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Study on the fluctuation and forecasting of capsize bulk carrier's freight

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STUDY ON THE FLUCTUATION AND FORCASTING OF CAPESIZE BULK CARRIER'S FREIGHT

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Declaration

I certify that all the material in this research paper that is not my own work has been

identified, and that no materials are included for which a degree has previously been

conferred on me.

The contents of this research paper reflect my own personal views, and are not

necessarily endorsed by the University.

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ABSTRACT

Title of research paper:
Study on the Fluctuation and Forecasting of the Capesize Bulk Carrier's Freight
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The freight rate on international bulk shipping market are constantly fluctuating. In 2008, as a result of the financial crisis, the world trade volume dropped sharply and BDI dropped by 11,130 points in a short period of one year, which brought huge losses to shipping companies and investors. Therefore, it is very necessary to know the fluctuation rules of the freight. It can provide advice for the decision of the managers and investors.

This paper firstly studies the demand and supply of international capesize bulk shipping market. i.e. the capacity of the capesize fleet and the main routes of capesize vessel. Analyzes the characteristics and the development of the Capesize fleet. Explain that freight rate is a reflection of the balance between supply and demand.

Secondly, it studies the fluctuation of BCI, analyzes the periodicity of BCI fluctuations and the "Chinese factor" that has a significant impact on capesize freight rates.

Thirdly, the freight rate of Capesize is modeled based on the ARIMA model, and compared with the real data to predict the freight rate of Capesize in the coming years. Find seasonal characteristic and the fluctuation law of the capesize freight market. Then provide a reference for the relevant enterprises in the world.

Key words: capesize shipping, freight, ARIMA model, forecast

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1 INTRODUCTION

1. 1 Background and significance of the topic

Affected by the financial crisis in 2008, the international dry bulk shipping market fluctuated greatly. In the fourth quarter of 2009, due to the seasonal factors, the international dry bulk shipping industry has witnessed a wave of rapid rally since the beginning of the December. However, the market demand for various cargoes has not fundamentally improved yet, and there are still many uncertainties ,the situation is still complicated and grim. Since 2010, the newly delivered vessels are mostly Cape-size vessels, and their capacity growth is relatively rapid. As a result, the market of Capesize vessels fluctuates greatly, adding a touch of uncertainty to the entire market. At this point, the Chinese shipyards engaged in construction of Cape-sized vessels accounted for 50% of the world's hand-held orders, an increase of 3% over 2008. How to deal with the volatile dry bulk shipping market and the Capesize market is of great significance to the Chinese enterprises.

1. 2 Literature Review

1. 2. 1 Dry bulk freight price behavior characteristics

The behavior and changes of price in the economic activities of commodity markets have always been the primary issues that experts and scholars in various fields are willing to study. Driven by Engle, Granger, Johansen and other scholars, econometrics research methods are widely used in the analysis of price in time series, especially in the study of price changes in financial markets. With the development of time, some scholars began to use these econometric models to study the changes of the freight rates in the dry bulk shipping market, which greatly promoted the dynamic behavior analysis and research development of the freight rates in the shipping market. Among them Including stationary test of the freight rate in time series, heteroscedasticity test, correlation test and so on.

Kavussanos used GARCH models to simulate the dynamic behavior and time-varying volatility of the spot tariffs and time-of-day tariffs of three dry cargo ship types. His research shows that the ARCH model can better simulate the freight rate dynamic behavior. GARCH model can better simulate the volatility behavior of time charter rates. In 2001, Kavussanos and Alizadeh established a single variable seasonal autoregressive integral moving average model and multivariable seasonal total and seasonal cointegration vector autoregressive VAR model to study the behavior of freight rates in dry bulk shipping market. They concluded: Dry bulk shipping market has seasonal fluctuations. Alizadeh and Nomikos et al. (2011) studied the term structure and volatility of shipping tariffs, and concluded that the fluctuations of freight rates have asymmetric reactions, when the rates show a price of backwardation, the tariffs fluctuate more than the Contango. Geman and Smith used the Constant elasticity of Variance (CEV) to study the variation of the BDI from 1988 to 2010 and concluded that there was a structural discontinuity in the index in August 2003, so they divided the index into 1988 to July 2003 and August 2003 to 2010 and concluded that the period of variation of the index before July 2003 is about 4. 52 years, equal to a new ship delivery cycle, which is called the shipbuilding cycle; and after August 2003, the index volatility cycle shortened to 2. 04 years, they explained that this is due to the rapid development of the shipbuilding industry in Asia in recent years (especially China And South Korea's shipbuilding industry) led to rapid growth of capacity growth, while the rapid economic development in developing countries led by China led to a substantial increase in trade demand, which is why the cycle of index volatility is shorter. Through analysis by GARCH model, Che Hengda (2013) concluded that there is a peak-tail, rapid response to external information, long lasting volatility memory, and strong continuity in the dry bulk shipping market. Through empirical research, it is concluded that the fluctuation of dry bulk shipping capacity demand is 2.5 times the changes in the world economic and trade demands. The fluctuations in the supply of shipping capacity are 1.8 times the fluctuations in the demand of shipping capacity. Finally, the bullwhip effect exists in the dry bulk shipping market.

