Economics & Business Management
ISSN Print: 3079-5214
ISSN Online: 3079-5222
https://doi.org/10.63313/EBM.2003

Study on Agricultural Products Logistics Capacity in Sichuan and Chongqing Region Based on Factor Analysis

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How to cite this paper: Meng, D. D., & Zhang, R. (2025). Study on Agricultural Products Logistics Capacity in Sichuan and Chongqing Region Based on Factor Analysis. Economics & Business Management, 1(2), 136–146. ISSN Print: 3079-5214, ISSN Online: 3079-5222.
https://doi.org/10.63313/EBM.2003
Published: 2025-05-06

Abstract

Based on factor analysis, this paper constructs an evaluation index system of agricultural products logistics capability by selecting several indexes such as economic development level of agricultural products logistics, basic level of logistics development and level of logistics informatization, and evaluates the agricultural products logistics capability of Sichuan and Chongqing systematically. The results show that there are significant differences in agricultural products logistics capacity between Sichuan and Chongqing, Chongqing City is better than Sichuan Province, Sichuan cities still need to improve logistics infrastructure and informatization level.

Keywords

Factor Analysis; Agricultural Product Logistics; Index Evaluation System

1. Introduction

1.1 Research Background

With the advancement of agricultural modernization and the improvement of consumers 'requirements for the quality of agricultural products, the role of agricultural product logistics as a bridge between agricultural production and consumption has become increasingly prominent. However, the agricultural products logistics system in Sichuan and Chongqing still faces many challenges, such as unbalanced logistics infrastructure, insufficient application of information technology and high logistics cost, which restrict the circulation efficiency and market expansion of agricultural products.

1.2 Research Significance

By constructing scientific evaluation index system of agricultural products logistics capacity, it provides theoretical basis for quantitative evaluation of agricultural products logistics capacity in Sichuan and Chongqing region. Secondly, it reveals key factors affecting logistics capacity by factor analysis method, which provides decision-making support for policy makers. Finally, through comparative analysis of logistics capacity of 19 cities, it clarifies the advantages and disadvantages of each region, which provides reference basis for coordinated development of regional logistics and optimal allocation of resources.

1.3 Research Contents

This study is based on 19 cities in Sichuan and Chongqing (Including 18 prefecture-level cities in Sichuan Province and Chongqing City) as the research objects, the specific research contents include the following aspects:

Construction of evaluation index system: According to the characteristics of agricultural product logistics and the actual situation of Sichuan and Chongqing, construction of evaluation index system including rural economic development level, informatization degree, agricultural product development conditions and other dimensions.

Data collection and processing: relevant data are collected through official statistics, industry reports and other channels, and pre-processed and standardized.

Factor analysis: factor analysis was carried out by SPSS software to extract the key factors affecting the logistics capacity of agricultural products, and the factor scores of each city were calculated.

Result analysis and discussion: based on the results of factor analysis, the agricultural logistics capacity of each city was ranked and compared, and the key factors affecting the logistics capacity and their mechanism were discussed.

Policy recommendations: According to the results of the study, the paper puts forward policy suggestions to improve the logistics capacity of agricultural products in Sichuan and Chongqing, and provides reference for government decision-making.

2. Literature Review and Theoretical Analysis

As an important branch of logistics industry, agricultural product logistics plays an important role in ensuring agricultural product supply and promoting agricultural industry development. In recent years, with China's policy support for agricultural product industry chain and steady increase in agricultural product market demand, the total amount of agricultural product logistics in China has continued to grow. According to the data of the National Development and Reform Commission, the total amount of agricultural product logistics reached 5.3 trillion yuan in 2022, accounting for 1.52% of the total social logistics, with a compound annual growth rate of 6.66%. As an important part of agricultural product logistics, cold chain logistics has developed rapidly in recent years and has become a new strategic industry. However, limited by terrain, climate, traffic and other factors, the development level of agricultural products logistics in Sichuan and Chongqing region lags behind relatively, and there are some problems such as weak infrastructure, difficult transportation and low information level.

