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China's Railway Transportation Demand Analysis

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Abstract: In recent years, the rapid growth of China's economic and the traffic volume also growth rapidly. By studying the relationship between railway freight volume and its influence factors to study the problem of railway goods transportation needs. Using the multiple linear regression to the data on railway freight volume and its influence factors of the empirical analysis. the result show that the transport of grain, metal ore freight volumes, GDP, steel and nonferrous metal volume have significant impact on railway freight volume; Fruit volume has negative impact on railway freight.

Keywords: Railway freight volume; Transport demand; Multiple linear regression

1. Introduction

China freight volume is 13.58682 billion tons in 2000, has risen to 43.81089 billion tons in 2014, has increased 2.22 times; China railway freight volume of 1.78581 billion tons in 2000, railway freight volume is 3.81334 billion tons in 2014 , has increased 1.14 times, Figure 1 can be seen clearly in recent years, China's freight volume is bigger than the increase in the growth of railway freight volume. China freight volume showed a trend of rapid rise since 2000, five different mode of transportation of freight volume are increased year by year, of which has a major highway transportation market, and its growth trend and total freight almost in parallel. Railway freight volume total ranked second in the five kinds of mode of transportation, contribution to Chinese freight volume is larger. Economy under the new normal, continuously adjustable structure steady economic growth in China, focusing on the economic structure of symmetrical state and on the basis of symmetrical state of sustainable development, since 2010 the railway freight volume proportion in the near future, though a decline in the trend of iron, shipping freight began more than railway freight volume and also showed a trend of rapid rise. With the upgrading of industrial structure, the bulk of the carriage of goods by energy, raw materials demand, pipeline transport and air transport also has a substantial proportion of railway, waterway will continue to fall, but the aviation and pipeline volume accounted for the proportion of freight volume is still small. Because the railway has low price, large capacity, strong stability, technical and economic characteristics, such as railway or will continue to be in a long distance between, interregional transport plays an important role. Now, under the impetus of the sustainable development strategy, under the promotion of new and high technology, the national railway still present a development trend. The research of Railway cargo transport demand is advantageous to the study of China railway freight volume forecasting so as to more accurately control the development trend of railway freight volume.

At present many scholars study cargo transport demand, Feng Lu (2005) [1] analyzed the change trend of China's industrial structure, the development of the railway freight volume and freight market, using the multivariate linear regression model to China's industrial structure changes direction and the correlation of railway freight volume is analyzed, and according to the change of industrial structure, put forward the relevant policy of railway freight development adjustment and measure suggestion. Xueqing cheng (2006) [2] analyzd the domestic and international railway freight demand growth model, put forward the four phases of railway freight transportation demand growth process division theory, combined with the present situation of the yunnan railway development lags behind, established to eliminate freight volume growth model of railway freight transportation capacity constraints. Shushing wen (2007)[3] based on the VAR model to analysis of China railway freight demand in empirical, it is concluded that railway transport of goods has a long-term stable, modest income elasticity, and long-term supply elasticity and unstable. Aurukun (2007)[4], based on the supply and demand of railway freight demand forecasting, the paper analyzes the relationship between supply and demand of China railway cargo transportation, the railway freight volume forecasting is divided into two stages, and gives the corresponding functions respectively. Chunrong yu (2008)[5] , analyzes the influencing factors of railway freight transportation demand, reflecting the railway freight transportation demand of railway freight volume is established with one of the main factors affecting the relationship between gross domestic product (GDP) model. Wenwei Guo

(2011)[6],adopt the macro model analysis and elasticity analysis respectively on China's current of railway transportation and to forecast the demand of the medium and long term scale, the results show that the past six years, China railway construction seriously lags behind the social demand, lead to the railway transport demand gap widening. Kejun MAO (2013) [7] points out that the new phase of China will enter the middle urbanization and late stage of industrialization, in this stage the Chinese passenger and cargo transport demand will continue to grow, at the same time transport category changes will occur to a certain extent, transportation structure and transportation service quality is higher.

