

On the Relationships Between Indexes of Merchant Vessel Accidents and Indexes of Economy and Shipping

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ABSTRACT: The statistics and analysis of the four accident indexes and the four marine transportation indexes have been carried out to indicate situations of marine safety and marine transportation in China. By grey correlation analysis, the main findings is that the number of marine traffic accidents is mainly determined by the number of merchant vessels; the number of foundering is mainly determined by freight amount, and the number of death and missing is mainly determined by the number of merchant vessels.

1 STATISTICS AND ANALYSIS ON INDEXES OF MARINE TRAFFIC ACCIDENTS

According to Regulations on Statistics and Reporting of Marine Traffic Accidents established by Chinese maritime safety administrations, four indexes are used to indicate the marine safety situation in China. The four indexes are named as follows: (1) number of accidents; (2) number of foundering ships; (3) number of deaths and missing; (4) direct economic losses. The data of marine traffic accidents is limited to accidents of merchant vessels only; it does not include accidents of fishing vessels and public vessels. A statistics and analysis of marine traffic accidents in Chinese navigable waters during the period 1993-2002 have been carried (Wu, et al 2005). In order to know the new situation of the marine safety situation in China, a statistics and analysis on basis of the data of four indexes in 1996-2005 years have made in this paper, and where above four indexes are called separately as A1, A2, A3 and A4 for short.

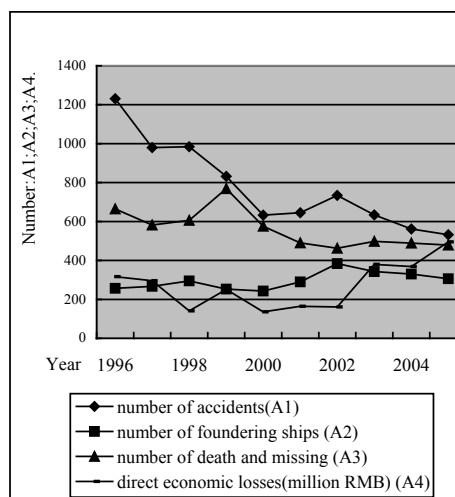


Fig. 1. Statistics on indexes of accidents

From this statistics, see Figure 1, it could be known that the variation and tendency of four indexes of accidents in last ten years. At first, the number of marine traffic accidents keeps a continued decrease in last ten years, except that there is an increase in 2002. Second, the general tendency of the number of foundering ships indicates slow increase in fore six years and slow decrease in later four

years. Third, the general tendency of the number of deaths and missing indicates slow decrease except that there is an sudden increase in 1999, because that a Ro-Ro passenger ship, named as “Dashun”, capsized in storm weather in November 24th, 1999, resulted in deaths and missing of 282 lives. However, it should be noted that direct economic losses keep a continued increase.

2 STATISTICS AND ANALYSIS OF ECONOMY AND SHIPPING DEVELOPMENTS

When analysis the variation and tendency of four accident indexes in last ten years, the economics and shipping development conditions at the same time should be also considered, because that quantity of marine traffic accidents has certain relationship with developments of national economy and shipping. In this paper, another four indexes are selected to be analyzed the relationship between four accident indexes and one economic index and three shipping indexes, which are named as follows: (1) GDP per person; (2) freight amount; (3) number of merchant vessels; (4) freight turnover. In order to know the detail of the relationship between them, a statistics and analysis on basis of the data of above indexes in 1996-2005 years have made. In this paper economy and shipping indexes are simplified separately as B1, B2, B3 and B4 for short.

From this statistics, see Figure 1, it could be known that the variation and tendency of economy and shipping conditions of China in last ten years.

First, if did not consider the influence of the price, GDP per person increased from 5539 Chinese Yuan (RMB) to 13944 Chinese Yuan in last ten years, about 2.5 times more. As one of indexes of national economic development, GDP per person could give the economy and shipping background of marine safety. It indicates that the occurrence of marine traffic accidents is under the background of high speed development of national economy, even if affected by the financial crisis in Asia from 1997 to 1999.

Second, at the same time freight amount grows continually; freight amount of 2005 is 1.7 times more than 1996. It could indicate the background of shipping development in China.

Third, the number of merchant vessels keeps continuously decrease, the reasons is the constitutive adjustment in merchant fleet. In one hand, the size of vessels trends to larger, in another hand, because of standardize of ships' type in inland waters and elimination of old-age ships, majority of them is small ships.

Fourth, growth tendency of freight turnover keep increase continuously at a large scale. It was 1.7862 billion ton kilometers in 1996 and increased to 4.9672 billion ton kilometers in 2005, about 2.78 times of it in 1996. Such fact may show the degree of busy of ports and harbors. Reduction of ships' quantity means that more and more ships are being larger, marine traffic volume in each navigable water area become increasing continuously. So it could be expected that the risk of navigation increases accordingly in navigable waters, if other conditions do not change. Analyzing relations between four indexes of marine traffic accident and the indexes of marine transportation, the transportation cargo volume by water of the circular flow can find out their degree of influences to the marine traffic accident clearly.