With regard to the research on agricultural product logistics, Yang Guimei et al.(2016) combined factor analysis and analytic hierarchy process to give a method to construct an evaluation index system for agricultural product logistics development strength, and obtained an evaluation model for agricultural product logistics development level. It can calculate the measurement value of agricultural product logistics development level in any region and quantitatively evaluate the development level of agricultural product logistics. Wu Jinshan et al.(2021) established a comprehensive evaluation system of agricultural product logistics development level in Shandong Province from four aspects: economic basic conditions, agricultural product development conditions, transportation conditions and informatization level conditions, and made objective evaluation and suggestions on agricultural product logistics development level in Shandong Province by factor analysis method. Yue Qi (2019) used grey correlation analysis, entropy weight method and principal component analysis to study the competitiveness of logistics industry and the status quo of logistics development level in various regions of China. Li Yijia et al.(2022) used factor analysis to comprehensively evaluate the logistics development level of cities in Henan Province, and put forward constructive suggestions such as strengthening logistics infrastructure construction and personnel training according to the specific development situation of Henan Province. Li Xiaohong et al.(2023) analyzed the comprehensive logistics level of each city in Henan Province by factor analysis and cluster analysis, and put forward suggestions on the future development focus.

As an important agricultural region, Sichuan and Chongqing area has received extensive attention for its agricultural product logistics development. However, there are relatively few systematic studies on agricultural product logistics capacity in this region, especially in-depth studies based on factor analysis.

3. Construction and Research Method of Evaluation Index System

3.1 Construction of Index System

The evaluation index of agricultural products logistics should reflect the actual situation objectively and accurately, and adapt to the characteristics of local logistics development. Based on consulting a large number of domestic and foreign documents, referring to the previous research on agricultural products logistics system, after applying Delphi method and communicating with experts in related fields, this paper draws lessons from the indicators selected by scholars such as Wang Shanshan to study logistics network system, combines the development of agriculture and logistics industry in Sichuan and Chongqing areas, and according to the characteristics of index data, the representativeness and scientific principles of research objects and the characteristics of Sichuan and Chongqing areas, the first level indicators are rural economic development level, Rural logistics development level, agricultural product development conditions, information level; Select 12 secondary indicators such as GDP per capita, total output value of agriculture, forestry, animal husbandry and fishery, total retail sales of social consumer goods, rural per capita consumption expenditure, output of main agricultural products, planting area of crops, highway mileage, ownership of civil vehicles, freight volume, total post and telecommunications business, number of mobile communication users and number of Internet users to construct the evaluation index system of agricultural product logistics development in 19 cities in Sichuan and Chongqing, as shown in Table 1. The data of each indicator comes from Statistical Yearbook of Sichuan Province and Statistical Yearbook of China in 2022.

Table 1. Evaluation system of agricultural product logistics development level of 19 cities in Sichuan and Chongqing

first-level indicators	secondary indicators
rural economic development level	per capita GDP（X_1）/ yuan gross output value of agriculture（X_2）/ 100 million yuan Rural consumption expenditure per capita（X_3）/ yuan total retail sales of consumer goods (X_4)/ 100 million yuan
Rural logistics development level	volume of freight traffic (X_5)/ million tons highway mileage (X_6)/kilometre Civilian vehicle ownership (X_7)/million
Conditions for the development of agricultural products	output of major agricultural products (X_8)/million tons planting area of crops (X_9)/thousand hectares
informationization degree	Total postal and telecommunications services (X_{10})/ 100 million yuan Internet broadband access users（X_{11}）/wan hu Number of mobile subscribers (X_{12})/ wan hu

3.2 Research Technique

According to the basic principle of factor analysis, the following mathematical models can be established: assuming that there are N sample data, P observed variables and m hidden common factors, the initial common factor variables can be expressed as Y_1, Y_2, ⋯, Y_m 。After standardization, it can be expressed asF＝（F_1, F_2, …, F_N）^{t}, If X is used to represent the new variable after transformation, it can be written as X=（X_1, X_2, …, X_P)^t, Hence the factor analysis model:

$$\begin{cases} X_1 = a_{11}F_1 + a_{12}F_2 + \cdots + a_{1N}F_N \\ X_2 = a_{21}F_1 + a_{22}F_2 + \cdots + a_{2N}F_N \\ \qquad \dots\dots \\ X_P = a_{P1}F_1 + a_{P2}F_2 + \cdots + a_{PN}F_N \end{cases} \tag{1}$$

4. Empirical Analysis

4.1 Data Standardization

Data standardization Because of different economic significance and expression forms, each quantitative index is not comparable, so in order to evaluate the index scientifically, each index must be standardized.The formula is as follows:

$$Z = \frac{X - \bar{X}}{S} \tag{2}$$

X is the raw data, $\bar{X}$ is the sample mean, and S is the sample standard deviation.

4.2 Data Fitness Test

The standardized data were subjected to KMO test and Bartlett sphere test by SPSS, and whether the data were suitable for factor analysis was judged according to the test results. It can be seen from Table 2 that the KMO value was 0.780, greater than 0.6; the Bartlett sphere test significance expression was 0.000, less than 0.001, indicating that it was suitable for factor analysis.