1. 2. 2 Market characteristics

There are a few literatures about the market efficiency and characteristics of dry bulk shipping in China. Most of the studies on the market characteristics and efficiency of traditional dry bulk shipping do research and analysis based on the basic assumption that freight rate follows random walk or Brownian motion. Assuming that the dry bulk shipping market is essentially viewed as a complete market with unimpeded access to capital and information, this does not quite fit the reality of highly asymmetric information often associated with the dry bulk shipping market, as well as large shippers oligarchy controls on tariffs and more. Lu Jing and Marlow et al. (2008) studied the volatility characteristics of the Capesize, Panamax and Handymax freight indices from March 1, 1999 to December 23, 2005. They concluded that the impact of external information have different influence on the freight index of different ships. They subdivide the asymmetric characteristics of freight rate change into different ship type markets. The empirical study shows the flexibility of the ship and the types of bulk cargoes transported and the differences in navigation making the different types of dry bulk shipping market fluctuations in the price characteristics are also different. Wei Fang (2008) conducted a systematic and comprehensive study on the fluctuation of dry bulk freight market and conducted a comprehensive risk assessment on it. He analyzed that the time series formed by the freight rate of return of dry bulk shipping has typical non-positive State distribution, showing a sharp peak fat tail phenomenon, there is a clear correlation between the period before and after, and its volatility has time-varying characteristics like other similar conclusions, and deny the reliability of EMH in the dry bulk shipping freight market, and supported that the dry bulk shipping market follows the assumption of Fractal Market Hypothesis (FMH). Wan Peixiang (2012) studied the daily return, weekly return and monthly return of the freight index of the dry bulk shipping market. He concluded that each series has a similar fractal distribution structure and calculated the daily gain of dry bulk The Hurst index of the series is 0. 77, indicating that the fluctuation of the freight index of dry bulk has the characteristics of persistence and cyclicality.

1. 2. 3 Freight analysis method (modeling techniques)

In 1999, Yang Weinian established a multiple linear regression model and a multivariate lagged variable model to analysis the freight. In 2003, Lv Jing and Chen Qinghui obtained the long-term trend items, periodic volatility items and seasonal fluctuation items respectively. and the zero-mean stationary sequence is formed and the ARMA prediction model is established. In 2004, Zeng Qingcheng established a model of forecasting trend by using the non-linear mapping function of BP network, and predicted the Baltic Freight Index from short-term, medium-term and long-term respectively. Li Zhenghong (2004) took a logarithm of the time series after extracting long-term trend items and seasonal fluctuation items, and made a poor comparison with the mean of the series, then established a stable time series. In 2005, Liu Jianlin and Shi Xin used cointegration technology to conduct a co-integration study on the future price and the spot price of BDI futures market and got a short-term futures pricing model. In 2006, Li Yao-Ding conducted a half-month from July 1984 to November 2005 BDI logarithmic sequence established a GARCH model. In 2007, Zhu Jian and Le Meilong did residual test on the ARIMA model and make AJC, BIC indicator comparison, then select the best model.

1. 3 Research content in this paper

This paper studies the capacity of the capesize fleet and the main routes of capesize vessel, and analyzes the supply and demand characteristics of the Capesize and the development trend of future capacity. Explain that freight rate is a reflection of the balance between supply and demand.

Secondly, it studies the fluctuation of BCI, analyzes the periodicity of BCI fluctuations and the "Chinese factor" that has a significant impact on capesize freight rates.

Thirdly, the historical data of the Capesize ship freight in the international market is modeled based on the ARIMA model, The principle of ARIMA model construction is introduced, and the ARIMA model is used to model the freight rate of Capesize vessels.

Finally, it is considered that the modeling results are valid and can predict the future market capesize freight.

2 DEMAND AND SUPPLY ANALYSIS OF CAPESIZE SHIPPING MARKET

2. 1 The supply of capesize vessels

Capesize ships generally refer to dry bulk carriers with a load capacity of over 80,000 tons, a width of 32.5 meters or more, a length of 250-300 meters, and a draught of over 10.5 meters. They are generally nine cargo holds and nine hatches. Due to the limitation of its scale, it is not possible to pass the Panama Canal and the Suez Canal, and it is necessary to bypass the Cape of Good Hope and Cape Horn. The annual wind near the Cape of Good Hope is greater than Grade 8. The strength and tonnage of this kind of ship must be able to pass safely through the worst weather in the Cape of Good Hope, so it is Called the Capesize type, it is a typical ship type that connects the Atlantic Ocean and the Pacific through the Cape of Good Hope.

Capesize ships are the largest tonnage bulk carriers currently constructed in China. With the development trend of large ships, the representative ship tonnage of Capesize ships has gradually increased from 120,000 DWT to 140,000 DWT and 190,000 DWT. The DWT determines that it can only transport large quantities of large-scale goods, mainly coal and iron ore.

The Capesize type is not a very clear classification. The average Capesize dry cargo ship has a load of 80,000-175,000 tons, but in fact more than 175,000 tons of dry cargo ships are also classified as Capesize. Due to the huge tonnage and volume of these vessels, their water depth and infrastructure requirements for the port are very high and there are not many ports that can let them berth in.

