Research on the Evaluation of Logistics Efficiency and Influencing Factors in Sichuan Province

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Abstract. In order to investigate the development of regional logistics efficiency, a logistics efficiency evaluation index system was constructed from three dimensions: logistics efficiency input, logistics efficiency output and influencing factors, and 10 indicators were selected. The results show that: the overall logistics efficiency of Sichuan Province is on the rise, from 0.001 in 2011 to 0.755 in 2020, which is a good development trend; the fixed asset investment in logistics industry X_1, gross regional product X_8 and financial transportation expenditure X_9 are the key factors affecting the development of logistics industry; in order to improve the level of regional logistics development, it is proposed to improve the factor input mechanism and strengthen the level of logistics resource allocation.

Keywords: logistics industry, efficiency, entropy TOPSIS model, gray correlation analysis, Sichuan Province

1 Introduction

Sichuan Province is an important trade province in the western region and the largest economic volume in the west. According to the data published by the Sichuan Provincial Bureau of Statistics: the gross value of logistics industry in Sichuan Province reached 147.228 billion yuan in 2020, compared with 54.503 billion yuan in 2011, an increase of more than 1.7 times, to achieve the goal of doubling the value of logistics production; from the perspective of annual growth rate, the gross value of logistics industry in Sichuan Province maintained positive growth development trend, the average annual growth rate remained at 12%, especially in 2014 The development is the most rapid, with an annual growth rate of up to 40%, and the gross value of logistics industry reaches 86.47 billion yuan, with a significant growth rate. Therefore, it is necessary to evaluate the development of logistics industry in Sichuan Province, and further explore the key factors affecting the development of logistics industry in Sichuan Province, and then provide strong support for the construction of new development pattern and smooth domestic circulation.

Scholars of logistics efficiency-related studies have carried out in-depth analysis, and Qin Wen (2020) measured the logistics efficiency of Guangdong-Hong Kong-

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Macao Greater Bay Area using a three-stage DEA model [1]; Zhong Changbao and Qian Kang (2017) measured the provincial logistics efficiency of the Yangtze River Economic Belt using a DEA-BCC model [2]; Cao Bingyu and Deng Lijuan (2019) measured the logistics efficiency based on the non-expected output of Super-SBM model and Malmquist index model to comprehensively measure the growth efficiency of logistics industry in Yangtze River Economic Belt from 2007-2016 [3]; Lei Li (2020) measured the logistics efficiency of 30 provincial areas in China from 2010-2018 based on Meta-frontier Malmquist index method [4]; Tu, Jian and Mei, Yihua (2021) used the super-efficient SBM model with non-expected output and Malmquist index to conduct static and dynamic analysis and research on green logistics efficiency in China [5];

Based on this, this study will be improved in the following aspects: using the entropy weight TOPSIS model to evaluate the logistics efficiency of Sichuan Province from 2011 to 2020; using the gray correlation model to explore the key factors affecting the gross value of logistics industry.

2 Evaluation index system, data sources and research methods

2.1 Evaluation index system construction

In terms of input, as for the input, the investment amount of fixed assets in logistics industry and the total number of civilian cargo vehicles are selected as capital input, and the logistics industry employees are selected as labor input; in addition, considering that the logistics output efficiency is closely related to road traffic facilities, the road mileage is taken as infrastructure input. As for the output, the gross value of transportation, storage and postal industry is selected as the economic output, and the volume of road freight and road cargo turnover are selected as the non-economic output. logistics efficiency evaluation index system is shown in Table 1.

Table 1. Logistics efficiency evaluation index system

Guideline level	Indicator level
Input Indicators	Fixed asset investment in logistics industry X_1
	Logistics industry employees X_2
	Road mileage X_3
	Ownership of goods vehicles X_4
Output Indicators	Total production value of logistics industry X_5
	Road freight volume X_6
	Road cargo turnover X_7
Influencing factors	Gross regional product X_8
	Financial transportation expenditure X_9
	Per capita consumption expenditure of urban X_{10}

2.2 Research Methods

2.2.1 Entropy-weighted TOPSIS method.

Entropy-weighted TOPSIS refers to the evaluation method that determines the superiority and inferiority status of the research object by calculating the distance between each index and the optimal or inferiority value [6].