Table 2. KMO test and Bartlett test values

KMO and Bartlett test		
KMO sampling appropriateness measure		0.780
Bartlett's sphericity test	approximate chi-square	611.893
	degree of freedom	66
	significance	0.000

4.3 Extract Common Factors and Name them

Factor analysis was performed on the normalized data to obtain the total variance interpretation table, and the results are shown in Table 3.According to the principle of eigenvalue greater than 1, two common factors are extracted F_1、F_2, At this time, the variance explanation rate of two common factors is 92. 714%, more than 85%,Therefore, these two common factors can basically represent the development of agricultural products logistics in 19 cities in Sichuan-Chongqing area, and can be selected as the comprehensive evaluation index of the overall logistics development level in Sichuan-Chongqing Shuangcheng Economic Circle.

Table 3. Total variance interpretation

ingredient	initial eigenvalue			sum of squares of rotational loads		
	aggregate	Percentage variance	accumulative total%	aggregate	Percentage variance	accumulative total%
1	8.927	74.395	74.395	6.553	54.611	54.611
2	2.198	18.319	92.714	4.572	38.102	92.714
3	0.610	5.084	97.798			
4	0.201	1.675	99.473			
5	0.038	0.319	99.791			
6	0.010	0.084	99.875			
7	0.007	0.061	99.937			
8	0.004	0.032	99.969			
9	0.002	0.017	99.986			
10	0.001	0.008	99.993			
11	0.001	0.005	99.998			
12	0.000	0.002	100.000			
Extraction method: principal component analysis.						

In order to obtain more logical common factors, this paper uses the maximum variance method to rotate the factors, and the rotated component matrix is shown in Table 4.The first common factor F_1 has a large load on the total output value of agriculture, forestry, animal husbandry and fishery, the per capita consumption expenditure of rural areas, the freight volume, the number of civil vehicles owned, the output of main agricultural products, the planting area of crops, and the total amount of post and telecommunications services, so it can be named the basic environment for rural logistics development.The second common factor F_2 has a large load on GDP per capita, total retail sales of social consumer goods, highway mileage, Internet broadband access users and mobile communication users, so it can be named rural logistics development economy

Table 4. rotated component matrix

	ingredient	
	1	2
Zscore(X_1)	0.103	0.768
Zscore(X_2)	0.953	0.274
Zscore(X_3)	0.794	0.604
Zscore(X_4)	-0.009	0.920
Zscore(X_5)	0.981	0.151
Zscore(X_6)	0.620	0.765
Zscore(X_7)	0.982	0.111
Zscore(X_8)	0.986	0.135
Zscore(X_9)	0.900	0.411
Zscore(X_{10})	0.756	0.647
Zscore(X_{11})	0.305	0.887
Zscore(X_{12})	0.496	0.827
Extraction Method: Principal Component Analysis.		
Rotation method: Caesar normalization maximum variance method.		

4.4 Factor Score Calculation

The score coefficients of each common factor after rotation are shown in Table 5. The coefficients in the factor score matrix are multiplied and added with the standardized values of variables to obtain the standardized principal component scores. The formula is as follows:

$$F_1 = -0.102X_1 + 0.177X_2 + 0.086X_3 - 0.153X_4 + 0.204X_5 + 0.019X_6 + 0.211X_7 + 0.208X_8 + 0.142X_9 + 0.070X_{10} - 0.074X_{11} - 0.020X_{12} \quad (3)$$

$$F_2 = 0.239X_1 - 0.065X_2 + 0.072X_3 + 0.309X_4 - 0.110X_5 + 0.154X_6 - 0.124X_7 - 0.116X_8 - 0.010X_9 + 0.092X_{10} + 0.246X_{11} + 0.195X_{12} \quad (4)$$

$$F = (0.54611F_1 + 0.38102F_2)/0.92714 \quad (5)$$

Table 5. Component score coefficient matrix

	ingredient	
	1	2
Zscore(X_1)	-0.102	0.239
Zscore(X_2)	0.177	-0.065
Zscore(X_3)	0.086	0.072
Zscore(X_4)	-0.153	0.309
Zscore(X_5)	0.204	-0.110
Zscore(X_6)	0.019	0.154
Zscore(X_7)	0.211	-0.124
Zscore(X_8)	0.208	-0.116
Zscore(X_9)	0.142	-0.010

Zscore(X_{10})	0.070	0.092
Zscore(X_{11})	-0.074	0.246
Zscore(X_{12})	-0.020	0.195
Extraction Method: Principal Component Analysis. Rotation method: Caesar normalization maximum variance method.		

