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Analysis of Factors Influencing General Cargo Prices: Based on a Causal Diagram

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Abstract:

Along with the bloom of foreign trade between China and "Maritime Silk Road" related country, shipping becomes increasingly important. In recent years, with the rise of Chinese creation, the export of industrial general cargo from China to the Belt and Road countries has gradually increased. Therefore, it is essential for general cargo shippers to grasp the causality of the change of general cargo shipping price. This paper constructs two causal loop diagrams of the factors influencing the general cargo shipping prices from China to Belt and Road countries using anylogic software, and explains the causes of the changes in the general cargo shipping prices from the cost-profit perspective and the capacity-demand perspective respectively. The model results show that the cost-profit subsystem reflects the changes in the psychological expectations of shipowners and charterers in the market, and the capacity-demand subsystem shows the game between the demand side and the supply side in the market.

Keywords*: General cargo; cause-effect diagram; cost-profit; capacity-demand.*

I. INTRODUCTION

In the maritime market, general cargo refers to goods that are completed during transportation, handling and storage. It is not a fixed concept relative to bulk cargo. Due to the imbalance of development, there are still a large number of logistics forms in China and even in the world that use the traditional way of general cargo, and their price fluctuations are affected by many factors. The most significant of these is that in recent years, under the background of the impact of the COVID-19, the global economic recovery and the epidemic prevention and control situation are grim, which has led to the suspension or reduction of production in some overseas factories, the significant increase in cross-regional order demand, while the efficiency of port operations has declined, and the price of shipping has continued to rise. In addition, the epidemic prevention and control has become one of the most special reasons for the fluctuation

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of the price of general cargo shipping in many years, such as the cost of personnel and lost work caused by the epidemic, the cost of testing equipment and time costs required by the epidemic, etc. All of them invisibly paved the way for the rise in the price of general cargo. However, the above analysis is not enough to study the full causes of the fluctuation of miscellaneous freight prices. Therefore, in order to better and comprehensively study the multi-faceted factors affecting the freight price of miscellaneous parts, in order to better evaluate the changes in the freight price index of sea freight parts, this paper divides the multi-faceted factors into the "cost-profit" subsystem causal loop and the "capacity-demand" subsystem causal loop in the form of causality diagram. The two loops include freight cost, maritime capacity, the impact of financial markets and market demand, etc., so as to intuitively reflect the various related relationships affecting the fluctuation of miscellaneous freight prices through the causality diagram.

There are more studies on the development of ship transport at home and abroad, especially the cost-effectiveness of container ship transport[1,2], but there is little analysis of the market segment of general cargo sea transport, and there is even less research on the factors affecting the price of general cargo. Looking at the global research on maritime prices, it mainly focuses on the characteristics of freight rate fluctuations and the study of cost-effectiveness. In terms of the fluctuation characteristics of freight rates, Jia Hongyuet al. revealed the inherent law of fluctuations in the CBFI index (China Coastal Bulk Freight Index) through the EMD (empirical mode decomposition) method, starting from the sequence characteristics of the shipping index itself[3]. Jun Woo JEON conducted an overall simulation of the CCFI Index (China Containerized Freight Index) and confirmed its regularity, thus considering the best time for container freight orders in an uncertain shipping environment[4]. Hans-Joachim Schrammbelieves that freight rates are at the heart of the shipping business, and shipping risks are characterized by fluctuations in freight rates[5]. To this end, whether the shipping tariff index truthfully reflects the changes in market freight rates is the key to the compilation of the CCFI index[6]. Ding Yan et al. examined the effect of GDP and other random factors on the BDI index by fitting the BDI (Baltic Dry Index) and the GDP index[7]. In terms of cost-benefit research, Qiu Zhiping et al. used social network analysis methods to study the cost impact of global liner shipping on international trade through LSBCI matrix data[8]. Wang Sheng et al. considered the background of the COVID-19 and the characteristics of the maritime era, starting from the variable and immutable fixed costs, studied the operating costs and performance improvement role of shipping enterprises[9].