(1) Data standardization.

$$r_{ij} = \frac{x_{ij} - min|x_{ij}|}{max|x_{ij}| - min|x_{ij}|} * 0.99 + 0.01 \quad (1)$$

Where r_{ij} denotes the value of the ith evaluation object in the j index, $\min|x_{ij}|$ and $\max|x_{ij}|$ denote the minimum and maximum values

$$p_{ij} = \frac{r_{ij}}{\sum_{i=1}^{n} r_{ij}}, e_j = -k \sum_{i=1}^{n} p_{ij} \ln p_{ij}, \omega_j = \frac{d_j}{\sum_{j=1}^{p} d_j} \quad (2)$$

where p_{ij} is the weight of each indicator; e_j is the information entropy, taking the value in the range of 0~1; k is a constant, $k = \frac{1}{\ln n}$; d_j is the coefficient of variation, $d_j = 1 - e_j$, and ω_j is the weight of the j indicator.

(2) Vector normalization.

$$Z_{ij}^{*} = Z_{ij} \cdot \omega_j, \; Z_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{n} r_{ij}^2}} \quad (3)$$

(3) Determine the optimal solution ${Z_{ij}}^{*+}$ and the inferior solution ${Z_{ij}}^{*-}$.

$$Z_{ij}^{*+} = \max_{n,p}\left(z_1^{*+}, z_2^{*+}, \cdots, z_p^{*+}\right)$$
$$Z_{ij}^{*-} = \min_{n,p}\left(z_1^{*-}, z_2^{*-}, \cdots, z_p^{*-}\right) \quad (4)$$

(4) Calculate the optimal distance and the worst distance of the evaluation object using the Euclidean distance.

$$D_i^{+} = \sqrt{\sum_j \left(Z_{ij}^{*} - Z_j^{*+}\right)^2} \; D_i^{-} = \sqrt{\sum_j \left(Z_{ij}^{*} - Z_j^{*-}\right)^2} \quad (5)$$

where D_i^{+}, D_i^{-} denote the distance between each index and the optimal or inferior value, respectively.

(5) Calculate the efficiency of the logistics industry.

$$C_i = \frac{D_i^{-}}{D_i^{+} + D_i^{-}} \quad (6)$$

Where C_i is the relative closeness, C_i is used to measure the efficiency level of logistics industry, the larger the value of C_i, the higher the efficiency value of logistics industry.

2.2.2 Gray correlation analysis.

Gray correlation analysis: the indicator with the greatest correlation is derived from the change of the curve [7]. The calculation process is as follows.

$$r_{ij} = \frac{\min\limits_{s}\min\limits_{k}|x_0(k)-x_s(k)|+\varepsilon\max\limits_{s}\max\limits_{k}|x_0(k)-x_s(k)|}{|x_0(k)-x_s(k)|+\varepsilon\max\limits_{s}\max\limits_{k}|x_0(k)-x_s(k)|} \tag{7}$$

The above equation r_{ij} is the correlation degree, ε is the discrimination coefficient, $\varepsilon \in (0,1)$, usually taken as 0.5. $|x_0(k)-x_s(k)|$ is the absolute difference between the comparison series and the reference series.

$$r_j = \frac{1}{n}\sum_k^n r_{ij} \tag{8}$$

The above equation r_j is the average correlation, and the larger the value of r_j, the stronger the correlation between the indicator and the logistics efficiency value.

