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Assessment Model about the Impact of Shanghai Expo 2010 on Transportation Economy

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Abstract. In this paper, we assess the 2010 Expo's impact on the transportation economy in Shanghai. We choose five different indicators about the transportation economy and assume that the annual index data before 2004 were not affected by Expo. Then, we adopt the fitting prediction method, comparing predicted index with the actual data in time series. At the same time, we calculate the importance weight of the different indicators in the transportation, then further explore the direction of the industrial structure with industry analysis. Quantitative analysis of the transportation economy can be good reference for China to organize a similar big event in the future in case of the huge amount input.

Keywords: transportation economy, impact assessment, fitting prediction, importance weight, quantitative analysis

1. Introduction

The transportation economy is a part of the third industry of a society. The proportion of tertiary industry is relatively higher in central cities, such as New York and Tokyo. The reason is that central cities have regional advantage, good infrastructure, convenient living conditions, abundant human resources and a relatively sound basis for the development and thus more conducive to development of the service functions of the tertiary industry. And to 2010, Shanghai has only 60% of the share. Shanghai should increase the proportion of tertiary industry in the future to stimulate the economy to a new level. To make preparation for Expo, Shanghai speed up the pace of urban development, such as construction of hub-type, functionality, networks of urban infrastructure systems, expansion of Pudong International Airport. During the Expo, the city's total retail sales reaches 309.5 billion yuan, and occupancy rate of rooms reaches 78% on average in star hotel. In 2010, 8,511,200 abroad tourists arrived in Shanghai, which is 35.3% over the previous year. Shanghai should play key role in regional economy, focusing on the development of the third industry which is good for coordination of regional development and overall planning.

In this paper, we take into account one part of the tertiary industry-transportation to analysis the impact of Shanghai Expo. Firstly, we choose five different indicators about the transportation economy, using the fitting prediction method to draw the line curve and the smooth curve which stand for the actual data and the predict data, respectively. Then, we calculate the importance weights of the two industries to get the comprehensive explanation of Expo impact. We assume that the relative construction of Expo mainly occurred in 2004-2009, the Expo will bring tourism benefits mainly in the last four years, and the collection of data is objective with no subjective effect on the model analysis.

2. Assessment Model of impact on Transportation Economy Development

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In the transport system, we mainly use the indicators of railways, highways, volume of air freight, RPK(passenger turnover) and cargohandling capacity, turnover volume of goods to reflect the development of transportation. Passenger volume reflects the quantity promotion of economy and people's lives accounting to transportation, and turnover volume can reflect the overall results produced by the transport industry. They are important indicators to study scale and speed of transport development. We selected the five transportation indexes as follows: (Note: including railways, highways, ports, civil aviation) passenger volume (unit: million people), passenger turnover (unit: million people • km), cargo volume (Unit: million tons), cargo turnover (unit: million tons • km), total port cargo throughput (unit: million tons).

2.1 Passenger Volume

We collect the data before 2004. We assume that the data are not affected by Expo. We use the curve fitting toolbox "cftool" in Matlab software, using a single variable curve approximation method to draw all transportation evaluation trends. This fitting method can predict the possible quantity of passenger volume in the next few years if we do not take into account Expo factor. Then we use the difference between the predicted data and the actual data to divide the predicted data, and the average of the calculation results reflect the impact of Expo, which we use I to express.

Drawing a line graph about passenger volume and time , we assume that the relationship of two variables is:

$$y_1 = a_1 \times e^{-((x-b_1)/c_1)^2} + a_2 \times e^{-((x-b_2)/c_2)^2}$$

We do the curve fitting in the tool of "cftool" in Matlab, and get the reasonable fitting results. The fitting function is provided below, with R=0.9762:

$$y_1 = 1.48e+004 \times e^{-((x-2013)/7.773)^2} + 5734 \times e^{-((x-1998)/12.5)^2}$$

We import data into excel table to draw two curves. The line curve represents the actual statistics of the indicator data, and the smooth curve represents data predicted by fitting function under no influence of Expo.

