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Influencing Factor Analysis of Break-bulk Cargo Freight Price Using SD Model

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Abstract:

Based on the influencing factors of shipping price of groceries, the system dynamics (SD) model is established and the corresponding flow chart is drawn. And according to the existing data of the same period, using the method of regression analysis to study the relationship between variables, according to the change of different variables and their mutual influence to analyze the change trend of grocery shipping price. The study found that due to the impact of COVID-19, the cost of fleet personnel, port operations and fuel costs have increased, leading to fluctuations in shipping prices of groceries. Relevant departments should actively pay attention to the situation of COVID-19, various costs of the fleet and the capacity of the world fleet in order to analyze the trend of shipping prices of groceries.

Keywords*: Break-bulk cargo; SD; Analysis of regression; Contributing factors.*

I. INTRODUCTION

The dry bulk cargo transportation market is closely related to the world economy and trade, but the market price is unstable due to many factors. Since January 2021, the dry bulk freight rate index BDI began to accelerate its rise until it reached the highest value in nearly a decade in October. With the demand side uncertainties such as China's restrictions on steel production, coupled with the impact of China's port congestion mitigation, capesize ships took the lead in retreating and correcting. In 2021, the dry bulk spot market finally ended at a higher price. Despite the high volatility, it still achieved a strong recovery compared with the past decade.

This is mainly due to the demand growth brought by China's rapid economic recovery since mid-2020, as well as the port congestion caused by the superposition of epidemic control and strong demand growth, as well as the historical low order of new dry bulk cargo ships in recent years, and the delivery volume will slow down significantly, resulting in the moderate growth of fleet capacity, and the very loose monetary policy of major countries in the world and the vigorous growth of consumer demand in important economies in Europe and the United States after the epidemic. At present, it is urgent to analyze the reasons affecting the shipping market from various angles. This paper constructs the system dynamics model of dry bulk cargo market in terms of transportation capacity, demand, finance and cost, makes regression analysis on the influencing factors, and tries to clarify the market operation mechanism and

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evolution law, so as to provide decision-making reference for the operators of dry bulk cargo shipping market.

Ⅱ. LITERATURE REVIEW

The shipping market is mainly composed of container transportation, bulk cargo and bulk cargo. This paper mainly studies the fluctuation of bulk cargo shipping price by studying the related factors that affect the shipping price of bulk cargo. In the process of sorting out the existing related papers, it is found that most of the papers, whether by model or text description, study the relationship between influencing factors and shipping price, are carried out around container transportation and bulk cargo transportation, but there are few papers on the shipping price of bulk cargo. Therefore, by summarizing scholars' research methods on bulk grocery and container transportation prices, we can get the method of shipping prices of studied pieces of grocery.

Nowadays, there are three main methods for scholars to study the price of groceries and container shipping. The first is to simply analyze the influencing factors without using data. Xiwen Bai et al constructed shipping index of dry bulk market from archives of shipping news through text analysis[1]. WEI Fang et al. also used the fractal theory to analyze the leverage effect of the market by ship type when studying the changes of the Baltic Freight Index[2]. Vangelis Tsioumas et al. first constructed a composite index with three groups of variables, and then analyzed the relationship between the composite index and dry bulk freight rate[3].

The second research method is to predict future freight rates through historical data, which includes traditional time series method, artificial intelligence algorithm and prediction method combining the above two methods. There are many researches on this aspect. Vangelis Tsioumas et al improved the Baltic Dry bulk freight index by establishing VARX model[4]. Li Diansheng et al. applied the fractal distribution theory when studying the distribution structure of international dry bulk price index, and finally concluded that the time series of international dry bulk shipping price index had the characteristics of peak tip and long-term memory distribution[5]. Wang Dashan et al established a joint equation model, which can simulate the main influencing factors of international dry bulk cargo and the change of BDI index[6]. Daniel M.Bernhofen et al studied product level trade from 1962 to 1990 through panel data, thus assessing the change of containerized freight rate index[7].

Finally, the influence of shipping factors on shipping price is studied by means of system dynamics. In order to more clearly analyze the different influences of various factors on the fluctuation of the Baltic Dry bulk price Index, Junwoo Jeon used the system dynamics model to analyze the changes affecting the dry bulk price index by taking the spot and time charter rates of dry bulk shipping as the influencing factors[8]. At the same time Vit Prochazka et al. believed that ships also had a certain impact on space and time. During the epidemic, many industries were impacted, including the shipping market[9]. Dai Tianlun et al. analyzed the short-term impact of COVID-19 on the international dry bulk shipping market[10]. While the epidemic has affected the shipping market, it has also affected shipping companies. Takuma Matsuda et al.