In summary, we find that domestic and foreign experts and scholars have different emphases on the study of maritime freight rate fluctuations. However, most of them are research on container freight rates, dry bulk freight rates and other fields. Research on the sea freight price

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of general cargo is slightly scarce. Based on this, this paper is based on the general cargo maritime transport market, based on the relevant characteristics of the sea freight price of general cargo, and deeply analyzes the various factors affecting the sea freight price of general cargo. Through the subsystem causal loop of "cost-profit" and "capacity-demand", the importance of various elements to the price fluctuation of general cargo is demonstrated, and relevant research methods and countermeasures are provided for effectively reducing the operating costs of enterprises and improving the market economic benefits of relevant shipping enterprises.

II. SYSTEM DYNAMICS MODEL CONSTRUCTION

When there is a relationship of mutual influence and interaction between one event and another event, whether the relationship is positive or negative, it means that there is a certain causal relationship between the two events, and usually "cause event" occurs before the "effect event", which is called two events causal to each other. A causal chain is formed by linking multiple events with causal relationships in the order of antecedents and consequences with line segments with arrows. On this basis, with some common "cause events" or "effect events" as the pivot point, multiple causal chains are linked to form a graph with multiple loops, which is called a causal diagram, and sometimes a system circulation diagram.

This study analyzes a number of factors affecting the freight rates of groceries, including freight costs, maritime capacity, financial market impact and market demand. These factors together constitute a relatively complex large system which has an effect on the price of general cargo, and this large system is composed of several subsystems. Among them, the two subsystems of "cost-profit" and "capacity-demand" have the strongest influence on general cargo prices. Cause-effect diagrams can describe complex relationships in a simpler way, simplifying and systematizing complex problems, and therefore simplifying the analysis of the larger system by analyzing the "cost-profit" and "capacity-demand" subsystems one by one. Finally, the simplicity and directness of cause-effect diagrams enable decision makers involved in maritime transportation to grasp the various influencing factors of the system more clearly, so that they can quickly clarify their thinking and make decisions.

Both "cost-profit" and "capacity-demand" subsystems contain many influencing factors, so they can be regarded as both the input and output of a complex system. As cost and capacity are dynamic processes, the influence of many factors needs to be taken into account. Therefore, based on the interrelationship between the influencing factors, two interrelated system dynamics models of "cost-profit" and "capacity-demand" are constructed. Because cause-effect diagrams can describe the logical relationships between system variables more clearly in the system

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dynamics model, cause-effect loop diagrams are constructed in the model. Also based on the cause-effect loop diagram causal relationships through the model equations can construct a stock flow diagram as a way to quantitatively analyze the internal variables of the system. The stock flow diagram can run out the dynamic change relationship between the influencing factors and simulate the change among the influencing factors.

In this paper, we use Anglogic software to construct a capacity model that affects general cargo, and we can quickly construct a simulation model of shipping prices.

2.1 The "cost-profit" subsystem causal loop

Costs and profits are one of the important influencing factors when evaluating the changes in the ocean freight index for general cargo. The causal loop of the "cost-profit" subsystem is shown in Fig 1. Total cost refers to the operating cost of the charterer, which is the total expenses incurred by it in conducting the marine agency business, including port operation efficiency cost, fuel cost, personnel cost, port miscellaneous cost and chartering cost. Ocean freight price for general cargo refers to the price that a shipper needs to pay when shipping general cargo. Expected ocean freight price refers to the revenue that the charterer expects to receive per marine transportation agency order. Expected charter price refers to the price that a shipowner charges a charterer for chartering a vessel. Expected profit refers to the rate of revenue that the charterer expects to receive from the marine transportation business agency. All the above concepts are based on the example of handysize vessels on the China-Indonesia route.