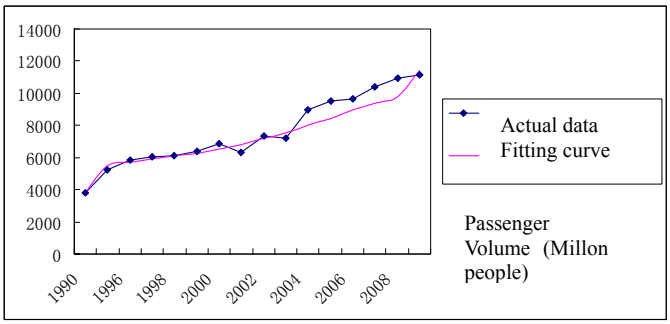

Fig. 1

We can quantize the impact of Expo by the actual statistics and forecast value. We define "value of impact" as actual statistics minus forecast value, and "rate of impact"as "value of impact" divided by the forecast value. Finally, we calculated the average impact rate of five years from 2005 to 2009 as the comprehensive impact of Expo. After statistics calculating, the value of the Expo impact on passenger volume is I =0.07149.

2.2 RPK (passenger turnover)

We use the same method as above to draw a line graph between RPK and time, and calculate the relationship of two variables as:

$$y_2 = a_1 \times e^{-((x-b_1)/c_1)^2} + a_2 \times e^{-((x-b_2)/c_2)^2}$$

We do the curve fitting in the tool of "cftool" in Matlab, and get the reasonable fitting results. The fitting function is provided below, with R=0.9841:

$$y_2 = 101.4 \times e^{-((x-2006)/2.102)^2} + 359.6 \times e^{-((x-2019)/27.22)^2}$$

We import data into excel table to draw two curves. The line curve represents the actual statistics of the indicator data, and the smooth curve represents data predicted by fitting function under no influence of Expo.

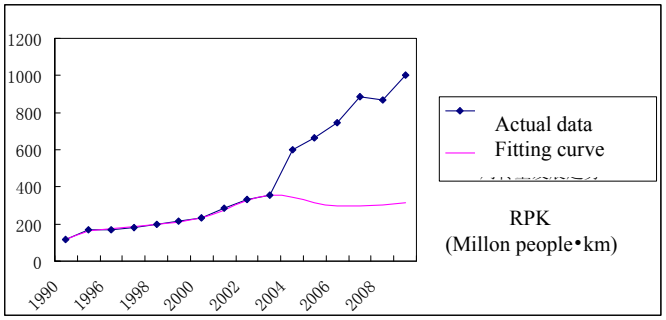

Fig. 2

As can be seen from the chart, the passenger turnover improved significantly after 2004, which also shows that the traffic in Shanghai has been great progress in delivery systems. As predicted curves and the fitted value of the actual statistics produced a huge gap after 2005, therefore, RPK becomes a large aspect impacted by Expo in transportation system of Shanghai. After statistics calculating, the value of the Expo impact on RPK is I =0.632.

2.3 Cargo Volume

Drawing a line graph between Cargo volume and time, calculate that the relationship of two variables as:

$$y_3 = a \times e^{(b \times x)}$$

We do the curve fitting in the tool of "cftool" in Matlab, and get the reasonable fitting results. The fitting function is provided below, with *R*=0.9762:

$$y_3 = 9.606e-044 \times e^{(0.05492x)}$$

We import data into excel table to draw two curves. The line curve represents the actual statistics of the indicator data, and smooth curve represents data predicted by fitting function under no influence of Expo.