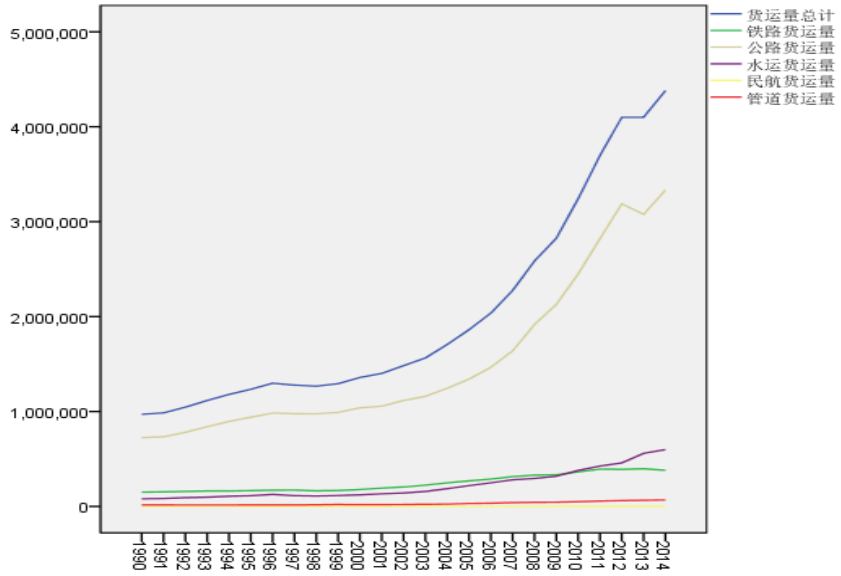

Figure 1. 1990-2014, five kinds of mode of transportation of freight volume and total freight volume trend chart

These scholars research on freight transportation demand select less influence factors, in order to reflect more comprehensive reaction of China railway transport demand status, on the basis of the other factors, this paper will use the multiple linear regression to establish the railway freight volume, gross domestic product (GDP), the second industry, coal freight volumes, GDP metal ore volumes, steel and nonferrous metal volumes, food production, the relationship between the sugarcane yield and fruit yield relationship model. And use Eviews software to calculate.

2. Modal Analysis

Multiple linear regression model is explained with multiple variables linear regression, is used to reveal explained variable and other multiple explain the linear relationship between variables. The mathematical model of multivariate linear regression is:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_p x_p + \varepsilon \qquad (1)$$

(1)is a p variable linear regression model, including p explanatory variables. It is showed that explained variable y can be explained into two parts. First, linear change parts caused by variable x, $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_p x_p$; Second, the other random factors caused y changes, namely ε . $\beta_0, \beta_1, \cdots, \beta_p$ Are unknown parameters in the model, referred to as the regression constant and partial regression coefficient respectively. ε known as the random error, is also a random variable, meet (1) expectations on both sides, therefore,

$$E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots \beta_p x_p \qquad (2)$$

(2) known as multiple linear regression equation. Estimate unknown parameters $\beta_0, \beta_1, \cdots, \beta_p$ in the multivariate linear regression equation is one of the core tasks of multiple linear regression analysis. parameter estimation is based on the sample data, parameter just is the $\beta_0, \beta_1, \cdots, \beta_p$ parameter values, namely, $\hat{\beta}_0, \hat{\beta}_1, \cdots, \hat{\beta}_p$. and there

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x_1 + \hat{\beta}_2 x_2 + \cdots \hat{\beta}_p x_p \qquad (3)$$

(3) called experience multiple linear regression equation. From the geometric sense, experience in multivariate linear regression equation is a hyperplane p dimensional space, namely regression surface. $\hat{\beta}_i$ shows when other explanation variables remain the same, x_i change one unit caused the explained variable y changes in the average number.

3. China Railway Freight Transportation Demand Modeling and Analysis

3.1. The connotation and the factors affecting the railway goods transportation demand analysis

Railway transport of goods is due to the need of social production and people's life and the demand for rail freight. Measures the size of the railway freight transportation demand quantity at present, railway freight volume and freight turnover, freight turnover not only reflects the number of transport goods, also reflect the transportation mileage, so railway cargo volume was used to measure the size of the railway freight transportation demand. Formation of cargo demand conditions, there are two: one is the need for rail freight; The second is the ability to form the rail freight. The influencing factors of railway freight transportation demand are:

(1) the level of economic development. Cargo transport demand is derived demand, the demand is determined by the size of the level of economic development. Countries in different phases of economic development the demand for transport, there is much difference in the quantity and quality. A country's cargo transport demand depends on the country's economic development level, depends on how much the output of material products. Gross domestic product (GDP) can be used to reflect a country's level of economic development.

