Grey Correlation Analysis of Logistics Information Service Industry and Three Industries in China

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Abstract. On the basis of analysing and defining the industry classification of logistics information service industry, select the statistical data of logistics information service industry and three industries in China in 2017, use the grey relational analysis method to analyse the related interactive development of logistics information service industry and three industries in different provinces with different economic development levels in China, reveal the objective requirements of the development of China's logistics information service industry.

1. Introduction
Logistics has developed rapidly since it entered China, and has gradually become an important supporting industry for the service industry. With the advancement of science and technology and society, and the rapid development of information science and technology, the logistics industry is no longer just a basic process such as transportation, warehousing and so on, through the integration with information technology, it can provide better services for the national economy industry, based on this logistics information service industry came into being [1].

As an emerging industry, there are few studies on logistics information service industry at home and abroad. Chinese scholars focus on the development prospects of logistics informatization and the construction of logistics information platform [2, 3]. Foreign scholars pay more attention to the role and influence of information technology on logistics activities. In order to explore the interactive relationship between logistics information service industry and national industrial economic development, this paper uses the grey relational analysis model to make an analysis by using the data of three industries in each province of China to further test the importance of logistics information service industry in the development of national economy, and provides ideas and basis for the development of national economy.

2. Industry division and development status of logistics information service industry
Logistics information service was first put forward by Ying Sun in 2009. She classifies them as an information service industry [4]. In addition, Jinhui Li believes that the road freight information service industry is the collective name of the intersection of road freight, information industry and modern logistics [5]. To author, it is broader and more detailed. It is a general term for the activities that follow the whole logistics process and use information technology to provide technology and methods in each link of logistics transportation. Broadly speaking, the logistics information service industry should first be categorized into the service industry. It belongs not only to the information industry, but also to the transportation industry. It is also an important part of the logistics industry. It
is the intersection of the three under the service industry. The details are shown in figure 1 below.

![Diagram](image.png)

Figure 1. Industry definition of logistics information service industry.

3. Grey relational analysis model

The grey relational analysis model is a quantitative analysis method that analyzes the gray correlation degree of different data sequences of a certain system to obtain the interaction between the comparison sequence and the reference sequence. It was put forward by Professor Deng Julong in 1982, a famous scholar in China. Its basic idea is to judge the relational degree by the similarity of the geometrical shape of the sequence curve. The approximation degree of curve shape is proportional to the correlation degree between the series [6]. The basic steps of grey relational analysis are as follows:

The first step, determine the original parameter sequence of the system $X(0)={x(0)(1),x(0)(2),…,x(0)(n)}$ and comparative sequence of related factors $X(i)={x(i)(1),x(i)(2),…,x(i)(n)}$, $i=1,2,…,n$, $n$ is the length of the series, $X(i)$ is the value of the variable $i$ in a certain area.

The second step, dimensionless processing of the variable sequence, in this paper, the initial value method is adopted for dimensionless processing of data to obtain its initial value image:

$$
X(i) = \frac{X(i)}{X(i)(1)} = \left\{x(i)(1),x(i)(2),…,x(i)(n)\right\}, (i=0,1,2,…,m)
$$

(1)

The third step, the absolute difference between the original parameter sequence and the comparison sequence of related factors, that is, the difference sequence is:

$$
\Delta(i) = \left\{\Delta(i)(1),\Delta(i)(2),…,\Delta(i)(n)\right\}, (i=0,1,2,…,m).
$$

among them, $\Delta(i)(k) = |x'(i)(0)-x'(i)(k)|$, $(k=1,2,…,n)$.

The fourth step, calculate the grey correlation coefficient. Where minmin$\Delta(i)(k)$ and maxmax$\Delta(i)(k)$ are respectively the minimum and maximum values of matrices consisting of difference sequences. $\rho \in (0,1)$ is called resolution, this article takes $\rho=0.5$.

$$
\gamma_{0k} = \frac{\min \min \Delta(i)(k) + \rho \max \max \Delta(i)(k)}{\Delta(i)(k) + \rho \max \max \Delta(i)(k)}, (i=1,2,…,m)
$$

(2)

The fifth step, calculate the grey correlation degree:

$$
\omega_{0i} = \frac{1}{n} \sum_{k=1}^{n} \gamma_{0k}(k), i = 1,2,…,m
$$

(3)

The sixth step, analysis of results based on the grey correlation degree.