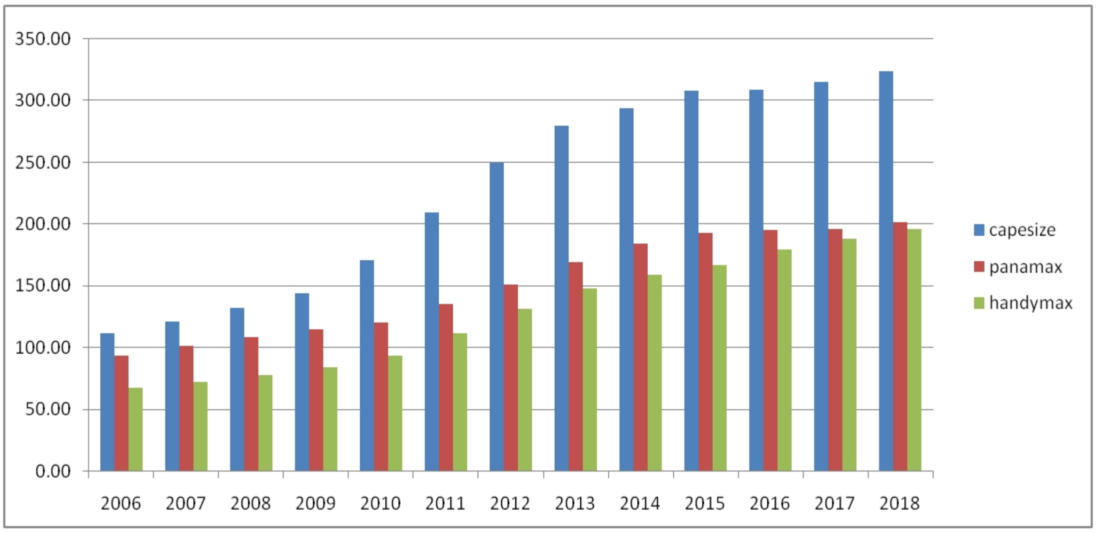

Figure 2. 1　The development of 3 major bulk carrier fleet in the world

Source : Clarkson database

2. 1. 1Transporting capacity

Figure2. 1 reflects the changes in the size of the three major types of bulk carriers during the five-year international bulk shipping market in 2006-2018.　From the figure, we can see that the capacity of the Capesize vessels has remained at a high level for five years and continues to grow every year.　The capacity of Panamax ships is second only to Capesize vessels, but its growth rate is slow.　The capacity of Handysize vessels is relatively stable and there is not much fluctuation.

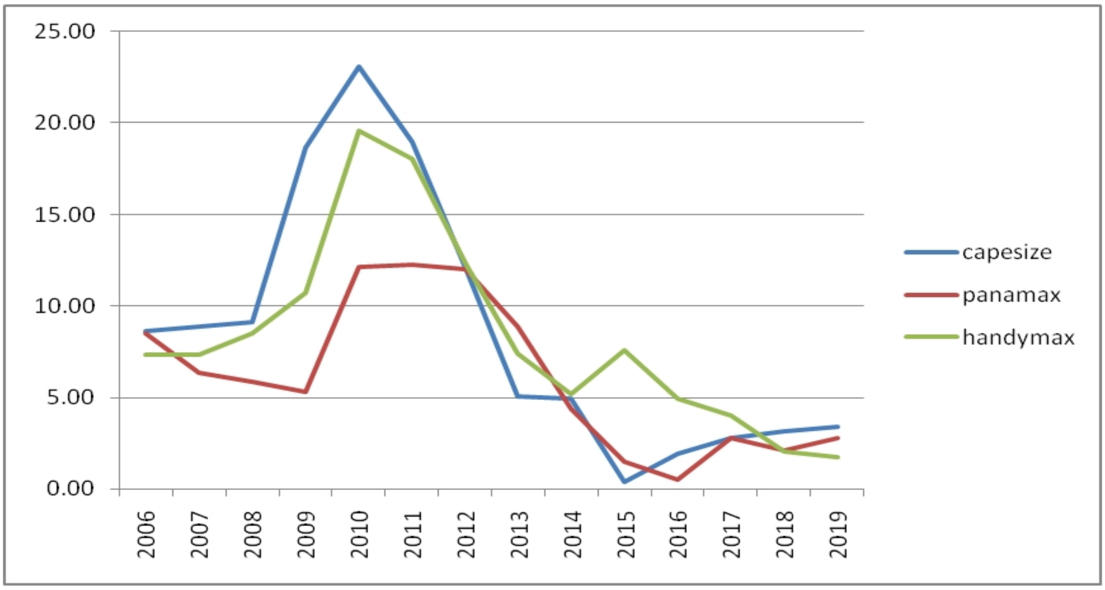

Figure 2. 2　The fleet growth of three main bulk carriers. (%)

Source: Clarkson database

On the whole, the total capacity of the transport fleet in the international dry bulk shipping market keeps increasing, and the scale of capacity growth from 2008 to 2009 is relatively the largest according to figure 2. 2