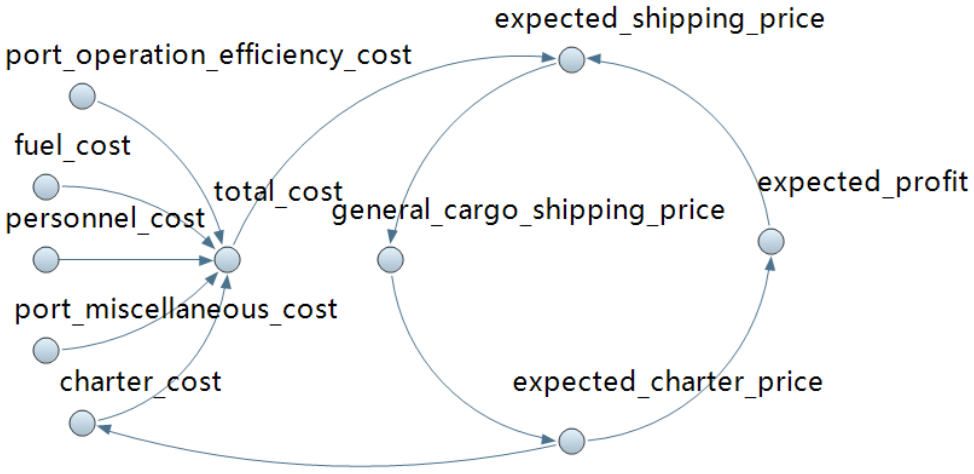

Fig 1: The "cost-profit" subsystem causal loop

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As shown in Fig 2 and Fig 3, the causal loop of the "cost-profit" subsystem for general cargo consists of two loops, as follows:

R1——general cargo shipping price → expected charter price → expected profit → expected shipping price → general cargo shipping price;

R2——general cargo ocean freight price → expected charter price → charter cost → total cost → expected shipping price → general cargo ocean freight price.

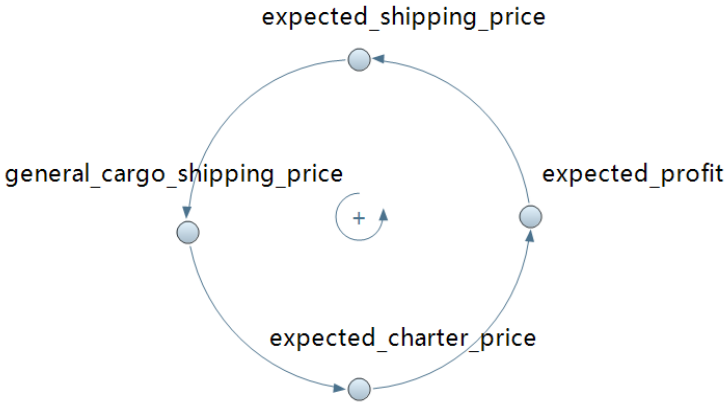

Fig 2: "Cost-profit" subsystem causal loop R1

From the loop R1, it can be seen that, firstly, the increase of the general cargo ocean freight price will make the shipowner observe the market that the demand of the general cargo ocean freight market is strong and the price multiplication ability of the cargo owner is stronger, so as to raise the expected chartering price and earn more return. Secondly, the general cargo ocean freight price will affect the charterer's chartering budget, when the capacity supply remains unchanged, every unit increase in the general cargo ocean freight price will increase the charterer's ability to accept the ship's charter, and its expected chartering price will increase by 0.095 unit, that is, the charterer will adjust its expected chartering price because of the increase in the general cargo ocean freight price. When the expected charter price is adjusted upward, its expected profit needs to be increased accordingly. When the expected shipping price is increased by one unit, in order to reduce the risk, the expected profit of the charterer will be increased by 3.112 units accordingly to guarantee the stability of income. When the expected profit is increased, the accepted value of the expected shipping price will also be increased because the shipowner's acceptability for other risks and shipping price changes will also be enhanced. Each unit increase in expected profit, the expected ocean shipping price will increase by 0.081 units, which further leads to the increase in the shipping price of general cargo.

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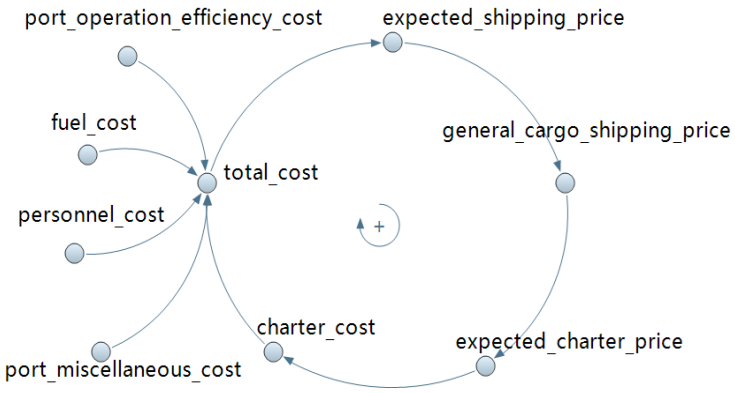