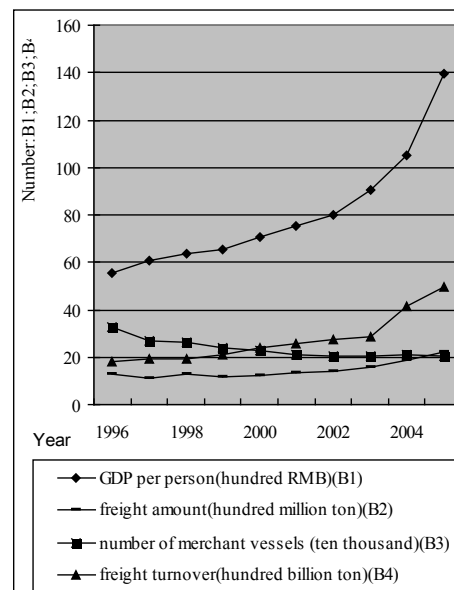


Fig. 2. Statistics on indexes of economy and shipping

3 GREY CORRELATION ANALYSIS ON ACCIDENTS INDEXES AND ECONOMY AND SHIPPING INDEXES

3.1 Selection of mathematical analysis method

From the views of system theory, happenings of marine traffic accident are related to some factors in the marine traffic system, such as persons, ships, environment, and management. From wider views to consider the influence factors, the background and conditions under which marine traffic accident happens, may have some relationship to accidents. Though integration of such factors results in the accident, but the different factor gives different influence to the happening of marine traffic accident in the extent, some is big, some is small. So it is necessary to know the relationship between accidents and the background or conditions under

which accidents happens. In this paper the accident indexes (number of accidents: number of foundering ships; number of death and missing: direct economic losses) and economy and shipping indexes (GDP per person: freight amount; number of merchant vessels: freight turnover) are used for relativity analysis. As said above, accident indexes and economy and shipping indexes may have some direct or indirect relationship, but it is not clear to know the relativity quantitatively. So grey correlation analysis measure is selected as a mathematical tool to analyze and investigate it quantitatively in order to seek the inherence contact, so called regularity.

3.2 Establishment of grey correlation matrix and calculation

The is used to find the primary factors which affect the index value though analyzing the limited data in grey system and seeking the relationship among the inherent factors. Based on four accident indexes data and four marine transportations indexes data, we divided the data into three parts which are 1996-2001, 2001-2005 and 1996-2005.

3.2.1 Calculation of the grey correlation matrix

After calculating the data from 1996 to 2005 through the calculation procedure of the grey relational degree, then the grey correlation matrix (1) is got as follows:

$$\begin{array}{cccc}
 \text{B1} & \text{B2} & \text{B3} & \text{B4} \\
 \left[\begin{array}{cccc}
 0.6636 & 0.7461 & 0.9298 & 0.6247 \\
 0.7827 & 0.8340 & 0.6783 & 0.7673 \\
 0.6913 & 0.7905 & 0.9016 & 0.6761 \\
 0.5535 & 0.7347 & 0.7208 & 0.5349
 \end{array} \right] \begin{array}{l} A1 \\ A2 \\ A3 \\ A4 \end{array} & (1)
 \end{array}$$

After calculating the data from 1996 to 2000, then the grey correlation matrix (2) is got as follows:

$$\begin{array}{cccc}
 \text{B1} & \text{B2} & \text{B3} & \text{B4} \\
 \left[\begin{array}{cccc}
 0.5826 & 0.7613 & 0.8978 & 0.5907 \\
 0.7267 & 0.7162 & 0.5403 & 0.6813 \\
 0.6570 & 0.7880 & 0.6829 & 0.6617 \\
 0.6029 & 0.7397 & 0.7748 & 0.6068
 \end{array} \right] \begin{array}{l} A1 \\ A2 \\ A3 \\ A4 \end{array} & (2)
 \end{array}$$

After calculating the data from 2000 to 2005, then we get the grey correlation matrix (3) is got as follows:

$$\begin{array}{cccc}
 \text{B1} & \text{B2} & \text{B3} & \text{B4} \\
 \left[\begin{array}{cccc}
 0.6884 & 0.7012 & 0.8624 & 0.6903 \\
 0.7098 & 0.7263 & 0.7630 & 0.6561 \\
 0.6808 & 0.6906 & 0.9714 & 0.6835 \\
 0.5835 & 0.5749 & 0.5555 & 0.5957
 \end{array} \right] \begin{array}{l} A1 \\ A2 \\ A3 \\ A4 \end{array} & (3)
 \end{array}$$

where: B1—GDP per person ;
 B2— freight amount ;
 B3— number of merchant vessels;

B4— freight turnover;
 A1— number of accidents ;
 A2— number of foundering ships;
 A3— number of death and missing ;
 A4— direct economic losses;