Table 2. 1 The fleet development of capesize vessels during 2003-2018

Date	Fleet (No.)	Fleet (DWT , million)	Deliveries (DWT)	Demolition (DWT)
2003	540	89. 09	5,140,268	760,206
2004	563	93. 47	7,427,583	0
2005	610	102. 35	8,752,421	247,299
2006	659	111. 35	10,437,875	295,895
2007	712	120. 95	10,675,669	0
2008	769	131. 63	8,801,645	2,157,823
2009	824	143. 61	20,983,080	1,443,270
2010	958	170. 38	38,579,487	2,725,373
2011	1,166	209. 72	45,366,073	10,508,627
2012	1,366	249. 43	41,891,839	11,726,251
2013	1,508	279. 48	22,063,009	7,934,419
2014	1,567	293. 58	18,740,586	4,230,694
2015	1,637	308. 09	16,918,025	15,438,232
2016	1,630	309. 21	19,969,735	13,335,427
2017	1,652	315. 17	15,327,876	6,376,585
2018	1,693	323. 85	6,057,437	1,427,505

Source: Clarkson database

In the year of 2007 alone, the Capesize fleet’s new ship delivery exceeded 10 million dwt, and the fleet capacity reached 1,209,500 dwt, an increase of 8. 8% from the previous year. In the following year, the Capesize fleet’s new ship delivery dropped sharply to only 8 million dwt. However, the declining trend has undergone a complete change in the year. The Capesize fleet’s new ship delivery peaked at a record high of 21 million dwt. Meanwhile, the amount of demolition of old ships in the shipping market was only kept at one level. The low level and slow growth rate have led to a rapid growth in the fleet size, with a growth rate of 18. 6%. The shadow of the economic crisis in 2008 has not yet completely dissipated, but Capesize’s new ship delivery continues to grow, and the amount of dismantling continues to remain steady. Only in 2008 and 2009 two years, the extra capacity brought to the international dry bulk shipping market was 8 million dwt. This makes the Capesize fleet's capacity and demand not match, resulting in an unbalanced situation.

In 2010, the capacity of Capesize ships continued to increase until the new input capacity peaked in 2011. At this time, due to the extreme excess capacity of Capesize vessels, the amount of demolition increased rapidly. In 2012, the new delivered capacity of Capesize vessels decreased. Since then, due to the reduction of new shipbuilding orders for Capesize vessels, the new deliverded capacity in the market has gradually decreased. However, the capacity of the Capesize in the market has not decreased, and it is growing until 2017. In the meantime, in order to appropriately reduce the capacity of the Capesize ship in the international market, the demolition volume of the Capesize ship reached its highest level in 2015. After 2015, due to the recovery of the shipping market, the Capesize ship's demolition volume has decreased, and the capacity increase and decrease have been in balance, but in general, the capacity of Capesize fleet is still growing.

2. 1. 2 The service characteristics of capesize bulk shipping

Capesize vessel transport is a special kind of service product. Its transporting capacity supply has the following main features.

1) Non storage

The supply of Capesize vessel is the same as general transport services. The consumption process and the production process are synchronized and cannot exist alone. This feature determines that the reserve of transportation products cannot be stored in the form of selling goods like traditional commodities. Only by increasing or decreasing the capacity to handle the changes in the demand for dry bulk cargoes of the Capesize vessel, but the adjustment period of the transportation capacity is longer. Therefore, the capacity adjustment may lead to imbalances in the supply and demand of the transportation market, especially the risks caused by oversupply.

2) Differences in time and space

The supply of capacity in the Capesize vessel market has a time and space difference from its demand. For example, it takes at least two to three years for a ship to arrive at the factory from the establishment of an order to use. In the ship's displacement process, the supply and the satisfaction of demand needs to be realized at the same time. This requirement creates a contradiction with the above-mentioned difference in the space-time of supply, and may eventually cause the ship owner to bear the loss of transport capacity. Even the economic risk of empty transportation.

3) unbalance

The imbalance in the supply of the Capesize vessel is mainly reflected in three aspects: First, the imbalance between supply and demand, manifested as supply exceeds demand or oversupply, while oversupply is seen as a major factor, and the dry bulk shipping market has been sluggish since the 1970s just proved this. Secondly, during the dry bulk transportation operation period, there are off-season and high-season seasons. Therefore, there will be a difference between peaks and troughs in the supply volume, and there will be an alternating phenomenon of supply shortage of capacity and supply excess of capacity. Then, the dry bulk cargo flow is unbalanced, which makes the dry bulk cargo transportation supply unbalanced. It is mainly manifested in the uneven distribution of the transport capacity in different regions, routes and the round-trip voyage of the same route. These imbalances may eventually cause the ship to bear the loss of transport capacity, or even the economic risk of empty transportation. The imbalance of dry bulk shipping supply is a relative concept, long-term and absolute. Therefore, in order to rationally utilize capacity and minimize waste, shipping companies need to make overall plans so that the fleet can maintain proper structure and scale.

2. 1. 3 The developing trend of capesize vessel

1) Large scale of the ship

In recent years, the development of ships in the direction of large-scale development has led to an increase in the tonnage , which is the result of increasing attention to the economies of scale of ships and the general trend of development of the international shipping industry. At the same time, more and more ports have increased their investment in deep-water berths, and have vigorously rectified the conditions of navigation channels and vigorously developed port facilities. These measures have laid a solid foundation for the development trend of large-scale ships. Over time, the ship's structure has also changed continuously. In the 1980s, large Handysize ships (tonnages of 40000 to 50,000 tons) dominated; during the 1990s, Panamax ships ushered in the glorious period, the size of the Capesize fleet was also rapidly increasing. At the beginning of the 20th century, the Supermax Handysize became the main ship type in the international dry bulk shipping market. According to statistics, as of the end of 2002, the proportions of the Capesize, Panamax, and Handymax vessels in the entire international fleet were 31. 6%, 25. 1%, and 43. 3%, respectively.