3 Evaluation of Logistics Efficiency in Sichuan Province Based on Entropy Power TOPSIS Model

3.1 Evaluation of Logistics Efficiency

According to the stage level: 2011-2013 low stage, from 0.001 in 2011 0.001 in 2011 to 0.320 in 2013, with faster development; the main reason: with the improvement of national living standards and modern service system, domestic consumer demand is fully released, enhancing people's demand level for logistics industry, making the modern logistics industry develop faster. 2014-2016 intermediate stage, from 0.187 in 2014 to 0.187 to 0.253 in 2016, with relatively slow development; the main reason: at this stage, the development of modern service industry is relatively slow, and the total retail sales of consumer goods and the proportion of tertiary industry are low, which restricts the stable development of logistics industry. 2017-2020 is at advanced stage, from 0.347 in 2017 to 0.755 in 2020 0.755 in 2017. It can be found that the overall development of logistics efficiency value in Sichuan Province is fast during the sample period, experiencing this good transformation from a period of low growth to a period of high growth.

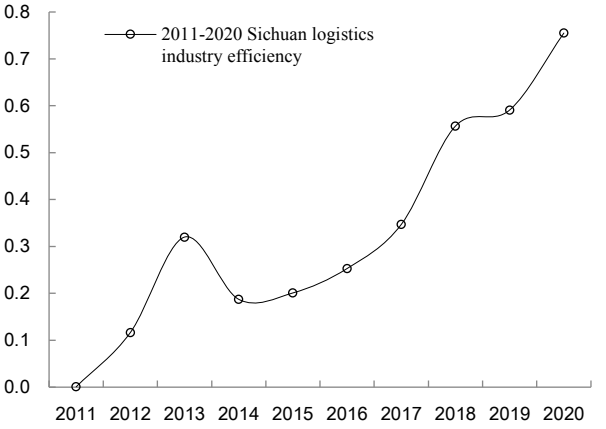

Fig. 1. 2011-2020 Sichuan Province, the trend of logistics efficiency

X_1 is 0.8671, which is the key factor affecting the gross value of logistics industry; the amount of fixed assets investment in logistics industry reflects the scale of capital invested in logistics industry [8]. Due to the spatial variability of fixed asset investment in logistics industry in Sichuan Province, the relative imbalance among regions makes this indicator an important factor influencing the development of logistics industry; X_8 correlation is 0.7473, which is the core factor influencing the gross value of logistics industry; the regional GDP reflects the degree of regional economic activity, and this indicator is closely related to the development of logistics industry; X_9 is 0.7078, which is an important factor influencing the gross value of logistics industry; the financial transportation expenditure reflects the importance of the government to the logistics industry, and this indicator plays an important role in influencing the development of logistics industry.

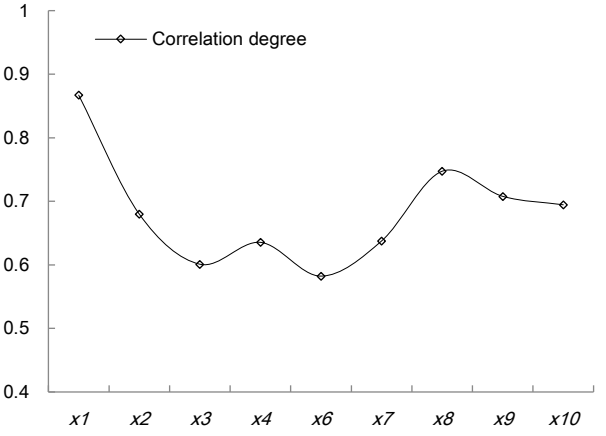

Fig. 2. Correlation analysis between GDP of logistics industry and individual indicators

4 Conclusions

This paper measures the efficiency of logistics industry in Sichuan Province from 2011 to 2020 based on the entropy power TOPSIS model, and uses gray correlation analysis to explore the key factors affecting the development of logistics industry. The conclusions of this study are as follows: (1) Logistics efficiency in Sichuan Province is on an upward trend, rising from 0.001 in 2011 to 0.755 in 2020, with a good development trend. (2) Fixed asset investment in logistics industry X_1 Gross regional product X_8 Financial transportation expenditure X_9 Three major indicators are the key factors affecting the development of gross logistics product.

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