(2) the national economy industrial structure and product structure. If use the freight turnover produced per unit of GDP to represent the freight intensity, the intensity of heavy freight is greater than the light industry, light industry of freight intensity and larger than services. some emerging industries such as electronics, information industry, the demand for transportation volume is small, but high quality requirements. With the improvement of industrial structure level, the intensity of freight will decline gradually. In heavy industry, coal, metal ore, steel and nonferrous metal freight volume is larger. In agriculture, food, sugar cane, fruit production is bigger, transportation demand is relatively large.

(3) the quality and quantity of railway transport network. Transportation network layout and quality directly affect the line of goods to attract the scope and the line capacity and demand to adapt to the degree. Lag of transportation industry will affect the production development inhibiting cargo transport demand.

(4) other mode of transportation of freight rate level changes. The level of transport demand for freight rate change is elastic, although different passenger and cargo demand price elasticity. In total, the freight transportation demand levels drop, but the freight transportation demand level rises will be suppressed. Highway, water transport, air transport and pipeline transport freight volume will have increase impact on railway transportation.

(5) the national economic policy and the change of the economic system. Since the economic system reform, the role of market mechanism in the operation of the national economy has been growing. under the action of the mechanism of competition and the pursuit of efficiency, flow products on the market relatively freely and rapidly expanding the range of Commodity Exchange, the exchange rate has greatly increased, so the transport demand also inevitable relative inflation. Some in the market economy in the past, such as "unreasonable transportation" or "violation of flow" ideas are changing, particularly with the enlargement of the radius of commodity market, the average length of haul goods is growing fast.

3.2. Railway cargo transport demand modeling

According to the influencing factors analysis, due to the need of social production and people's life and the main factors of rail freight is the economic development level and industry structure, under the condition of invariable in other factors to build the railway freight volume, gross domestic product (GDP), the second industry, coal freight volumes, GDP metal ore volumes, steel and nonferrous metal volumes, food production, the relationship between the sugarcane yield and fruit yield model. Table 1 is the analysis of the related data from 2004 to 2013 in China.

Table 1. China railway freight volumes from 2004 to 2013 and its influence factors of the data (Source: statistical yearbook)

Years	Railway freight volume (million ton-km)	GDP (billion)	The second industry GDP (one hundred million yuan)	Coal shipments (ten thousand tons)	Metal ore volumes (ten thousand tons)	Steel and nonferrous metal volumes (ten thousand tons),	Food (ten thousand tons)	Sugar cane (ten thousand tons)	Fruit (ten thousand tons)
2004	249017	159878.3	73904.3	9921	19319	16083	46946.6	8984.9	15340.9
2005	269296	184937.4	87598.1	107082	22187	17536	48402.2	8663.8	16120.1
2006	288224	216314.4	103719.5	112034	25568	20059	49804.2	9709.2	17102.0
2007	314237	265810.3	125831.4	122081	27577	232889	50160.3	11295.1	18136.3
2008	330354	314045.4	149003.4	134325	29796	20716	52870.9	12415.2	19220.2
2009	333348	340902.8	157638.2	132720	35680	21527	53082.1	11558.7	20395.5
2010	364271	401512.8	187383.2	156020	38088	22428	54647.7	11078.9	21401.4
2011	393263	473104	220412.8	172126	39148	22779	57120.8	11443.5	22768.2
2012	390438	519470.1	235162	167946	40112	21932	58958.0	12311.4	24056.8
2013	396697	568845.2	249684.4	168515	40187	21570	60193.8	12820.1	25093.0