2) Ship types are constantly optimized

With the continuous advancement of science and technology in the shipbuilding field, the market demand will be fully taken into consideration in the shipbuilding process, and the optimal load-carrying tonnage of the ship will be designed according to the demand. From ship design to construction to the end of the new ship's put into use, modern concepts are always in sight. The goal is to build the ship with the shallowest draught and the fastest speed while having the lowest fuel consumption.

In addition, some ship owners have included double-hull bulk carriers in their construction plans in order to ensure the safety and economy of ships. Companies such as Safmarine, oakSteamship, and Kawasaki of Japan have already begun construction of double-hull bulk carriers. There are also some ship owners who have changed their old single-hull Capesize into double-hull vessels. Experience has shown that the hull steel plates on both sides of dry bulk carriers are most prone to rupture when they are hit, stranded, vibrated and twisted, causing seawater to sink. If a dry bulk ship uses a double-hull structure, even if there is a crack or a hole in the hull on both sides, the inner layer of the hull can also withstand the backwater, preventing the cargo from leaking out of the cabin or the mechanical power equipment inside is immersed by seawater in the cabin. So it can greatly improve the marine safety performance of dry bulk carriers.

3) The young aging trend of ships

International practice stipulates that ships whose age are more than 20 years are not suitable for the transportation of goods that require very high shipping conditions. In recent years, the world has attached great importance to the safety of old ships, international conventions and the International Ship Society's inspection of older ships has become increasingly stringent. IACS said that the safety of bulk carriers is a top priority and new requirements was introduced in 2003. These new requirements include strengthening the slotted bulkhead between No. 1/2 cargo holds, the double bottom of No. 1 cargo tanks, and measures relating to the protection of cargo tank hatches. All in all, the implementation of these requirements will result in the dismantling of more and more old ships in the international dry bulk shipping market.

2. 2 The demand of capesize shipping market

2.2.1 Factors affected the demand

There are mainly four factors that affect the demand of shipping market.

1) The development of the world economy. As the international dry bulk shipping market is a derivative market for international trade, the demand for dry bulk shipping is a derivative demand for international trade, which is mainly affected by international trade exchanges. While the volume of international trade is mainly

determined by the world economy. When the world economy grows faster, the volume of international trade will also show a trend of rapid growth. As a result, its demand for shipping will also increase rapidly. Conversely, if The negative growth of the world economy will lead to a significant reduction in international trade volume. Due to the lack of adequate supplies in the dry bulk shipping market, the shipping market will enter a recession period and appear sluggish. When analyzing the impact of the world economy on the international dry bulk shipping market, we cannot simply think that its impact on dry bulk shipping needs is direct or very simple. It also needs to take into account the worldwide business cycle and economic areas. Incidents and other factors, these will have different degrees of impact on the demand for dry bulk shipping. In the long run, with the gradual deepening of the integration of the world economy and the multilateral trade system aimed at achieving global trade liberalization, the international dry bulk shipping market will inevitably leap forward.

2) The average transport distance. The sea haulage of goods largely determines the dry bulk cargo transportation demand. This is because the longer the transported dry bulk cargoes of the same tonnage, the greater the amount of traffic generated. The change in the average transport distance will completely change the supply and demand balance of the dry bulk shipping market, so that the dry bulk freight rates will fluctuate.

3)Political event. Political events generally refer to the deterioration of relations between countries, regional wars, a country's internal revolution or coup, and the nationalization of foreign capital. The impact of political events on the dry bulk shipping market is obvious. It often brings abrupt, unpredictable abrupt changes to the international dry bulk shipping market, thus affecting the supply or demand of the international dry bulk shipping market.

4)Science and technology development. The influence of scientific and technological factors on the international dry bulk shipping market is often of far-reaching significance. The third scientific and technological revolution made it possible for many science and technology to be realized. Ships are being renewed, and greatly increased in size. The efficient automation of loading and unloading equipment and the bulk production of large cargoes have also made economies of scale a reality. These are the world's economic and international The demand for trade provides unprecedented transport capacity and promotes the development of international trade.

2.2.2 The main transportation routes of capesize vessel

The main cargoes carried by Capesize bulk carriers are iron ore and coal. According to the Review of Maritime Transportation 2017, world iron ore trade reaching 1.4 billion tons in 2016 by 3.4 per cent increase than last year, and coal trade total volumes were estimated at 1.14 billion tons.