The comprehensive scores of 19 cities in Sichuan and Chongqing can be obtained by substituting the data into SPSS software for calculation. The results are shown in Table 6. From the actual situation of comprehensive factor F score, it can be found that the rural logistics development level of each region is very different.

Table 6. Ranking of Logistics Capacity of Cities in Sichuan and Chongqing

city	F_1	ranking	F_1	ranking	F	ranking
Chongqing City	3.91054	1	0.5907	2	2.55	1
Chengdu City	-0.31789	12	3.64187	1	1.31	2
Mianyang City	-0.1625	9	0.15696	6	-0.03	3
Nanchong City	0.40828	3	-0.68404	16	-0.04	4
Yibin City	-0.1418	7	0.00269	9	-0.08	5
Dazhou City	0.41609	2	-0.91149	18	-0.13	6
Deyang City	-0.40822	14	0.24164	4	-0.14	7
Luzhou City	-0.0552	6	-0.29782	13	-0.15	8
Leshan City	-0.45697	16	0.23752	5	-0.17	9
Neijiang City	-0.27414	11	-0.15236	11	-0.22	10
Zigong City	-0.45207	15	0.02895	8	-0.25	11
Suining City	-0.3993	13	-0.11118	10	-0.28	12
Meishan City	-0.48962	17	0.03195	7	-0.28	13
Panzhihua City	-0.89386	19	0.50327	3	-0.32	14
Guangyuan City	0.02782	5	-0.82569	17	-0.32	15
Guang 'an City	-0.16007	8	-0.56587	14	-0.33	16
Ziyang City	-0.17691	10	-0.59049	15	-0.35	17
Bazhong City	0.15671	4	-1.08364	19	-0.35	18
Ya 'an city	-0.53088	18	-0.21298	12	-0.4	19

4.5 Result Analysis

The top five in the first common factor（F_1）are Chongqing City, Dazhou, Nanchong City, Bazhong City and Guangyuan City respectively, indicating that these five areas are better in the basic environment of rural logistics and conducive to the development of logistics industry.However, the scores of Ya 'an city, Meishan City, Panzhihua City, Zigong City and Leshan City are relatively low. The development of rural logistics environment in the above areas needs to be improved, indicating that it is necessary to further increase the investment in logistics infrastructure development.

The top five in the second common factor（F_2）are Chongqing City, Chengdu City, Panzhihua City, Deyang City and Leshan City respectively, indicating that these five cities are superior to other cities in the province in terms of logistics economic scale development and informatization, especially Chengdu.However, the overall score and individual factor scores of Panzhihua City are very different, indicating that the influencing factors represented by each factor have developed unevenly. If you want to get the development of agricultural product logistics that is specifically suitable for a certain city, further analysis is needed. Ziyang City, Nanchong City, Guangyuan City, Dazhou and Bazhong City have lower scores. These areas have low levels of logistics economy and informatization, and lack of vitality for logistics economic development.

According to the comprehensive score, Chongqing City, Chengdu City, Mianyang City, Nanchong City and Yibin City have relatively high scores at present, indicating that the rural logistics development level of these five regions is relatively good.Among them, the score of Chongqing City is much higher than that of Sichuan Province. As a municipality directly under the Central Government, Chongqing City government attaches great importance to the development of agricultural products logistics and promotes the perfection of agricultural products logistics system through policy support and capital investment. However, Guang 'an City, Bazhong City, Ya' an city and Ziyang City scored lower, because of poor logistics infrastructure, generally older agricultural producers and operators, and lack of modern logistics management concept.

5. Conclusions and Recommendations

5.1 Conclusions

Through factor analysis, we can get the situation of agricultural products logistics capacity in Sichuan and Chongqing. There are significant differences in agricultural products logistics capacity between Sichuan and Chongqing. Chongqing City relies on its unique geographical advantages and rapid development of multimodal transport system (such as Chongqing-Xinjiang-Europe Railway, Yangtze River Golden Waterway and expanded airport), through UAV transshipment + civil aviation cargo plane, it has realized efficient and rapid transportation of agricultural products, significantly improved logistics efficiency, and provided a solid foundation for agricultural product logistics. With its strong economic strength and relatively perfect logistics infrastructure, it has shown obvious advantages in agricultural product logistics capacity; As the capital city and economic center of Sichuan Province, Chengdu City enjoys a relatively high level of agricultural product logistics development. Chengdu City has perfect logistics infrastructure and advanced logistics technology, which can efficiently and rapidly transport agricultural products to all parts of the country. Other cities in Sichuan Province have relatively weak logistics infrastructure, underdeveloped transportation network and large gap in cold chain logistics facilities. Due to the long transportation distance and many transit links, the logistics cost of agricultural products is relatively high, which affects the logistics efficiency and market competitiveness. The informatization level of agricultural products circulation is not high, and the logistics information is opaque, which makes it difficult to optimize the allocation of logistics resources. The comprehensive development level of rural logistics in many cities is not high, and the advantages and disadvantages of various regions are obviously different.

