Grey Correlation Analysis on the Economic Factors of Regional Logistics in Guangdong Province

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Abstract: Taking the regional logistics of Guangdong Province as the research object, this paper uses the relevant data of logistics and economy of Guangdong Province from 2015 to 2019, and applies the grey correlation analysis method to study the correlation degree between the relevant indicators of economic development of Guangdong Province and the development level of regional logistics. Through quantitative calculation, it clearly shows the relevant economic factors that have a greater impact on regional logistics, and provides good suggestions and Countermeasures for the healthy development of regional logistics.

1 INTRODUCTION

Logistics system is a subsystem of social economic system, which plays a very important role in regional economic system. With the acceleration of the process of regional economic integration, the relationship between regional logistics and regional economy has become more and more close. The development of regional economy will promote the demand market of regional logistics and the development of regional logistics. Regional logistics is an important part of regional economy, which will provide a good platform for the development of regional economy and promote the rapid development of regional economy. The regions with more developed regional economy tend to have more developed logistics industry and strong logistics demand, and vice versa.

Regional logistics demand refers to the requirements of space, time, workload and cost of goods generated by the allocation of raw materials, finished products and semi-finished products, used goods and waste materials in the fields of production, circulation and consumption by social and economic activities in a certain period of time and within a certain region, involving transportation, warehousing, packaging, loading and unloading and handling Circulation processing and related information processing and other aspects of logistics activities. There are two kinds of indicators to measure regional logistics demand: one is the entity system indicators, such as freight volume, freight turnover, inventory, processing volume. The second is the value system indicators, such as transportation, warehousing and other logistics costs, total logistics costs, the proportion of logistics costs in GDP, total logistics revenue.

According to the "Iceberg Theory", the logistics system itself is a gray system, with obvious randomness and uncertainty. The relationship between regional economy and regional logistics is constantly changing.

The economic factors affecting regional logistics have obvious timeliness. The data collected are the data of recent years. This is a small sample problem, and the information reflected is not comprehensive enough, with gray characteristics. Therefore, in the study of the relationship between regional logistics and regional economy, it is suitable to use grey correlation analysis method to compare the relationship between the two. This paper uses this method to quantitatively analyze the relationship between regional logistics and various economic indicators in Guangdong Province, and puts forward some opinions and suggestions, which has certain practical significance for the scientific and reasonable development of regional logistics in Guangdong Province.

2 Literature review

With the increasingly fierce competition in regional economy, the impact of regional logistics on regional economy is becoming more and more important. The rapid development of regional economy promotes the continuous increase of regional logistics demand and the continuous improvement of regional logistics efficiency, which can better promote the healthy development of regional economy.

In foreign countries, the research on the direct relationship between regional logistics and regional economy is earlier. Heehoo ham and others believe that the development of regional economy is affected by the unexpected events in the process of physical flow between regions, and make a quantitative analysis of the relationship by building a mathematical model^[1]; Donald J. Bowersox studied the interaction between regional logistics and regional economy^[2]. The results show that regional economy and logistics industry influence and promote each other; Macuilis qualitatively analyzes the relationship between logistics infrastructure investment

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and economic growth, clarifies the positive and negative effects of logistics infrastructure investment on economic growth, and puts forward feasible strategies for coordinated growth between the two^[3].

Many domestic scholars use grey correlation method to analyze the correlation between regional logistics and regional economy. Xiao Jing and Dong Qingxue used the grey correlation analysis method to analyze the correlation degree between freight turnover and regional economic indicators in Jilin Province, and put forward reasonable suggestions to promote the development of regional logistics according to the order of correlation degree from high to low^[4]. Gao Sheng and Zhang Xifeng studied the relative economic factors which have important influence on the regional logistics of Zhejiang Province through the grey correlation method, and provided some suggestions for the development of regional logistics^[5]. Rong Luqing constructs the influencing factors system from the aspects of regional economy, regional logistics environment, industrial development and informatization, and uses gray correlation analysis to analyze the relevant factors affecting the waterway freight volume.^[6] These scholars have applied the grey correlation method to analyze the factors that have great influence on regional logistics, and put forward some suggestions. For the development of regional logistics in Guangdong, the grey correlation analysis method has not been applied to study the relevant economic factors.