2. 2. 2.1 Iron ore sea transporting routes

There are many importers of iron ore, so the flow of goods is very complicated. However, the consumption of iron ore is as concentrated as that of the source of supply. At present, the most favorable iron ore transportation routes are Australia-Europe, Australia-Japan and Far East, Brazil-Japan and Far East, and Brazil-Europe. Since there is no land connection between the consumption place of iron ore and the source of supply, the transaction volume of international iron ore is basically the amount of iron ore shipped in the world. Customarily speaking, similar to other international trade cargo transportation markets, the international iron ore transportation market is generally roughly divided into the transatlantic market , the Atlantic to the Pacific market and the Atlantic market. The flow of iron ore in the transatlantic market is mainly from the South America(Brazil) to Europe. The flow from the Atlantic to the Pacific market is mainly from South America(Brazil) to Japan, China, South Korea. And the flow in the Pacific market is Australia and India to Japan, China, South Korea. Benefiting from the significant increase in global steel consumption, especially China's consumption, the world's iron ore seaborne volume will increase rapidly. China's iron ore demand will account for half of the world's iron ore demand on the whole. The route of largest iron ore transportation volume has been replaced by the routes from west coast of Australia to China and from Brazil to China.

Due to main iron ore import and export countries, the typical sea transport routes of iron ore are as following:

1) The west coast of Australia to China, Japan ,South Korea and Europe

2) Brazil to China, Japan ,South Korea and Europe

3) South Africa to China

4）Norway, Canada and Venezuela to China, Japan ,South Korea and Europe

5）India to China, Japan ,South Korea

2. 2. 2.2 Coal sea transporting routes

Coal transportation plays a decisive role in the world's dry bulk transportation. The distribution conditions of coal resources in different parts of the world are different. The supply and demand of the international coal market are not evenly matched. The realization of maritime trade can effectively balance resources. Except for a few land-connected countries and regions that can use railroad road transport, most of the world's coal trade is completed by sea. According to statistics from the World Coal Association, shipping trade accounts for about 90% of the world's total coal trade.

The coal is a low price commodity and it has a large volume. And coal is the main bulk commodity for Capesize vessels. Based on this feature, the freight rate accounts for a relatively large proportion of the delivery price. Therefore, based on the transport distance, the Pacific and Atlantic ,two coal trading circles are naturally generated. By the area, the direction of coal cargo flow can be divided into three trade circles: Pacific market, Atlantic market and Indian Ocean market. In the Pacific market, Australia, China, and Indonesia are the major coal exporters. Japan, South Korea, India, and China Taiwan are the main demanders. The goods are transported mainly northward along the Australian coast to Japan and from the US East Coast via the Panama Canal across the Pacific Ocean to Japan. In the Atlantic market, South Africa, Russia, and Colombia are the main suppliers of steam coal, and Western European countries are the main demanders, such as Germany, the United Kingdom and Spain. The supply of coking coal is mainly concentrated in Australia, Russia, the United States and Canada, so the goods are mainly transported from the east coast of the United States across the Atlantic to Western Europe, and along the east coast of South Africa. Going north through the Cape of Good Hope along the west coast of Africa to the countries of Western Europe. In the Indian Ocean market, goods are shipped from Australia to Western Europe and from South Africa to Japan, South Korea, Taiwan, and so on. Among the three regions, except for the Indian Ocean route, which has both eastbound and westbound routes, all other regions have only one-way routes. When coal supply is sufficient, prices are high, and shipping costs are low, cross-circle trade will also occur between major coal markets.

Due to main coal import and export countries, the typical sea transport routes of coal are as following:

1) The east coast of Australia to China, Japan, South Korea and Europe
2) South Africa to China and Europe
3) Indonesia to Europe
4) Columbia to Europe
5) Canada and America to China, Japan and South Korea

2. 3 The freight on capesize shipping market

The freight of capesize bulk carrier is affected by the relationship between supply and demand on the shipping market. It is a market equilibrium price achieved by the supply and demand parties of dry bulk shipping through free bidding, just as other commodity's price on a fully competitive market. In addition, the fright of bulk carrier is also influenced by factors as following:

First, the shipping costs. The shipping cost is the main basis for shipping companies to set tariffs, and has a profound impact on the changes in freight rates. The rise in crude oil prices, the rise in crew training fees, the increase in the cost of acquiring ships and the use of ports, have increased the costs of transportation costs. The increase in the opportunity cost of funds has led to a clear upward trend in transportation costs and the long-term rising trend of dry bulk shipping freights.

Second, the global economic situation. The international dry bulk shipping demand is derived from international trade. Therefore, the dry bulk shipping market conditions are positively related to the development of the global economy. When the global economic conditions are relatively good, the dry bulk shipping market is correspondingly prosperous and has ample supply, and the demand for ships is relatively large. When the global economic crisis occurs, the dry bulk shipping market will also experience a corresponding downturn. For example, the recovery of the global economy at the end of 2003, the rapid development of the "BRIC" countries, especially China, drove the demand for raw materials and shipping markets, and BDI went all the way higher since then. However, the market freight went down dramatically after hit by the financial crisis in 2008.

Third, shipping financial derivatives. In recent years, financial derivatives such as freight index futures have been widely used, such as the forward freight agreement FFA transactions. Since 2002, the demand for hedging and arbitrage by market participants has driven the rapid development of the FFA market. The sharp increase of its trading volume makes the futures market and the spot market interact with each other. The freight rate of shipping has fluctuate more than before. In considering the current trend of the international shipping market, there is an increasing need to consider the important impact of shipping tariff derivatives. The shipping financial derivatives themselves have increasingly become an investment that benefits more than the hedging function. Its speculative nature has magnified the market volatility and amplitude.