Fig 3: Causal loop R2 of the "cost-profit" subsystem

For loop R2, both port operation efficiency and each cost have an effect on total cost, but their influence is in different directions. Port operation efficiency has a negative effect on total cost, while each cost has a positive effect on total cost. In order to improve efficiency, R2 is analyzed here on behalf of port operation efficiency, and the effect of each cost on the loop is the opposite. When the port operation efficiency decreases, the same work such as loading and unloading time will be extended, and the time in port will become more, and the time of the ship in port will not only affect its operation efficiency, but also generate some in port costs, so in the port operation efficiency decreases, the in port time becomes longer will increase its various in port costs, and the in port costs are included in the total cost, and thus the port operation efficiency decreases increases the total cost; and When the total cost increases, the charterer will increase the shipping cost budget, so within a certain range, the shipping price is expected to increase. According to the calculation, 1) for each unit increase in total cost, the charterer's expected shipping price will also rise by 0.932 units. 2) for the transportation of general cargo, the increase in expected shipping price is reflected in the increase in the shipping price of general cargo, and for each unit increase in expected shipping price, the shipping price of general cargo will also increase by about 3.112 units. 3) in order to accomplish the set transportation target, with the The expected charter price will increase by 0.095 units under the influence of one unit increase in the sea freight price of general cargo. 4) For the charterer, the expected increase in the charter price will make its charter cost higher, and the charter cost, as a part of the total cost, will once again make the total cost higher when it shows an upward trend.

From the above analysis, it can be seen that the control of fuel costs, personnel costs, port miscellaneous charges and the rise of chartering costs can effectively reduce the sea freight price of general cargo, while the improvement of port operation efficiency to a certain extent can also bring down the price of sea freight general cargo.

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2.2 Causal loop diagram of the "Capacity-Demand" subsystem

The relationship between capacity and demand in the general cargo market is also a key factor affecting ocean freight prices. The causal loop diagram of the "capacity-demand" subsystem is shown in Fig 4. Fleet size refers to the current total number of world maritime vessels, where the initial ship size refers to the world fleet size in May 2021, ship idle volume refers to the current state of the former idle or out of capacity, ship scrapping volume refers to the current dismantling volume, new shipbuilding volume refers to the volume of new production completed in the month, and fleet size is the number of ships that can be transported by their combined influence, the relationship is: fleet size = Initial ship volume + new shipbuilding volume - ship idle volume - ship dismantling volume. In-transit capacity is equal to the number of ships that can carry out the delivery of cargo at the moment and is equal to the current fleet size. BHSI is the Handysize Ship Rate Index. At present, handysize ships are the main carriers of general cargo in the market, but handysize ships not only carry general cargo but also steel, so the import and export volume of steel and the in-transit capacity will affect the rise and fall of BHSI.

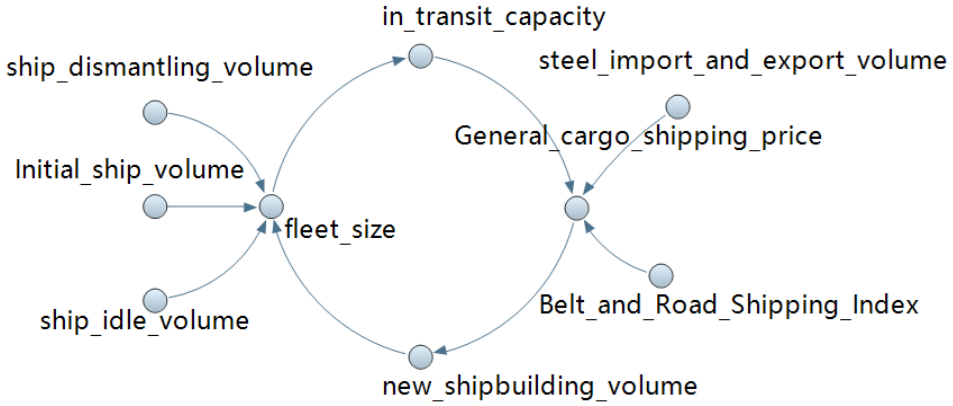

Fig 4: "Capacity-demand" subsystem cause-effect loop

As shown in Fig 4, the capacity-demand subsystem cause-effect loop contains one feedback loop, as follows.

General cargo shipping price → new shipbuilding volume → fleet size → in-transit capacity → general cargo shipping price.

