

Research on Relationship between Traffic Volume and GDP in Tianjin

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Abstract: Relying on the superior geographical advantages and national ring Bohai Bay Economic Circle together with Beijing, Tianjin and collaborative development strategy, in recent years, not only in the railways, highways, waterways but also air transport, Tianjin is showing great achievements. There is close relationship between Transportation and Economic Development, so it is significant to study on the relationship between transport volume and GDP of Tianjin, by using gray relational analysis we come to the conclusion, that of the whole traffic volume of Tianjin, the relationship of railway freight turnover quantity and GDP is the maximum, followed by the highway freight turnover, water freight turnover. Therefore Tianjin needs to grasp the relationship between of railway freight turnover quantity and GDP to ensure the sustained and stable development of the transportation industry in Tianjin and the economy of Tianjin.

Keywords: Freight turnover; GDP; Gray correlation degree

1. Introduction

Tianjin city is located in the Intersection point of Beijing Tianjin Hebei Urban Agglomeration and Bohai economic circle, adjacent to the capital Beijing, and has the largest comprehensive port named Tianjin port in northern China, therefore Tianjin is the largest coastal open city in the north of China, at the same time, it is an important transportation hub in the north of China. (Figure 1. Geographical position of Tianjin City). In recent years, especially since the Binhai New Area has been incorporated into the national strategy, the economic of Tianjin City is developing rapidly. The GDP of 2015 in Tianjin is 16538.19 billion yuan, with an increase of 9.3% over the previous year. Meanwhile, with the reform and opening to the outside world intensified, the development of the transportation industry is promoting. Transportation, warehousing and postal services added value of 2015 in Tianjin has been 764.68 billion yuan, thus increasing 7.7%.

Through literature review we found that many scholars have studied on the relationship between transportation and economic. Ma Shoufeng, Bu Junfeng (2007) [1] used the co integration method to study the dynamic relationship between transportation system and macro economic development in China. Ma Zhuqing, Yan Jianping (2010) [2] analyzed the adaptability of transportation and economic growth with the method of transport elasticity coefficient, but both of the two were not that specific to include the relationship between the transport volume and economic development. Jiang Gefeng (2009) [3] used the gray system model and exponential smoothing methods to study on the Inner Mongolia comprehensive transport demand forecasting, and concluded with that

Inner Mongolia regional transport demand would continue to maintain an upward trend in 2010--2015. Besides, Li Rui, Dai Mingrui, Li Fengzi (2015) [4] selected 5 impact factors of freight volume with the method of gray correlation degree to find the key factors, which showed that this method is effective. Therefore, from this point of view, I use the gray correlation degree method to study on the relationship between the freight turnover and the GDP of Tianjin city. Hope to provide some reference for the development of Tianjin transportation.

This paper was organized as follows. The following section is devoted to the model building. Section 3 uses the gray relational analysis to analyze the relationship between the freight turnover and the GDP of Tianjin city. In section 4 we come to the conclusions and make a summarize.



Figure 1. Geographical position of Tianjin City

2. Model Building

Gray system correlation degree mathematical model is an important method of system analysis. In the process of system development, to confirm which factors are the main influencing factors, we can use the sort of correlation degree to analyze, the main steps are as follows.

First of all, we should carry on the qualitative analysis to the research object, determine the sequence of reference factors $X_1, X_2, X_3 \dots X_n$, and comparison sequence of factors $Y_1, Y_2, Y_3 \dots Y_n$.

Due to the dimension of the factors in the system not being necessarily the same, sometimes the numerical order of magnitude are usually with phase difference, data are difficult to compare directly. Therefore, it is necessary to deal with the original data. At present, the transformation of the original data has the following commonly used methods: Means transformation, the transformation of the initial value, the standard transformation and so on. If the data in the study have positive and negative data, we need to standardize the data.

Calculation steps:

1) Calculated difference sequence. Using difference sequence formula.

$$\Delta_i(k) = |x_0(k) - x_i(k)| \quad (1)$$

$x_0(k)$ represents the mother sequence,

$x_i(k)$ represents the compared sequence.

2) Look for the two magnitude difference and minimum difference. The formula is as follows.

$$M = \max_i \max_k \Delta_i(k), m = \min_i \min_k \Delta_i(k) \quad (2)$$

3) Look for the correlation coefficient

The formula of correlation coefficient is as follows.

$$r_i(k) = \frac{\min_i \min_k |x_0(k) - x_i(k)| + \rho \max_i \max_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \rho \max_i \max_k |x_0(k) - x_i(k)|}$$

$\rho \in (0,1)$, normally, the range of ρ is 0.1-0.5. The correlation coefficient reflects the degree of close (close) of the two sequences.

To calculate the degree of Association

From the above we can know that the correlation degree analysis is essentially the

geometric relation of time series data. If the two sequence is coincident at all time points, the correlation coefficient is 1, that is, the degree of correlation is equal

to 1. On the other hand, the two comparison sequence at any moment can not be vertical, so the correlation coefficient is greater than 0, that is, the degree of correlation is greater than 0. Therefore, the average correlation coefficient of two sequence correlation uses the two sequence comparison of each moment to calculate.

Sort. Arranged the degree of compared sequences to the same mother sequence in order, which is directly reflect the "good or bad" relationship of each compared sequence to the mother sequence.