Overall, the freight is logically set by cost, but mainly influenced by the market mechanism, i.e. it is a market equilibrium price achieved by the supply and demand parties on dry bulk shipping market. Thus the factors who influence the demand and supply will eventually have the impact on freight, such as the factors influence the international trade of iron ore and coal, factors influenced the supply of capesize vessels.

3 THE FLUCTUATION OF CAPESIZE FREIGHT

3. 1The introduction of BCI

In 1999, the Baltic Shipping Exchange officially announced a new daily index BDI(the Baltic Dry Index) to replace its former index BFI(the Baltic Freight Index , start from 1985). the BDI is made up of BCI, BPI and BHI. Among them, BCI is used to reflect the freight rate of Capesize bulk carriers, while BPI and BHI are used to reflect the changing trend of freight rates of Panamax and Handymax bulk carriers respectively. The Baltic Dry Index (BDI) is an authoritative index of the world's international shipping situation and a barometer of the global dry bulk trend. At the same time, the international dry bulk shipping market has openness and free competition. It is affected by many factors such as international economic, political, military and climate. Its influence will be reflected in the trend of the freight index through the fluctuation of freight rates. BCI is composed of 7 voyage chartered routes and 4 time chartered routes that are weighted according to their respective weights. and be published every working day morning. BCI's constituent routes are shown in table 3. 1

BCI is one of the three single-hull freight rates index. Unlike BPI and BHMI, BPI and BHMI do not include Chinese routes, while BCI includes two Chinese routes. They are Tubarao—Beilun—baoshan route and the West Australia—Beilun—Baoshan route. Since Chinese importing iron ore transportation are dominated by Capesize vessels, the rise and fall of the BCI is directly related to the transportation costs of Chinese steel companies.

Table 3. 1 BCI's constituent routes

Route	Tonnage	Type of goods	Specific route	Weight
1	120000	Coal	Hampton/Rotterdam	5%
2	160000	Iron ore	Tubarao/Rotterdam	10%
3	150000	Iron ore	TUbarao/Beilun/Baoshan	10%
4	150000	Coal	Richard Bay/Rotterdam	5%
5	150000	Iron ore	West Australia/ Beilun/ Baoshan	15%
6	120000	Coal	New castle/ Rotterdam	10%
7	150000	Coal	Bolivar/Rotterdam	5%
8	161000	Time charter	Atlantic Round Trip voyage time 35-40 days	10%
9	161000	Time charter	Europe-far east voyage time 65 days	5%
10	161000	Time charter	Pacific round trip voyage time 30-40 days	20%
11	161000	Time charter	Far east-Europe voyage time 65 days	5%

3. 2 The periodicity analysis of BCI time series

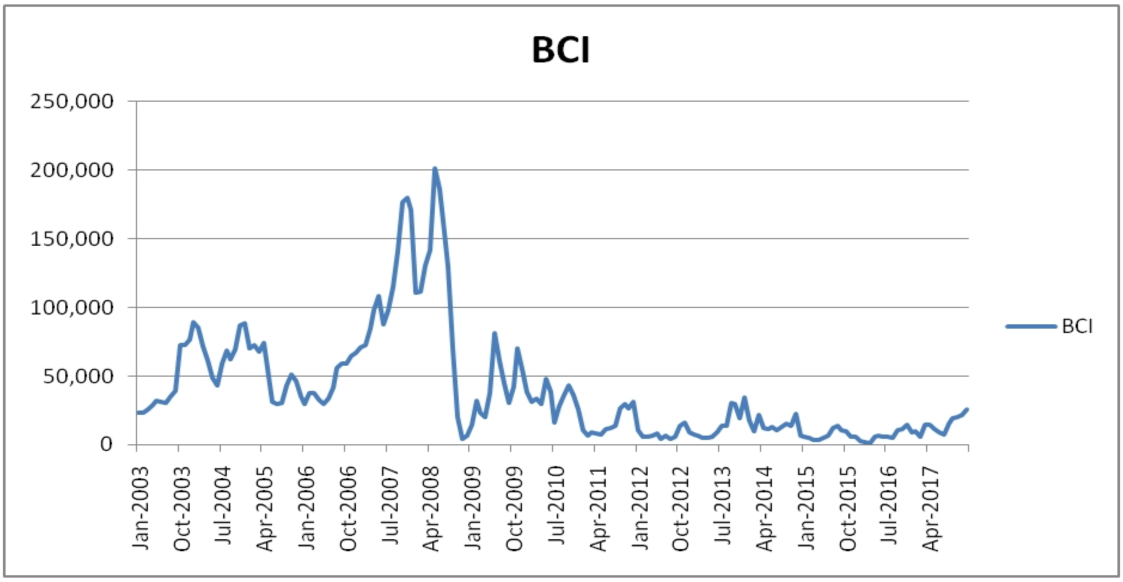

Figure 3. 1 The fluctuation of BCI during 2003-2017

Source: Clarkson database

By observing figure 3.1, the periodic fluctuation of the BCI is obvious during 2003-2017. In my opinion, every cycle is almost 3 years. There are three obvious 3-year cycles. From January 2003 to January 2006, January 2006 to January 2009, and January 2009 to 2012 January. During these three cycles, there is a first increase and then a small decrease, and then rise again sharply. After reaching the peak, it greatly reduced until the beginning of another cycle. Comparing these three cycles, the fluctuation of the cycle from January 2006 to January 2008 was relatively sharp, and the peak appeared at the May of 2008.