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analyzed the changes of their freight rate index by using econometric methods[11].

To sum up, the current research mainly adopts system dynamics, text analysis, historical data and modeling methods, and focuses on dry bulk cargo and containerized freight index, while there are few studies on general cargo. In order to have a more accurate understanding of the shipping market and international shipping situation, In addition to grasping the trend of dry bulk freight and container freight index, it is still necessary to pay attention to the fluctuation of the grocery market, and at the same time keeping an eye on the trend of sea freight related freight index, find the relevant influencing factors, and analyze the relationship between influencing factors and freight index according to the actual situation. Therefore, this paper adopts the system dynamics model and analyzes the change of shipping price of groceries with a variety of influencing factors.

Ⅲ. MODEL INTRODUCTION

3.1 AnyLogic simulation

AnyLogic simulation software is a professional virtual prototyping environment for designing complex systems with discrete, continuous and mixed behavior. The platform simulation mainly simulates different things in the real system through active objects. The active object is the main square graph of AnyLogic model, which has different properties and behavior states. The properties of the object can be expressed by setting variables and parameters, and the behavior states of the object can be set by setting the state graph and writing functions. Objects can encapsulate other objects downward, and objects can interact and transfer messages through ports to simulate the movement and information transfer of flowing entities in the real world. Designing AnyLogic model is actually designing active objects and defining their relations. Running model is the process of displaying the dynamic activities of active objects.

AnyLogic is used to realize the modeling of shipping price of groceries. By designing different simulation scenarios, the causal relationship process of shipping price of groceries is simulated, which can study and analyze the factors affecting the shipping price of groceries, and provide support for the optimization design of shipping capacity demand of groceries.

3.2 Process simulation modeling of influencing factors of freight price of groceries

3.2.1 Objects in the system

The basic elements of the object category of the grocery shipping price model include grocery shipping price, expected shipping price, in-shipment capacity, demand-oriented orders, Belt and Road Shipping index, steel import and export volume; Total cost, expected profit margin, BHSI, capacity change, initial vessel capacity, number of new vessels; Port miscellaneous, personnel cost, charter cost, port operation efficiency cost, fuel cost, expected charter income, import and export volume of steel, total change in shipping capacity, investment-oriented orders; The number of new infections, actual sailing time, vessel closing time, average serviceable days of vessels, load of convenient vessels, transaction price index of

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convenient vessels, investment tendency of ship owners, etc. The setting of object classes in the flow chart of influencing factors of freight rate of groceries mainly uses the system dynamics components of AnyLogic such as stock, flow, dynamic variables, links and other elements to study and realize, and the conditions generated are mainly determined according to the survey data.

3.2.2 Operation process of the system

The whole simulation flow chart of the influencing factors of the freight price of groceries considers two major factors: cost and freight capacity. The cost part is to show the impact of total cost such as fuel cost, charter cost, personnel cost and other cost factors on the freight rate of groceries. The transportation capacity part is mainly used to understand the transportation capacity of groceries and reflect the impact on the freight price of groceries through the transportation capacity. In this paper, the above two factors are taken as the whole research object of AnyLogic diagram, and the data required by the object is calculated and filled into the attribute formula through Excel, and the shipping price of groceries is taken as the starting point of the whole flow chart for research.

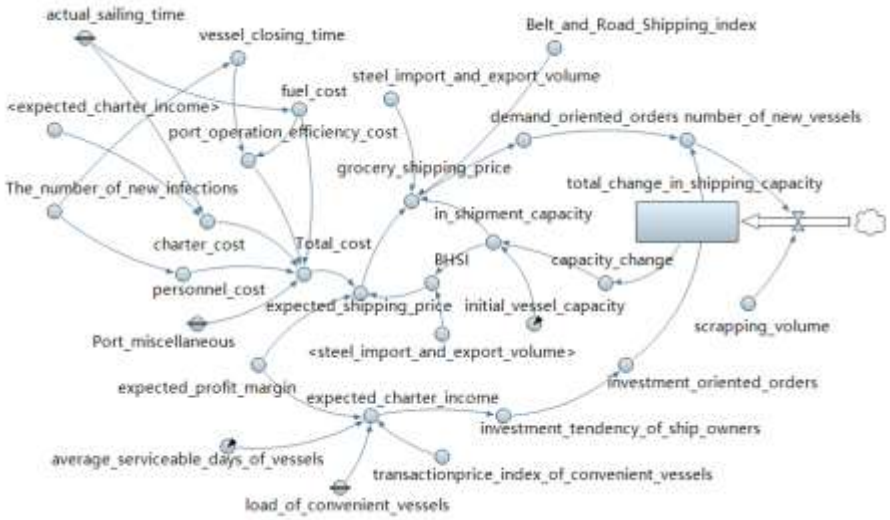

Figure 1 AnyLogic flow chart of influencing factors of shipping price of groceries