4. Grey correlation analysis of logistics information service industry and three industries in China

According to the classification mentioned above, depending on the availability of data, and taking the National Economic Industry Classification (GB/T 4754-2017) as the standard, logistics information service industry is a combination of category G transportation, warehousing and post industry, and category I information transmission, software and information technology service industry in the
tertiary industry. Selecting the logistics information service industry, GNP and output value-added of three industries in each province in 2017 as the basic indicators of grey correlation analysis. Setting the output value-added series of logistics information service industry (X0) as the system reference series, the output value-added series of total output (X1), primary industry (X2), secondary industry (X3) and tertiary industry (X4) is used as the sequence of comparative factors, the specific data are shown in Table 1 below. Meanwhile, in order to reflect the relationship between logistics information service industry and three industries in different provinces with different levels of economic development, provinces are divided into backward regions, developing regions and developed regions according to the per capita GDP in 2017[7]. The data obtained are from the National Bureau of Statistics and the provincial 2018 statistical yearbook and the 2017 Statistical Bulletin.

Table 1. Value-added data of industrial output of provinces in 2017.

| Province     | Value-added Output Data | (X0) | (X1) | (X2) | (X3) | (X4) |
|--------------|-------------------------|------|------|------|------|------|
| Gansu        | 611.76                  | 7459.90 | 859.75 | 2561.79 | 4038.36 |
| Yunnan       | 502.61                  | 16376.34 | 2338.37 | 6204.97 | 7833.00 |
| Guizhou      | 1895.51                 | 13540.83 | 2032.27 | 5428.14 | 6080.42 |
| Shanxi       | 1675.15                 | 15528.42 | 719.16  | 6778.89 | 8030.37 |
| Guangxi      | 1493.03                 | 20396.25 | 2906.87 | 9297.84 | 8191.54 |
| Heilongjiang | 2559.58                 | 16199.90 | 2968.80 | 4289.70 | 8941.40 |
| Jiangxi      | 1366.65                 | 20006.31 | 1835.26 | 9627.98 | 8543.07 |
| Anhui        | 1386.00                 | 27018.00 | 2582.27 | 12838.28 | 11597.45 |
| Qinghai      | 191.70                  | 2624.83  | 238.41  | 1162.41 | 1224.01 |
| Sichuan      | 2711.35                 | 36980.20 | 4282.80 | 14294.00 | 18403.40 |
| Henan        | 3108.78                 | 44552.83 | 4139.29 | 21105.52 | 19308.02 |
| Hebei        | 3048.20                 | 35964.00 | 3507.90 | 17416.50 | 15039.60 |
| Hainan       | 378.60                  | 4462.54  | 962.84  | 996.35  | 2503.35 |
| Hunan        | 3965.40                 | 34590.60 | 3690.00 | 14155.50 | 16755.10 |
| Liaoning     | 2414.42                 | 23942.00 | 2182.10 | 9397.80  | 12362.10 |
| Jilin        | 929.01                  | 14944.53 | 1095.36 | 6998.51  | 6850.66 |
| Shanxi       | 2277.00                 | 21898.81 | 1741.45 | 10882.88 | 9274.48 |
| Hubei        | 2820.52                 | 35478.09 | 3528.96 | 15441.75 | 16507.38 |
| Shandong     | 4421.85                 | 72634.15 | 4832.71 | 32942.84 | 34858.60 |
| Guangdong    | 7398.17                 | 89705.23 | 3611.44 | 38008.06 | 48085.73 |
| Fujian       | 2674.93                 | 32182.09 | 2215.13 | 15354.29 | 14612.67 |
| Zhejiang     | 4852.98                 | 51768.26 | 1933.92 | 22232.08 | 27602.26 |
| Jiangsu      | 5588.95                 | 85900.90 | 4076.70 | 38654.80 | 43169.40 |

First, grey correlation analysis of logistics information service industry and three industries in backward regions. The backward regions here refer to the provinces and cities with a per capita GDP of less than 44,000 yuan in 2017. Eight provinces are selected here. The correlation coefficient and correlation degree are obtained as shown in Table 2 below.

Table 2. Correlation coefficient and correlation degree between logistics information service industry and three industries in backward regions.

| Province     | Value-added Output Data | (X0) | (X1) | (X2) | (X3) | (X4) |
|--------------|-------------------------|------|------|------|------|------|
| Gansu        | 1.0000                  | 1.0000 | 1.0000 | 1.0000 |
| Yunnan       | 0.4999                  | 0.4197 | 0.4617 | 0.5512 |
| Guizhou      | 0.5169                  | 0.6514 | 0.5836 | 0.4629 |
| Shanxi       | 0.6765                  | 0.4193 | 0.9371 | 0.6468 |
| Guangxi      | 0.8238                  | 0.5935 | 0.5359 | 0.7691 |
| Heilongjiang | 0.4056                  | 0.6526 | 0.3536 | 0.4107 |
| Jiangxi      | 0.754                   | 0.9325 | 0.4739 | 0.9206 |
| Anhui        | 0.5031                  | 0.6504 | 0.3333 | 0.6937 |
| correlation degree | 0.6475 | 0.6649 | 0.5849 | 0.6819 |