3 Research Methods

Grey relational analysis is a quantitative analysis method for the development and change trend of a system. Its basic idea is to determine whether they are closely related by determining the geometric similarity of a reference sequence and several comparison sequences^[7]. It reflects the degree of correlation between curves. The calculation steps of grey correlation analysis method are as follows.

Let n data form the following matrix

$$(X_1', X_2', \dots, X_n') = \begin{pmatrix} x_1'(1) & x_2'(1) & \dots & x_n'(1) \\ x_1'(2) & x_2'(2) & \dots & x_n'(2) \\ \vdots & \vdots & \ddots & \vdots \\ x_1'(m) & x_2'(m) & \dots & x_n'(m) \end{pmatrix} \quad (1)$$

Where m is the number of indicators

$$X_i' = (x_i'(1), x_i'(2), \dots, x_i'(m))^T, \quad i = 1, 2, \dots, n \quad (2)$$

Step 1: determine the reference sequence

$$X_0' = (x_0'(1), x_0'(2), \dots, x_0'(m)) \quad (3)$$

Step 2: dimensionless processing of comparative sequence data

The measurement units of each series data in the system are inconsistent. When the grey correlation analysis is carried out, the direct comparison will produce large errors. Generally, it is necessary to deal with the data of each sequence dimensionless, and the initial value method is used to do dimensionless processing.

$$x_i(k) = \frac{x_i'(k)}{x_i'(1)} \quad (4)$$

$$i = 0, 1, \dots, n; \quad k = 1, 2, \dots, m.$$

Step 3: calculate absolute value

Calculate the absolute difference between each index sequence (comparison sequence) and the corresponding element of reference sequence one by one.

$$\text{That is } \Delta_i = |x_0(k) - x_i(k)| \quad (5)$$

(number of objects evaluated)

Step 4: determine the maximum and minimum difference

$$\Delta_{\min} = \min_{i=1}^n \min_{k=1}^m |x_0(k) - x_i(k)| \quad (6)$$

$$\Delta_{\max} = \max_{i=1}^n \max_{k=1}^m |x_0(k) - x_i(k)| \quad (7)$$

Step 5: calculate the correlation coefficient

The correlation coefficients of each comparison sequence and the corresponding elements of reference sequence are calculated respectively.

$$\zeta_i(k) = \frac{\min_k |x_0(k) - x_i(k)| + \rho \cdot \max_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \rho \cdot \max_k |x_0(k) - x_i(k)|} \quad (8)$$

$$k = 1, \dots, m$$

In the above formula ρ For resolution coefficient, value between (0, 1), if ρ The smaller the correlation coefficient, the greater the difference, the stronger the ability of differentiation, usually 0.5.

Step 6: calculate the association order

The mean value of correlation coefficient between each index and the corresponding elements of reference sequence is calculated for each evaluation object (comparison sequence), so as to reflect the correlation relationship between each evaluation object and reference sequence, and call it the correlation order, and record it as

$$r_{0i} = \frac{1}{m} \sum_{k=1}^m \zeta_i(k) \quad (9)$$

4 Empirical Analysis

4.1 Selection of regional logistics economic factors in Guangdong Province

There are many evaluation indexes of regional logistics development level in Guangdong Province. Based on the existing research, from the perspective of data availability, rationality and representativeness, the whole social freight volume is usually used to represent the regional logistics development demand. Relevant data of 2015-2019 are collected from the statistical yearbook of Guangdong Province 2020, and the data of the designed freight volume (10000 tons) is x_0 ; The regional gross product (billion yuan) is set as X_1 ; The turnover of goods (100 million tons km) is set to x_2 ; The GDP of the third industry (billion yuan) is set to X_3 , and the data of transportation, storage and postal transportation (billion

yuan) is set to X_4 ; The total import and export amount (billion yuan) is set to X_5 ; The mileage (km) of the highway is set to X_6 , and the following table 1 is obtained.