As shown in the above flow chart, the paper takes the shipping price of groceries as the center point and deduces the related influencing factors through progressive relationship. According to the existing data, regression analysis is used to analyze the influencing factors and obtain the influencing coefficient. First of all, starting from the first circle, the expected sea freight price, in transport capacity, demand-oriented orders, the Belt and Road Shipping index, steel import and export volume are the five parts that have the greatest influence on the sea freight price of groceries, and their formula is shown in the following TABLE I:

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TABLE I. AnyLogic Attribute Formula in the First Circle

OBJECT	FORMULA
expected sea freight	(0.1*bhsi+0.9* total cost *(1+ expected profit margin))/30000
sea feright capacity	initial number of ships + change in capacity
belt and road shipping index	belt and road shipping index fun.get(getdayofmonth()-1)
imports and exports of steel	imports and exports of steel fun.get(getdayofmonth()-1)

Secondly, in the first circle, the influencing factors of expected sea freight price, in transport capacity, demand-oriented orders, Belt and Road Shipping index, and steel import and export volume can be traced to the second layer respectively, namely, total cost, expected profit margin, BHSI, initial vessel volume, change in capacity, and number of new ships. The formula is shown in the following TABLE II:

TABLE II. AnyLogic Attribute Formula for the Second Circle

OBJECT	FORMULA
total cost	personnel cost + fuel cost + port miscellaneous fee + charter cost + port operation efficiency cost
expected rate of profit	expected rate of profit
bhsi	-5781.824-1.692* imports and exports of steel + 0.041* sea freight capacity
the initial capacity	default =205000
change in capacity	total change in capacity
number of ships added	(demand-led orders + investment-led orders)*0.1+ new ships fun.get(getdayofmonth()-1)

Continue to back down, by the total cost, profit margin, BHSI, initial capacity, capacity variation, the number of new vessels linked to the effects of the six key elements in the object mainly by the port incidental expenses, personnel costs, charter costs, port efficiency cost, fuel cost, expected income, steel exports, chartering capacity of total variation, investment-led orders, The formula is as follow TABLE III:

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TABLE III. AnyLogic Attribute Formula of the Third Circle

OBJECT	FORMULA
port miscellaneous	default =1150
staff cost	0.1* the number of new infections + staff cost fun.get(getdayofmonth()-1)
charter costs	actual sailing time * expected charter income
port operational efficiency costs	port operational efficiency costs fun.get(getdayofmonth()-1)
fuel costs	actual sailing time * fuel cost fun.get(getdayofmonth()-1)
expect charter income	(1+ expected profit margin)*(handy ship deadweight ton * handy ship transaction price index/average number of days available)
investment-oriented orders	shipping price of one piece of general cargo /40

Thirdly, the third circle of factors, including port miscellaneous charges, personnel costs, charter costs, port operation efficiency costs, fuel costs, expected charter income, steel imports and exports, total changes in shipping capacity, and investment-oriented orders, affect the fourth circle of objects related to them respectively. For example, the number of new epidemic infections, actual sailing time, vessel closure time, average serviceable days of vessels, load of convenient vessels, transaction price index of convenient vessels, and investment tendency of ship owners, the formula is as follow TABLE IV:

TABLE IV. AnyLogic Attribute Formula of the Fourth Circle

OBJECT	FOMULA
the number of new infections	the number of new infections fun.get(getdayofmonth()-1)
actual sailing time	default =9
vessel call time	the number of new infections/10000
average number of days available to ship	default =4000
flexible ship load capacity	default =30000
convenient ship transaction price index	convenient ship transaction price index fun.get(getdayofmonth()-1)
investment orientation of ship owners	expect charter income /10000

Finally, by using the formula and obtained data, click the running button of AnyLogic to realize the intuitive reproduction of the process of freight rate influence of groceries.