From the above circuit, it can be seen that the change of general cargo sea freight price has some influence on the new shipbuilding volume. When the general cargo freight price rises, it means that the sea freight market is hot and the market is likely to be short of capacity. At this time, shipowners will place orders with shipbuilders because they want to get more profit, thus

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leading to the increase of newbuilding volume. Fleet size is influenced by several factors including initial ship volume, shipbreaking volume, ship idle volume and newbuilding volume, which is a relatively simple additive and subtractive relationship. Fleet size growth will inevitably lead to the growth of the current market in the transport capacity, and in the transport capacity will increase to a certain extent to alleviate the mismatch between supply and demand in the shipping market, making the general cargo shipping prices fall. In addition, general cargo shipping price is also affected by the shipping market demand. Steel import and export volume and general cargo share handy bulk carrier, its import and export volume changes largely represent the shipping market shippers' demand for handy ships, when steel import and export volume increases, it means the transportation demand increases. The Belt and Road Shipping Index represents the demand of maritime trade between China and Belt and Road countries, which is more macro. Therefore, the steel import and export volume and the Belt and Road Shipping Index have a positive impact on general cargo prices.

Through the above analysis, general cargo ocean freight prices are influenced by the "capacity-demand" subsystem mainly in the two aspects of capacity and steel import and export volume, and BHSI is a microcosm of general cargo ocean freight prices. When examining the general cargo ocean freight rates, shippers need to consider the prosperity of the steel import and export market and avoid marine transportation activities during the more active steel market. Secondly, general cargo owners should also pay attention to the changes in the capacity market, especially the changes in the number of ships, and avoid using sea freight during the time when the capacity is insufficient.

III. CONCLUSIONS AND SUGGESTIONS

3.1 Conclusions

According to the above analysis, the sea freight price for general cargo from China to Belt and Road countries is influenced by several factors, mainly divided into cost-profit part and capacity-demand part.

3.1.1 The cost-profit loop reflects the will of shipowners and charterers

The core influencing factors in cost-profit subloop R1 are expected charter price, expected profit and expected shipping price, and the core influencing factors in subloop R2 are expected charter price, charter cost, total cost and expected shipping price.

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The cost-profit subsystem is influenced by the shipowner and the charterer in both directions. The expected charter price represents the interests of the shipowner and is the expected revenue of the shipowner based mainly on the general cargo ocean freight price, and the expected charter revenue also rises when the general cargo ocean freight price keeps rising. The expected ocean freight price represents the interest of the charterer and is determined by the total cost of chartering and the expected profit.

Total costs were divided into a number of categories, with port operational efficiency and personnel costs being the most severely affected by the outbreak. The increase of disinfection links at the port and the continuously high number of infections among port staff led to a significant increase in the operation time of cargo ships after arrival and a decrease in the number of available crew. Therefore, the efficiency of port operation is reduced and personnel costs are rising.The China-Indonesia general cargo shipping in this study is international shipping, and the fuel cost is greatly affected by the international oil price. Port miscellaneous charges are usually very stable, as they mainly refer to the national import and export shipping policy and port operation charges, both of which are not easy to change.

Expected profits are a reflection of shipowners' and charterers' judgment of the trend of the ocean freight market. When the general cargo shipping price rises, both the shipowner and the charterer will think that the cargo owner's demand is stronger, which will raise their expectation of expected profit, and thus make them raise the price of chartering and ocean freight forwarding business. The charterer needs to bear the total cost of chartering from the shipowner's expected chartering price, therefore, the charterer's shipping agency business price will change more drastically than the chartering price.

3.1.2 The capacity-demand loop reflects the balance of the shipping market

The price of general cargo in the capacity-demand circuit is jointly determined by the in-transit capacity representing capacity and the steel import and export volume representing demand and the Belt and Road Shipping Index. When the capacity is greater than the demand, the general cargo shipping price shows a downward trend; when the capacity is less than the demand, the price shows an upward trend; when the capacity is equal to the demand, the price is flat. In turn, when market prices continue to change, shipowners increase or decrease the number of vessels they hold to stabilize costs; charterers increase or decrease their leasing practices to maintain a more stable profit. Cargo owners choose whether to engage in ocean freight operations and whether to use general cargo vessels for transportation depending on the situation. These factors come together to form the causal loop of the system. Therefore, the capacity-demand subsystem is a good representation of the balance of supply and demand in the shipping market.