4.2 Data collection and grey correlation calculation of regional logistics influencing factors

Table 1. Regional logistics development index of Guangdong Province from 2015 to 2019

Year	2015	2016	2017	2018	2019
X_0	349832	377645	400601	424996	446018
X_1	74732.44	82163.22	91648.73	99945.22	107671.07
X_2	14667.43	22032.27	28192.23	28644.77	29230.88
X_3	37628.92	43163.49	49500.68	54710.37	59773.38
X_4	2662.73	2877.45	3166.69	3363.48	3466.42
X_5	63559.70	63099.68	68168.86	71645.73	71484.39
X_6	216023	218085	219580	217699	220290

Data source: Guangdong statistical yearbook 2020

Step 1: Obtain the following sequence after dimensionless processing of data sequence

$$X_0' = \{1.0000, 1.0795, 1.1451, 1.2149, 1.2749\}$$

$$X_1' = \{1.0000, 1.0994, 1.2264, 1.3374, 1.4408\}$$

$$X_2' = \{1.0000, 1.5021, 1.9221, 1.9530, 1.9929\}$$

$$X_3' = \{1.0000, 1.1471, 1.3155, 1.4539, 1.5885\}$$

$$X_4' = \{1.0000, 1.0806, 1.1893, 1.2632, 1.3018\}$$

$$X_5' = \{1.0000, 0.9928, 1.0725, 1.1272, 1.1247\}$$

$$X_6' = \{1.0000, 1.0095, 1.0165, 1.0078, 1.0198\}$$

Step 2, find the difference sequence

The following difference sequence is obtained according to formula (5)

$$\Delta 01 = \{0.0000, 0.0199, 0.0812, 0.1225, 0.1658\}$$

$$\Delta 02 = \{0.0000, 0.4226, 0.7770, 0.7381, 0.7180\}$$

$$\Delta 03 = \{0.0000, 0.0676, 0.1704, 0.2391, 0.3135\}$$

$$\Delta 04 = \{0.0000, 0.0011, 0.0441, 0.0483, 0.0269\}$$

$$\Delta 05 = \{0.0000, 0.0867, 0.0726, 0.0876, 0.1503\}$$

$$\Delta 06 = \{0.0000, 0.0700, 0.1287, 0.2071, 0.2552\}$$

$$\Delta 07 = \{0.0000, 0.0700, 0.1287, 0.2071, 0.2552\}$$

$$\Delta 08 = \{0.0000, 0.0700, 0.1287, 0.2071, 0.2552\}$$

$$\Delta 09 = \{0.0000, 0.0700, 0.1287, 0.2071, 0.2552\}$$

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development speed is leading in the country. From the above analysis, it is found that the impact of transportation, post and transportation on regional logistics development is very important. It is necessary to strengthen and improve the infrastructure construction constantly, increase investment in highway, railway, aviation, port and other traffic infrastructure and post and telecommunications communication equipment, and promote the construction and improvement of logistics facilities. On the basis of the existing development, we will continue to improve.

Secondly, the total import and export of Guangdong Province has reached more than 20% in the whole country for many years. The huge import and export demand has greatly promoted the development of international logistics and played a great role in the development of Guangdong logistics. The mileage of highway opening to traffic is closely related to the logistics development level of Guangdong Province. In 2020, Guangdong Province will achieve 10000 kilometers of high-speed mileage, and realize the county county expressway, which lays a solid foundation for the smooth development of logistics in the province. In the future, we still need to continue to increase investment in these areas and maintain high-speed development.

Thirdly, in recent years, Guangdong has been committed to industrial transformation and upgrading, vigorously promoting the development of modern service industry, promoting the transformation and upgrading of processing and manufacturing industry and the rise of emerging industries, making the third industry of Guangdong show a unique performance in the whole country. The third industry is closely related to the level of regional logistics development, and the rapid development of the tertiary industry is conducive to the continuous improvement of logistics level. The correlation between the turnover of goods and the volume of logistics freight in Guangdong Province is relatively small. We need to strengthen the level of the tertiary industry development and improve the development capacity of regional logistics.

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