3.2.2 Ordering the correlation results

After analyzing anglicizing grey correlation matrix (1) in row and comparing the degree of relationship between characteristic factors and children factor, the result is got as follows:

- The order of degree of correlation between the number of accidents and the economy and shipping factors is: B3 > B2 > B1 > B4
- The order of degree of correlation between the number of foundering ships and the economy and shipping factors is: B2 > B1 > B4 > B3
- The order of degree of correlation between the number of death and missing and the macro factors is: B3 > B2 > B1 > B4r
- The order of between direct economic losses and the economy and shipping factors is: B2 > B3 > B1 > B4

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- The order of degree of correlation between the number of foundering ships and the economy and shipping factors is: B1 > B2 > B4 > B3
- The order of degree of correlation between the number of death and missing and the macro factors is: B2 > B3 > B4 > B1
- The order of between direct economic losses and the economy and shipping factors is: B3 > B2 > B4 > B1

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- The order of degree of correlation between the number of foundering ships and the economy and shipping factors is: B3 > B2 > B1 > B4
- The order of degree of correlation between the number of death and missing and the economy and shipping factors is: B3 > B2 > B4 > B1
- The order of degree of correlation between direct economic losses and the economy and shipping factors is: B4 > B1 > B2 > B3

3.2.3 Analysis of the calculation result

On basis of the results of above calculating and analyzes the conclusions could be summed as follows:

- The number of accidents has the closest relationship with the number of merchant vessels, the second is freight amount. It could be explained that the number of merchant-vessels is the primary factor that impact on the number of marine traffic accident. It may say that more the number of merchant vessels, more the number of ship accidents.
- The number of foundering ships has the closest relationship with freight amount; the second is GDP per person. It could be explained that the freight amount is the primary factor that impact on the number of foundering ships. It may say that more freight amount, more the number of foundering ships.
- The number of death and missing has the closest relationship with the number of merchant vessels, the second is freight amount. It can be explained that the number of merchant-vessels is the primary factor that impact on the number of death and missing. It may say that more the number of merchant vessels, more the number of death and missing.
- According to the calculating results, there is no obvious close relationship between the direct economic losses and GDP per person, freight amount, number of merchant vessels and freight turnover, relatively speaking, freight amount and number of merchant vessels have more effects.

3.3 Comparison of the results of grey correlation analysis between USA with China

For more detailed analysis of the effecting factors on marine traffic accidents, similar grey correlation analysis has been made by the authors of this paper. On basis of the same nature of data of USA, the results have been got as follows: the order of correlation between the accidents indexes and the economy and shipping factors is consistent: $B_4 > B_3 > B_2 > B_1$. The results could be explained that the freight turnover is the primary factor that impact on the number of marine traffic accident, is also the primary factor that impact on the number of foundering, the number of death and missing and direct economic losses. It may say that more the number of the freight turnover, more the number of ship accidents; more the number of the freight turnover, more the number of foundering ships; more the freight turnover, more the direct economic losses. Obviously the results of grey correlation calculating on data collected from USA are different to the results of grey correlation calculating on data

collected from China. The reasons of the different calculating results between China and USA need to be find out and analyzed later.

4 CONCLUSION

Through the calculation of grey correlation matrix and its result analysis, the main findings could be concluded as followings: In China, the number of marine traffic accidents is mainly determined by the number of merchant vessels; the number of foundering ships result from marine traffic accident is mainly determined by freight amount, and the number of death and missing result from marine traffic accidents is mainly determined by the number of merchant vessels.

It is predicted that in the coming five years, freight amount of China will increase by 38%, while cargo throughput of national ports and main coastal ports will increase by 46 percent and 78% separately. Until 2010, with cargo throughput of national ports exceeding 7.2 billion tons and marine cargo transporting volume reaching 3 billion tons or so. According to the results of grey correlation analysis of data of 1996~2005, 1996~2000 as well as 2001~2005, it is possible that the number of marine traffic accidents will continue to increase, in case that marine cargo transporting volume increases from 2.196 billion tons (2005) to 3 billion tons (2010).

It should be noted that, under the background of high speed development on economy and shipping, the national policies of "safety first" and "prevention first" have carried out effectively. The maritime safety administrations, shipping companies and seafarers all pay their attentions to improve marine safety. Some necessary measures have been taken, such as eliminating old-age ships, standardization of inland water ships, standardization of local maritime safety administration, and continuously enhanced administration on passenger ships, dangerous cargo ship and high risk sea areas, and so on. It should be believed that the with the improvement of marine traffic environment and conditions, the marine traffic safety situation of China will keep steady or further improved in the coming five years, even if great increase of numbers of merchant vessels and freight amount will continue.

REFERENCE

- Wu, Zhaolin & Liu, Zhengjiang (2005). Statistics and analysis of maritime traffic accidents in Chinese navigable waters. *IAMU Journal*, 1, 2005, 63-72.