It can be seen from Table 2 that the correlation between the three industries and logistics
information service industry in backward regions of China is relatively low on the whole. Among them, the tertiary industry has the highest correlation with the logistics information service industry (0.6189). In addition, the primary industry is second only to the tertiary industry (0.6649), this is because most of the backward regions are large agricultural provinces, the production and sales of agricultural products require a large amount of logistics and information services such as transportation, warehousing and wholesale and retail. The second industry has the lowest correlation with the logistics information service industry (0.5849). This indicates that there is less demand for logistics information in manufacturing, mining and construction industries in backward regions.

Second, grey correlation analysis of logistics information service industry and three industries in developing regions. The developing regions here refer to the provinces and cities where the per capita GDP in 2017 is between 44,000 yuan and 60,000 yuan. Nine provinces are selected here. The correlation coefficient and correlation degree are obtained as shown in table 3 below.

Table 3. Correlation coefficient and correlation degree between logistics information service industry and three industries in developing regions.

| Province | X1  | X2  | X3  | X4  |
|----------|-----|-----|-----|-----|
| Qinghai  | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Sichuan  | 0.9872 | 0.5271 | 0.6975 | 0.8269 |
| Henan    | 0.8491 | 0.7881 | 0.6870 | 0.9059 |
| Hebei    | 0.6594 | 0.7820 | 0.8227 | 0.5409 |
| Hainan   | 0.9394 | 0.6736 | 0.7921 | 0.9838 |
| Hunan    | 0.3619 | 0.4498 | 0.3333 | 0.3783 |
| Liaoning | 0.5507 | 0.5530 | 0.4856 | 0.6305 |
| Jilin    | 0.8340 | 0.9442 | 0.7838 | 0.8501 |
| Shanxi   | 0.5464 | 0.4821 | 0.6286 | 0.4975 |
| correlation degree | 0.7476 | 0.6889 | 0.6923 | 0.7349 |

It can be seen from table 3 that the logistics information service industry in China's developing regions has a strong correlation with the three industries. Among them, the total output has the highest correlation with the logistics information service industry (0.7476). It shows that the development of the logistics information service industry is greatly affected by the overall development of the national economy. Similar to backward regions, the correlation of the tertiary industry ranks second only to the total output (0.7349). It shows that the relationship between the tertiary industry and the logistics information service industry is very close. Besides, the correlation of the secondary industry is slightly larger than that of the primary industry, but the gap between the two industries is obviously narrowed.

Third, grey correlation analysis of logistics information service industry and three industries in developed regions. The developed regions here refer to the provinces and cities where the per capita GDP is above 60,000 yuan in 2017. Six provinces are selected here. The correlation coefficient and correlation degree are obtained as shown in table 4 below.

Table 4. Correlation coefficient and correlation degree between logistics information service industry and three industries in developed regions.

| Province | X1  | X2  | X3  | X4  |
|----------|-----|-----|-----|-----|
| Hubei    | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Shandong | 0.6252 | 0.8013 | 0.5858 | 0.5952 |
| Guangdong| 0.8943 | 0.3333 | 0.8319 | 0.7339 |
| Fujian   | 0.9509 | 0.7138 | 0.9457 | 0.9268 |
| Zhejiang | 0.7537 | 0.4055 | 0.7401 | 0.9428 |
| Jiangsu  | 0.6453 | 0.4918 | 0.6052 | 0.5580 |
| correlation degree | 0.8116 | 0.6243 | 0.7848 | 0.7928 |

It can be seen from table 4 that the correlation between the three industries and the logistics information service industry in China's developed regions is the highest. Geographically, the developed regions are mainly concentrated in the southern coastal areas, with rapid economic development and frequent foreign trade exchanges, so there is a high demand for the logistics
information service industry. In addition, the primary industry has the lowest correlation (0.6243), it shows that the overall development of China's largest agriculture, forestry, fishery and animal husbandry production regions is relatively backward, high-end equipment and advanced technology are relatively scarce, and it is necessary to strengthen the investment of high-tech equipment and high-level personnel.

5. Summary
As an emerging industry, the logistics information service industry plays a vital role in the development of the service industry and the national economy. This paper uses the grey relational analysis method to conduct an empirical analysis of the interaction between China's logistics information service industry and the three industries.

First, the development of the tertiary industry must insist on accelerating the pace of strengthening the development of logistics information service industry. Second, it is an important way for China to develop into a powerful agriculture country to achieve the modernization of logistics information services for agricultural production development and processing and export. Third, promote the linkage integration and coordinated development between industries, in order to achieve the high-quality development goals of China's economy.

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