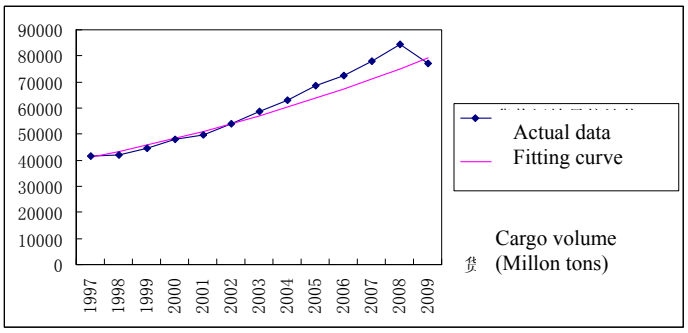

Fig. 3

The goods traffic was steady increase in 97-08 years of growth, especially after the success of the Shanghai Expo application.but the data of 2009 decreased compared with that of 2008, which may be affected by economic crisis. After statistics calculating, the value of the Expo impact on cargo volume is I =0.061769.

2.4 Cargo Turnover

Drawing a line graph between Cargo turnover and time, calculate the relationship of two variables as:

$$y_4 = a_1 \times e^{-((x-b_1)/c_1)^2} + a_2 \times e^{-((x-b_2)/c_2)^2}$$

We do the curve fitting in the tool of "cftool" in Matlab, and get the reasonable fitting results. The fitting function is provided below, with *R*=0.9766:

$$y_4 = 5864 \times e^{-((x-2006)/5.698)^2} + 1.292e+004 \times e^{-((x-2080)/76.42)^2}$$

We import data into excel table to draw two curves. The line curve represents the actual statistics of the indicator data, and smooth curve represents data predicted by fitting the function under no influence of Expo.

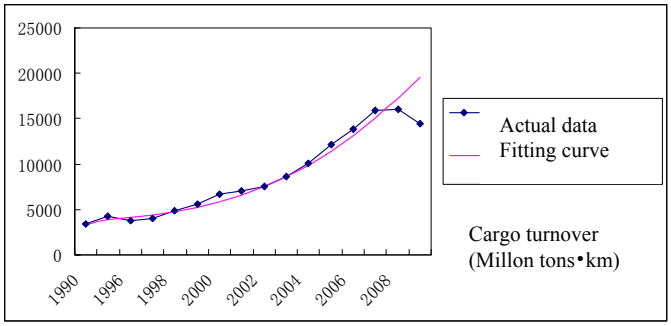

Fig. 4

The same as cargo volume, the data of 2009 decreased compared with that of 2008, which may be affected by economic crisis. After statistics calculating, the value of the Expo impact on cargo turnover is I =0.05043.

2.5 Port Cargo Throughput

Drawing a line graph between port cargo throughput and time, calculate the relationship of two variables as:

$$y_5 = a_1 \times e^{-((x-b_1)/c_1)^2} + a_2 \times e^{-((x-b_2)/c_2)^2}$$

We do the curve fitting in the tool of "cftool" in Matlab, and get the reasonable fitting results. The fitting function is provided below, with R=0.9958:

$$y_5 = 4.399e+004 \times e^{-((x-2009)/5.466)^2} + 3.769e+004 \times e^{-((x-2095)/106.6)^2}$$

We import data into excel table to draw two curves. The line curve represents the actual statistics of the indicator data, and smooth curve represents data predicted by fitting function under no influence of Expo.

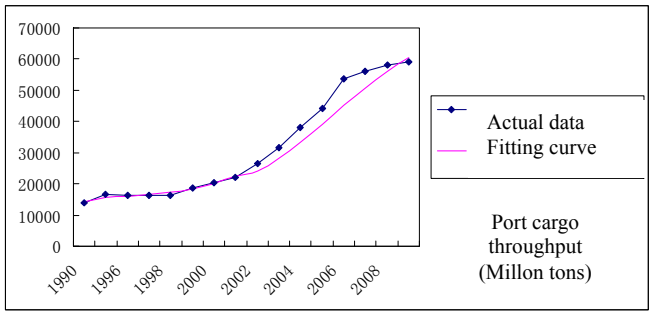

Fig. 5

After statistics calculating, the value of the Expo impact on port cargo throughput is I =0.07719.