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3.2 Suggistions

International shipping is restricted under the influence of the epidemic, and the change of general cargo shipping price is more complicated, showing a sharp upward trend. For general cargo shippers, how to clarify the catalysts behind the rising general cargo shipping prices, so as to control shipping costs, develop with the trend and stand out among many competitors under the situation that the epidemic tends to be normalized, combined with the discussion of this paper, and put forward relevant suggestions.

3.2.1 Focus on epidemic prevention to reduce the impact of the epidemic

Due to the global spread of the COVID-19 since 2020, its negative impact on the maritime transport market cannot be underestimated. The negative image is mainly reflected in the rise of personnel costs and the decrease of port operation efficiency, which can lead to higher costs when shippers choose ocean freight as breakbulk transportation. Companies want to avoid such risks should first ensure that they choose a reliable shipping agency service provider, and disinfection and prevention work must be in place. Secondly, choose ports that use more mechanical operations as ports of departure and destination, with the aim of reducing direct contact with personnel, thus reducing delays caused by the infection of crewmembers.

3.2.2 Concerned about the changes in the market of competing products of ship type

The general cargo ocean freight market is closed and does not have the same public price data as the container ocean freight market for shippers to understand the current strength of market demand and predict future supply constraints. Therefore, general cargo shippers must pay attention to the market demand of competing products using the same type of vessels. Take the handysize vessels commonly used for general cargo as an example, they commonly carry cargoes other than general cargo, including steel. Then, the import and export volume of steel can give an idea of the demand level of handysize vessels and whether breakbulk cargoes will need to increase their tariffs in the future in order to get the capacity.

3.2.3 Concerned about the price changes of other ship types shipping market

Other ship types shipping market will also have an impact on the sea freight prices of handysize ships used for general cargo shipping. In the case of the situation that emerged during the outbreak, container shipping prices in China soared as container ships could not return with normal cargo from China due to differences in the effectiveness of the outbreak control. This makes many of the goods using the container transport switch to cheaper dry bulk ships, crowding out the bulk and general cargo transport market makes a serious decline in supply, ultimately leading to a significant increase in the price of bulk and general cargo shipping.

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Therefore, price changes in other markets are also a factor that general cargo shippers must pay attention to.

At present, China's opening up to the outside world is increasing, and maritime transport, as an important means of international transport, is in a state of price volatility. When choosing sea freight as the transportation mode, the owners of general cargo must consider the above mentioned points in order to avoid the risk of epidemic and cost risk.

REFERENCES

[1] VMware Inc (2020) Patent Issued for Methods and Systems to Determine Container Costs and Attribute Container Costs To Applications (USPTO 10,671,951). Computers, Networks & Communications

[2] YU FP, KUANG HB (2012) BDI index nonlinear mean reversion characteristic. Journal of Management hedging performance of International dry forward freight 2:55-61

[3]JIA HY, ZHOU CX, WANG YH, LIN Y (2021) Study on fluctuation characteristics of China's Coastal bulk freight Index. Statistics & Decision 37(03):158-161 (in Chinese)

[4]Jun Woo JEON (2017) Study of the Optimal Timing of Container Ship Orders Considering the Uncertain Shipping Environment. The Asian Journal of Shipping and Logistics 33(2):085-093

[5]Schramm Hans-Joachim, Munim Ziaul Haque (2021) Container freight rate forecasting with improved accuracy by integrating soft facts from practitioners. Research in Transportation Business and Management 41

[6]ZHANG Y, WANG Y (2010) Research on Relevance between CCFI and Actual prices. Navigation of China 33 (02):95-99

[7] DING Y, YANG L (2015) Empirical research on the attraction force of China’s GDP across BDI[J]. Journal of University of Shanghai for Science and Technology 2:199-204 (in Chinese)

[8] HAO YZ, ZHANG L (2016) Empirical analysis of international crude oil price fluctuations on the Baltic index. Journal of Commercial Economics 6: 25-28 (in Chinese)

[8]QIU ZP, LIU Z, GUO H (2021) The International Trade Effect of Global Liner Shipping Network-Analysis of UN LSBCI Matrix Data-Based on the Social Network. International Business 05:79-95

[9]WANG S, REN X (2021) On Supply Chain Optimization Strategies of Fresh Agricultural Products under E-commerce Empowerment. Price: Theory & Practice 01:149-152