3. Gray Relational Analysis

Tianjin actively responds to the national development strategy. And in recent years, the results are obvious. The freight turnover of Tianjin city and the data of Tianjin's gross domestic product (GDP) in 2004-2014 are shown in Table 1.

Following the above steps, we carry out our calculations as follows.

(a) The standard transformation of data

According to the character of the data, I choose to use the standard transformation. And the results are showing in the Table 2.

(b) Sequence difference calculation

Select the GDP as the mother sequence, and freight turnover quantity as the compared sequences, using the differential sequence formula (3), the obtained results are shown in Table 3.

(c) Find the maximum and minimum values

According to the above table sequence difference. Using the formula (2), we get the maximum and minimum values respectively

$$M = 1.499601, m = 0.000166$$

(d) Finding the correlation coefficient

For $\rho = 0.5$, based on the M and m derived from the above, using the formula (3), to calculate the correlation coefficient of each comparison sequence, and the result is showing in the Table 4.

(e) Get the correlation coefficient

According to the correlation c table,

get the average value, that is, the final correlation coefficient, as shown in Table 5.

Table 1. The freight turnover of Tianjin city and the data of Tianjin's (GDP) in 2004-2014

year	GDP (billion yuan)	Freight turnover		
		railway	highway	Water transport
2004	3110.97	359.5	72	10791.8
2005	3905.64	410.6	74	12108.4
2006	4462.74	453.4	75.8	11711.6
2007	5252.76	483.7	88	14717.6
2008	6719.01	480.9	178.3	2044.3
2009	7521.85	458.1	205.9	8942.5
2010	9224.46	509.5	231.2	9324.3
2011	11307.28	520	266.7	9550.6
2012	12893.88	513.2	318.2	7012.7

2013	14442.01	515.86	313.7	2267.84
2014	15726.93	519.35	349.02	2734.01

Table 2. After standard transformation

year	GDP (billion yuan)	Freight turnover		
		railway	highway	Water transport
2004	0.361865	0.756971	0.364503	1.301562
2005	0.4543	0.864568	0.374628	1.460352
2006	0.519101	0.954689	0.383741	1.412496
2007	0.610996	1.018489	0.445504	1.775039
2008	0.781549	1.012594	0.902652	0.246556
2009	0.874934	0.964585	1.042378	1.078524
2010	1.07298	1.072814	1.17046	1.124572
2011	1.315251	1.094923	1.350181	1.151865
2012	1.499803	1.080605	1.610902	0.845778
2013	1.67988	1.086206	1.58812	0.273516
2014	1.829341	1.093555	1.76693	0.32974

Table 3. Sequence difference

year	Δ1	Δ2	Δ3
2004	0.395106	0.002638	0.939697
2005	0.410268	0.079672	1.006052
2006	0.435587	0.135361	0.893394
2007	0.407493	0.165492	1.164043
2008	0.231045	0.121103	0.534993
2009	0.089651	0.167444	0.20359
2010	0.000166	0.097481	0.051592
2011	0.220328	0.034929	0.163386
2012	0.419198	0.111099	0.654026
2013	0.593674	0.09176	1.406364
2014	0.735786	0.062411	1.499601

table 4. Table of correlation coefficient

year	Correlation coefficient		
	Railway r1	Highway r2	Water transport r3
2004	0.655046	0.996715	0.443899
2005	0.646485	0.904149	0.427124
2006	0.632676	0.847265	0.456408
2007	0.648035	0.819374	0.391864
2008	0.764612	0.861136	0.583725
2009	0.893401	0.81763	0.786631
2010	1	0.885144	0.935829
2011	0.773059	0.955701	0.821263
2012	0.641546	0.871143	0.53423
2013	0.558229	0.891162	0.347824
2014	0.504829	0.923364	0.333407

Table5. The final correlation coefficient

Railway r1	Highway r2	Water transport r3
0.701629	0.888435	0.55111

The correlation coefficient degree between the freight volume of Tianjin city and the GDP of Tianjin City are respectively:

$$r_1 = 0.701629, r_2 = 0.888435, r_3 = 0.55111, r_2 > r_1 > r_3,$$

That is, of the freight turnover in Tianjin, the relationship between railway freight turnover and GDP is the largest, followed by the road freight volume and the water freight turnover.

4. Conclusions

In this paper, gray relational analysis is used to analyze the relationship three types of transportation (Railway, Highway, Water transportation) and the GDP of Tianjin, and finally we get that the gray correlation degree are

respectively 0.701629, 0.888435, 0.55111. The correlation between railway freight turnover and Tianjin's GDP is the largest. It shows that in the development of the transportation industry, the railway develops particularly significant. This is mainly because that Tianjin is located in the center of Bohai, and it is a port city. Rail transport is not only for the local industrial and agricultural production in Tianjin, it also serve for the port. Meanwhile, as a traffic hug, the goods from the hinterland city also bear by the railway, thus leading a large freight turnover, which contribute a lot to the Tianjin GDP.

In the future, Tianjin transport industry will be in a sustained and stable developing period, so Tianjin need to grasp the relationship between railway freight turnover quantity and GDP, to ensure the sustained and stable development of the transportation industry in Tianjin city and Tianjin city economy.

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