3. Importance Weight for the Comprehensive Impact of Expo

3.1 A model of importance weight

There are m indexes: $A_1, A_2, \ldots, A_m$ according to the specific meaning of different indicators and Saaty comparison laws, we got the comparison matrix between different importance weights:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \cdots & \cdots & \ddots & \cdots \\ a_{m1} & a_{m2} & \cdots & a_{mm} \end{bmatrix} \quad with \quad a_{ii} = 1, a_{ij} = \frac{1}{a_{ji}}$$

In the $m \times m$ matrix, a_{ij} means that the division between the importance of the i indicator and the importance of j indicator.

Saaty comparison scales

Table 1

Scales	Meaning
1	The importance of A_i is equal to the one of A_j
3	The importance of A_i is little stronger than the one of A_j
5	The importance of A_i is stronger than the one of A_j
7	The importance of A_i is much stronger than the one of A_j
9	The importance of A_i is absolute stronger than the one of A_j
2,4,6,8	The importance level of A_i and A_j is between the levels above

We calculate the largest eigenvalue of comparison matrix λ, and do the consistency test.

Consistency index of A is

$$CI = \frac{\lambda - m}{m - 1}$$

Consistency ratio of A is：

$$CR = \frac{CI}{RI}$$

The value of *RI* (Random Index) is provided in this following chart:

m	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.21

If $CR < 0.1$，A is reasonable, and the Eigenvector to Eigenvalue λ is $\alpha = (\alpha_1, \alpha_2, \ldots, \alpha_m)$. And the value of the importance weight vector is:

$$(w_1, w_2, \cdots, w_m) = \left(\frac{\alpha_1}{\sum_{i=1}^{m} \alpha_i}, \frac{\alpha_2}{\sum_{i=1}^{m} \alpha_i}, \cdots \frac{\alpha_m}{\sum_{i=1}^{m} \alpha_i}\right)$$

3.2 The importance weights of transport impact

We establish and calculate the comparison matrix for importance weights of five indicators in transportation:

$$A = \begin{pmatrix} 1 & 1 & 1 & 2 & 3 \\ 1 & 1 & 2 & 3 & 2 \\ 1 & 1/2 & 1 & 3 & 2 \\ 1/2 & 1/3 & 1/3 & 1 & 2 \\ 1/3 & 1/3 & 1/2 & 1/2 & 1 \end{pmatrix}$$

And the importance weights of the five indicators of traffic volume are offered as below:

$$(w_1, w_2, w_3, w_4, w_5) = (0.255, 0.306, 0.231, 0.119, 0.089)$$

We have already obtained impact of Expo on transportation on average:

$$P = (I_1, I_2, I_3, I_4, I_5) = (7.14\% \quad 62.3\% \quad 6.17\% \quad 5.04\% \quad 7.72\%)$$

Based on the above results, we get the overall impact of Shanghai Expo on transportation industry:

$$I = w_1 I_1 + w_2 I_2 + w_3 I_3 + w_4 I_4 + w_5 I_5 = 0.3025$$

4. Conclusions

In this paper, the impact rate that Expo brought to Shanghai transport reached 30.25%. And we can use this assessment model to evaluate more industries based on the statistics data. It can be seen that the Shanghai World Expo has already had a huge impact on the transportation economy. In this paper we use data on an annual basis to establish the model. The advantage of the model is its obvious long-term trends, but the

drawback is that tourism revenue which is sensitive to time period will make the model blurred and lack of accuracy.

According to the mathematical model, we predict that radiation effects on the surrounding area is profound, pulling economic growth of the surrounding areas and upgrading of the level of consumption, improving the development of tertiary industry. Expo made contribute to Shanghai's industrial restructuring, while promoting the Yangtze River Delta transportation services industries. Because of the SARS in 2003 and financial crisis in 2009, the data are anomalies in these years which affect our analysis.

5. References

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