij} - G_j^-)^2} \quad \#(2.12)$$

Step 7, calculate the closeness of rural revitalization to the optimal solution:

$$K_j = \frac{H_j^-}{H_j^+ + H_j^-} \quad \#(2.13)$$

### 3. Analysis of the level of rural revitalization in China

This paper measures the level of rural revitalization in China from 2012 to 2021 using five primary indicators and 20 secondary indicators. All raw data were mainly obtained from the China Rural Statistical Yearbook, the China Statistical Yearbook, the China Urban and Rural Construction Statistical Yearbook and the Ministry of Agriculture and Rural Development of the People’s Republic of China. For missing data in individual years, the annual rate of change of other years was used to extrapolate the data. 3.1 Analysis of the level of rural revitalization in China.

#### 3.1 Entropy weight method to determine the weight of indicators

The standardized data were subjected to the calculation of indicator weights and the results are presented in the table below:

**Table 2 Weight ratio of rural revitalization indicators**

Level 1 indicators	Level 2 indicators	Weight (%)
Thriving businesses	Labour productivity (%)	2.357
	Total power of agricultural machinery (billion watts)	5.108
	Rural per capita grain output (kg)	3.039
	Gross output value of agriculture, forestry, fishery and animal husbandry (billion yuan)	5.874
Pleasant living environment	Rural fertilizer application (pure) (tonnes)	10.101
	Rural sanitary toilet penetration rate (%)	4.084
	Beds in medical and health institutions per 1, 000 population (units)	6.371
	Percentage of administrative villages with centralized water supply (%)	5.206
Social etiquette and civility	Proportion of heads of households of rural residents who have not attended school (%)	4.36
	Per capita expenditure on education, culture and entertainment by rural residents (yuan)	3.648
	Number of colour TVs per 100 rural residents (units)	2.934
	Internet penetration rate in rural areas (%)	6.582
Effective governance	Ratio of consumption level of urban and rural residents	5.327
	Number of village committees (number)	3.952
	Ratio of income level of urban and rural residents	4.19
	Rural minimum living standard (yuan/person-yuan)	6.675
Prosperity	Per capita disposable income of rural residents (yuan)	5.544
	Number of household cars per 100 rural households (cars)	6.464
	Rural residents' per capita consumption expenditure (yuan)	4.661
	Engel's coefficient for rural residents (%)	3.522

#### 3.2 TOPSIS evaluation method calculations

The following table shows the composite index of rural revitalization and the fit of the first-level indicators for 2012-2021 in China:

**Table 3 Comprehensive Score Index and Ranking of Rural Revitalization**

Year	Composite Score Index	Sort
2012	0.22181709	10
2013	0.25207771	9
2014	0.316714	8
2015	0.39926317	7
2016	0.42913478	6
2017	0.49234109	5
2018	0.56023478	4
2019	0.67643634	3
2020	0.71854224	2
2021	0.79556146	1

**Table 4 Compliance of Primary Indicators for Rural Revitalization**

year	Comprehensive Score	Thriving businesses	Pleasant living environment	Social etiquette and civility	Effective Governance	Prosperity
2012	0.194	0.265	0.156	0.158	0.273	0.000
2013	0.219	0.341	0.131	0.149	0.299	0.140
2014	0.276	0.464	0.140	0.241	0.352	0.213
2015	0.351	0.580	0.188	0.374	0.396	0.302
2016	0.380	0.343	0.243	0.480	0.492	0.431
2017	0.450	0.373	0.346	0.542	0.538	0.528
2018	0.545	0.406	0.519	0.497	0.627	0.652
2019	0.684	0.533	0.719	0.677	0.680	0.759
2020	0.758	0.643	0.827	0.799	0.723	0.772
2021	0.826	0.850	1.000	0.853	0.706	0.860

### 3.3 Analysis of evaluation findings

The results of the analysis show that the overall level of rural revitalization is on an upward trend, with both the composite score index and the level 1 indicator fit increasing with each passing year.

## 4. Conclusions and recommendations

With the promotion of rural revitalization strategy in China, the process of rural revitalization is accelerating. The results of the fit of the first-level indicators show that the selected indicators play an increasingly important role in the development of the optimization of the level of rural revitalization in China.

In the area of thriving businesses, it is necessary to speed up the process of agricultural mechanization, informationization and intelligence, and to strengthen the training and introduction of rural talents. In terms of pleasant living environment, we should reduce the use of chemical fertilizers, continue to popularize sanitary toilets in rural areas, and strengthen the construction of primary medical institutions in villages. In the area of social etiquette and civility, we should actively promote nine-year compulsory education, guide outstanding teachers to teach at the grassroots level, and promote the construction of information technology in villages. In terms of effective governance, village committees should do their job and enhance the cultural quality of rural grassroots organizations. In the area of prosperity, the integrated development of rural employment will be promoted, and farmers' wage incomes will be increased.

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