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3.3 Data Sources

The core data of this paper, such as the shipping price of groceries, are provided by the company. Cost and capacity factors are mainly obtained from maritime Service network, Shipping information network, China Shipbuilding Industry Association, Shipping Market Weekly, website of General Administration of Customs, website of National Development and Reform Commission, Ningbo Small and Medium-sized Shipping Enterprises Association & Century Sea-around Pansea, etc.

IV. ANALYZE

According to the flow chart of grocery shipping price, the fluctuation of grocery shipping price is due to the joint effect of transportation capacity, expected shipping price, import and export volume of steel and shipping index of the Belt and Road. At the same time, due to the impact of the epidemic, the shipping price of groceries fluctuated greatly recently, as shown in the figure below:

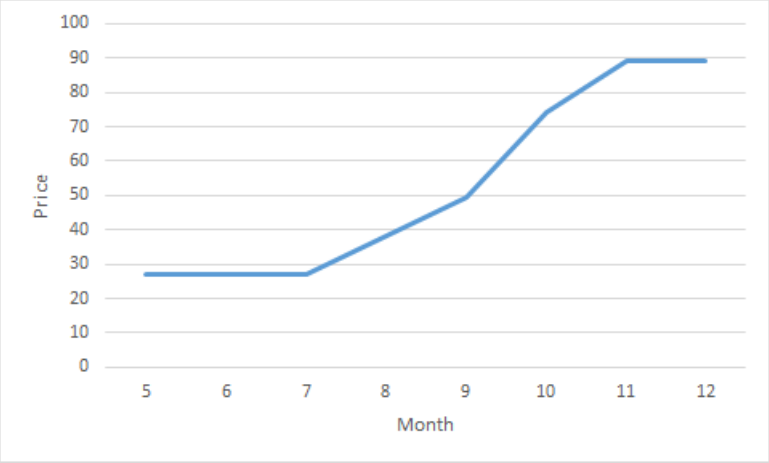

Figure 2 Shipping price of groceries

It can be seen that in recent months of 2021, the shipping price of groceries has an obvious upward trend with a large increase. Thus, the four influencing factors of transport capacity, expected shipping price, import and export volume of steel and shipping index of the Belt and Road are analyzed respectively.

According to the flow chart, it can be seen that the transport capacity is mainly determined by the change in transport capacity and the initial vessel capacity, while the change in transport capacity is mainly determined by number of new ships and ships dismantled. At present, the annual change in the world's fleet capacity is not much different from the initial capacity. In 2021, for example, the initial capacity is 2.05 million tons, and the annual capacity change is only 4 to 7 million tons. Compared with the initial transport capacity, the variation of transport capacity has been relatively stable, in a slow growth trend. Therefore, the change in transportation capacity has a small impact on the price of grocery shipping and will not lead to drastic changes in the price of grocery shipping.

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Steel imports and exports fluctuate between six and seven million tons a year, and the OBOR Shipping index fluctuates between 100 and 200 tons. However, due to its small base, it has a large change relative to the shipping capacity, thus causing a significant change in the price of groceries by sea.

The expected shipping price is mainly determined by the total cost and expected profit margin, while the total cost is calculated by adding port incidentals, personnel cost, charter cost, port operation efficiency cost and fuel cost, among which personnel cost, fuel cost and charter cost account for a large proportion and are important factors affecting the total cost. Because of the influence of the outbreak, personnel costs rise greatly, at the same time because of the outbreak resulting in a decline in the efficiency of the port, which leads to the total costs rise, so the lessee to achieve expected profit with the expectation of higher shipping price, at the same time, according to the factors which affect the price of breakbulk know expect shipping prices for break-bulk influence coefficient is the largest, So cost changes are a major factor in the price of groceries.

V. CONCLUSION

In this paper, AnyLogic software is used to analyze the shipping price of groceries and the influencing factors of shipping price of groceries, and draw the flow chart of the corresponding influencing factors. The relationship between different influencing factors can be clearly seen in the figure. The outbreak of COVID-19 has greatly impacted the shipping market. First of all, the epidemic has not only affected the normal operation of the fleet, but also affected the personnel cost of the fleet. Many sailors cannot return to work due to the epidemic. Second, the epidemic has seriously reduced the port's operational efficiency. Finally, fuel prices have been greatly affected. Expect shipping prices to rise due to various cost increases, thus affecting the fluctuation of shipping prices of groceries. In order to have a clearer understanding of the fluctuations of grocery shipping prices, relevant departments should continue to pay attention to the epidemic situation and the fluctuations of various grocery costs, and actively pay attention to the changes in the world's fleet capacity, so as to better predict the trend of grocery shipping prices.

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