1) Multiple linear regression model is established

This paper analyzes how the railway freight volume changes over other things, determine the railway freight volume is interpreted variable (Y), gross domestic product (X1), the second industry GDP (X2), coal (X3) for freight volume, metal ore volumes (X4), steel and non-ferrous metals (X5) for freight volume, grain yield (X6), sugar cane yield (X7) and fruit yield (by 8) as the explained variable. According to the most fitting way to draw a scatter diagram to determine the regression model. Figure 2 for the scatter diagram of railway freight volume and its influence factors, from figure known railway freight volume and gross domestic product (X1) and the second industry GDP (X2) are basic linear relationship, only slightly in 2009 and 2009 special; And coal volumes (X3), metal ore volumes (X4), steel and non-ferrous metals (X5) for freight volume, grain yield (X6), sugar cane yield (X7) and fruit yield (by 8) is a linear relationship, compared to the front for the growth of small here, that is, the correlation coefficient is relatively small; But in 2007, the railway freight volume and the abnormal color metal (X5) for freight volume, the year of the steel and non-ferrous metal freight traffic is suddenly increased and the highest in recent years, the reason is that 2008 years ago, China's economic rapid increase caused its rapid development, and the financial crisis of 2008 steel and non-ferrous metal impact is bigger and the effect is negative.

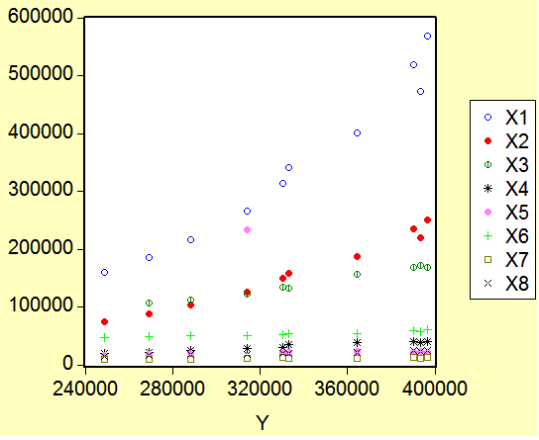

Figure 2. A scatter diagram of railway freight volume and its influence factors

According to the scatter diagram analysis, build multivariate linear regression model (regression results are shown in table 3). The table 3 shows that using the least square method through four steps gradually delete selected to complete the establishment of the regression equation, the final model includes five factors significantly, and illustrates its influence degree on freight volume is bigger. From the perspective of the process of equation, with the continuous decrease of explanatory variables, equations of goodness-of-fit is changeless, but adjusted goodness-of-fit has a slightly upward trend. In turn out variable is the second industry GDP, coal shipments and sugar cane production (GDP). Leaving variables in the equation of the GDP, metal ore volumes (ten thousand tons) and steel and non-ferrous metals (ten thousand tons) for freight volume, grain yield (ten thousand tons) and fruit yield (ten thousand tons).

A. forecast: constant GDP, GDP ($one hundred million), the second industry (one hundred million yuan), coal shipments (ten thousand tons), metal ore volumes (ten thousand tons), steel and nonferrous metals (ten thousand tons) for freight volume, grain yield (ten thousand tons), sugar cane yield (ten thousand tons) and fruit yield (ten thousand tons)

B. forecast: constant, GDP (one hundred million yuan), coal shipments (ten thousand tons), metal ore volumes (ten thousand tons), steel and nonferrous metals (ten thousand tons) for freight volume, grain yield (ten thousand tons), sugar cane yield (ten thousand tons) and fruit yield (ten thousand tons)

C. forecast: constant, GDP (one hundred million yuan), metal ore volumes (ten thousand tons), steel and nonferrous metals (ten thousand tons) for freight volume, grain yield (ten thousand tons), sugar cane yield (ten thousand tons) and fruit yield (ten thousand tons)

D. GDP, metal ore prediction: constant volume (ten thousand tons), steel and non-ferrous metals (ten thousand tons) for freight volume, grain yield (ten thousand tons) and fruit yield (ten thousand tons)

E. the dependent variable: railway freight volume (ten thousand tons)

Table 3 of the top three in the model because there are no significant regression coefficient of explanatory variables, so these equations are unavailable, the fourth model is the final equation. If significant level α is 0.05, as a result of significance test of regression equation probability P value is less than the significant level α, thus be explained and explained variables significantly, the linear relationship between the linear model is appropriate. Because there was not significant in three model in front of the factors that influence can be seen in table 3 by gradually eliminate not significant explanatory variables, increase slightly adjusted r-squared figures, F test value is reduced, goodness of fit of the model get higher. Equation of the DW test value is showed a trend of decline and gradually close to 2, residual ego related degree in subdued.