Sichuan-Chongqing region, as an important part of Chengdu-Chongqing dual-city economic circle, the coordinated development of agricultural product logistics capacity is of great significance to promote regional economic integration. However, there are still deficiencies in logistics infrastructure construction and information sharing between Sichuan and Chongqing. It is necessary to strengthen regional cooperation, perfect agricultural product logistics industry policy system and jointly improve agricultural product logistics capacity.

5.2 Recommendations

5.2.1 Complementary advantages and coordinated regional development

According to the result of factor analysis, the development level of rural logistics in 19 cities has its own advantages and disadvantages. Chengdu and Chongqing present the phenomenon of double dominance, while the logistics development level of other cities in Sichuan is relatively low.Chengdu should make use of its infrastructure, geographical and economic advantages to drive the development of agricultural products logistics in other cities in Sichuan Province, transport agricultural products to all parts of the country, and drive the economic growth of each city. Learn from Chongqing's "postal express" mode, promote efficient logistics modes such as unmanned aerial vehicle transfer and civil aviation freight charter, shorten the transportation time of agricultural products, and improve logistics efficiency. Strengthen the application and promotion of cold chain logistics technology, reduce the decay rate of agricultural products, and improve the quality and market competitiveness of agricultural products. At the same time, Chengdu and Chongqing should strengthen the interconnection of logistics infrastructure in Chengdu and Chongqing through information sharing and resource sharing, improve the coordinated operation level of agricultural product supply chain, and promote the development of regional economic integration, so as to make the comprehensive development of logistics in Chengdu-Chongqing economic circle virtuous circle, promote the coordinated development of agricultural product logistics in Sichuan-Chongqing region, strengthen inter-regional cooperation and linkage, and realize the sharing and optimization of logistics resources. Strengthen cooperation and exchanges with neighboring provinces and international markets, and broaden sales channels and market space for agricultural products.

5.2.2 Strengthen policy support and infrastructure construction

The government should introduce more supportive policies to encourage social capital to invest in agricultural logistics, especially cold chain logistics. Strengthen industry guidance and planning, guide logistics enterprises to rational layout and orderly development, and avoid resource waste and vicious competition. Give priority support to land approval for logistics parks, cold chain logistics bases and other projects to ensure smooth implementation of logistics projects. In areas where logistics development lags behind, such as Panxi Economic Zone and Northwest Sichuan Ecological Economic Zone, we will focus on building cold chain logistics infrastructure such as cold chain warehouses and refrigerated trucks to ensure the freshness and quality of agricultural products during transportation. Advanced cold chain preservation technology will be introduced to improve the shelf life of agricultural products and reduce losses. Increase investment in transportation infrastructure, especially road construction in remote areas, build more agricultural logistics centers and cold chain logistics facilities, improve transportation networks, and improve transportation efficiency and service quality of agricultural logistics.

5.2.3 Improving the informatization level of agricultural products logistics

Sichuan-Chongqing region should actively promote the construction of logistics informatization, establish agricultural products logistics information platform, realize real-time sharing and transparency of logistics information, strengthen the construction of agricultural products logistics traceability system, and improve the optimization allocation ability of logistics resources. Promote the application of Internet of Things, big data and other modern information technology means in agricultural product logistics, improve the intelligent level of logistics management and traceability of agricultural products, realize the combination of online and offline agricultural product logistics, reduce the cost of the entire logistics system, improve the refined level of logistics management. Encourage the application of modern logistics modes such as e-commerce logistics and third-party logistics in rural areas, and improve the level of logistics specialization.

5.2.4 Strengthen personnel training and technological innovation

Sichuan-Chongqing region should pay attention to the cultivation and technological innovation of agricultural product logistics professionals, increase the cultivation of agricultural product logistics professionals, regularly organize agricultural product logistics training, improve the professional quality and operation skills of employees. At the same time, strengthen cooperation with universities and scientific research institutions, promote talent cultivation and technological innovation, and provide strong support for the continuous improvement of agricultural product logistics capacity.

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