Table 3. Railway freight volume multiple linear regression analysis results

Modle	R square	Adjusted R square	Durbin-Watson sta	Prob(F-statistic)
1	0.999	0.995	3.489	0.047

2	0.999	0.997	3.544	0.002
3	0.999	0.998	3.293	0.000
4	0.999	0.997	2.527	0.000

If the level α is 0.05, the fourth model is the final equation. Figure 3 shows the fourth model of each variable in the partial regression coefficient and partial regression coefficient significance test. The significance test of regression coefficient probability P value is less than level α, therefore, metal ore freight volumes, GDP steel and non-ferrous metal freight volume, grain yield and fruit yield larger influence on railway freight volume. The final regression equation is

$$y = 39796.74 + 0.705x1 + 7.328x4 + 0.112x5 + 16.010x6 - 52.054x8$$

$$(0.7305)\ (0.0055)\ (0.0004)\ (0.0022)\ (0.0041)\ (0.0019)\ \bar{R}^2 = 0.997$$

From coefficient can be seen, food is the largest demand for railway transportation, and then in turn is metal ore freight volumes, GDP, steel and nonferrous metal volumes. The analysis results of fruit production of railway freight volume is negative impact, because the fruit has the characteristics of perishable, she needs to be fast in time from production to sale to ensure to reach consumers in the hands of the fruit is fresh, and rail flexible and timeliness short of fruit transportation demand, so the fruit of railway transport demand is low.

Figure 3 is the fourth model residual figure, actual values and fitted values in figure 4 almost in a line, in addition to the residual is -3586 in 2012, residual are controlled in other years - 1500 ~ 2500. This model of goodness of fit is higher.

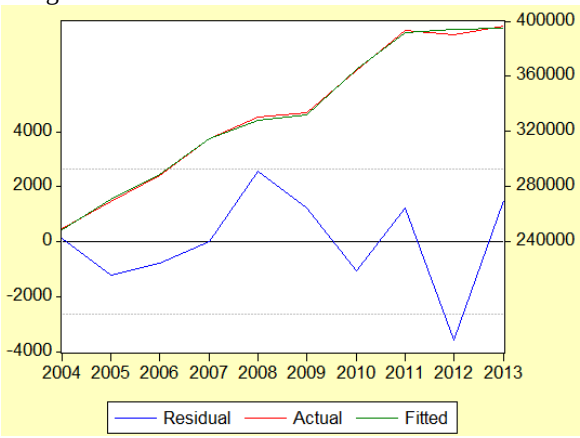

Figure 3. Residual figure of the model

4. Conclusion

According to China's 2004-2013 data of railway freight volume and its influence factors to establish a multiple linear regression model. In the framework of this model, it is concluded that the railway freight volume and grain transportation, metal ore freight volumes, GDP, steel and non-ferrous metal volumes, closely related to fruit production, but the fruit is negative influence for railway freight volume. Production is mainly in the larger contribution to railway freight volume, metal ore volume and GDP. Gross domestic product (GDP) no other big contribution to the railway freight volume, it may be because the proportion of the tertiary industry in GDP is larger, the third industry value is big, small volume and flexible cargo demand caused it to small demand for railway transportation. And as the adjustment of economic structure and industrial structure transformation, coal, iron and steel, and the ore social demand growth trend of these commodities become very slow, combined with the water transportation cause competition to railway, so the three dependencies and contribution to railway are in decline.

Policy implications of the above Suggestions are as follows: although in recent years, the mode of transportation of railway freight by road, and other challenges, but the railway traffic little change in the short term, contributions to the growth of the national economy will continue to grow steadily, so cause the attention of the government is still worth of railway transportation. On the other hand, managers in the railway network construction should strengthen the new railway industry function analysis and positioning, and strengthening the management of newly built railway network and shorten the input and output, to meet the needs of the existing transport of goods as soon as possible, to generate economic benefits.

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