Since October 2003, the demand for global transport has gradually recovered and the market has rebounded. So at the beginning of 2004, the international capesize freight index showed a peak. In 2005, although global economic growth slowed down and other factors caused the global dry bulk shipping market to experience a drop in heat, these changes did not affect the market's growth. Demand was still strong and prices remained high, Afterwards, under the influence of the continuous decline in the growth of the global economic situation, the impact on the market has also gradually emerged, showing a decline in freight rates. This downward trend continues until the start of the second cycle.

Since the beginning of 2007, the economic development of China, the Mediterranean and Eastern Europe, the international capesize transportation market has recovered. During this period, the volume of trade continued to grow, the demand for transportation was strong, the transportation distance was long, and the port turnover caused by the ship's low turnover rate made it difficult for the actual capacity to meet the strong market demand. This demand was higher than the supply status. In terms of price, the freight index has risen sharply. This round of upswing continued until May of 2008, and the peak in this cycle appeared.

The US subprime mortgage crisis broke out in 2008, which caused the global economy enter into a depression period. The demand for Capesize vessels was seriously frustrated, and the freight rate was further reduced. In 2010, the global economy gradually came out of the trough and recovered due to main developed and developing countries' rescue policies. The global dry bulk shipping industry also began to turn a profit. however, large-scale new ship order come to delivery in 2011 and after which cause the capacity surged and a very serious impact on the shipping industry, so the freight rate fell again.

Since 2012, the freight fluctuation of capesize has been more intense than before and the cycle has been relatively shortened. Although the entire market still faced the same challenges as in 2011, various shipping companies actively launched coping strategies. Instead of blindly seizing market share, they focused on the recovery of freight rates and the rational deployment of capacity. These strategies are quite effective and as a result, the freight rate has rebounded. In 2014, various shipping companies preferred to launch mega-vessels, and in order to avoid the negative impact caused by the loss of market share in the medium and long term, each carrier adopted a downward adjustment of freight rates to retain market share, and thus formed a round of vicious cycle made the overall freight rate drop sharply.

3. 3 Chinese factors affecting BCI fluctuations

Since the reform and opening up, driven by the global economic integration and the rapid growth of China's foreign trade, China's total import and export trade has entered the forefront of the world. According to statistics, in 2017, the total value of China's foreign trade imports and exports increased by 14. 2% over the previous year, and the total value reached 27. 79 trillion US dollars. After the financial crisis, China adopted a tight monetary policy and a loose fiscal policy. China's macro-economy continued to develop steadily, and China's foreign trade continued to grow rapidly.

Minerals, food and other raw materials are the main imported items in China every year. Taking iron ore as an example, according to relevant data, the trade volume of iron ore in the world reached 2. 1 billion tons in 2016, but only 0. 5 billion in 2002. China accounted for 78% of the increase. Since the beginning of the 21st century, China has played a leading role in the increase of iron ore trade in the world, which means that China plays a pivotal role in the rapid growth of world trade. At present, China has become one of the most important shipping countries in the world, and dry bulk transportation related to Chinese ports accounts for almost a quarter of the world's dry bulk shipping. Therefore, China's position in the dry bulk market has become more and more important. Among them, the data shows that the contribution of China's shipping development to foreign trade growth is as high as 25%. General analysis is determined by the characteristics of China's large quantity, rapid growth and very low price elasticity of dry bulk demand, but in addition to the characteristics of the commodity itself, special and complex domestic economic and social factors are also an aspect that cannot be ignored.

The key factor in the development of shipping is the shipping demand. With the rapid expansion of the world economy and the demand for trade, the shipping market is also very hot. China's shipping demand growth has four significant characteristics: the first is the huge scale of growth. As a country with a population of more than one billion, it has a huge potential market; followed by a faster growth rate. In 2003, China only accounted for 6. 6% of the total world trade, but with the rapid development of foreign trade, the proportion in 2008 reached 11. 8%; again, the longer growth period. In recent years, China has been one of the fastest growing countries in terms of international trade, driven by an average annual GDP growth rate of 9. 7%. China has a large import demand and a strong export capacity; and finally a higher dependence on the international market. China's iron ore trade volume has increased year by year. In 2008, it imported 443 million tons, accounting for 52. 5% of the global iron ore trade volume. Imports accounted for 97. 81% of the global iron ore trade increase, ranking first. In 2008, it imported 0. 41 billion tons of coal, accounting for 5. 14% of the global coal trade volume; in 2008, it imported 0. 015 billion tons of grain, accounting for 0. 47% of the global grain trade. In 2008, China's imports of iron ore, coal and grain accounted for 9. 38% of the international dry bulk trade volume. In 2009, China imported 628 million tons of iron ore and produced 568 million tons of crude steel, showing a stabilizing rebound. The large-scale, high-speed, continuous, and international price-free growth model of China's shipping demand has also occurred in the previous shipping market. The difference is that China is the protagonist of this shipping cycle, and the scale of change is also incomparable. After the industrial revolution, if a country has a high economic development, it will make a huge change in shipping. But it is only a country, or the development of tens of millions to hundreds of millions of people in the region, such as the revival of Europe after World War II, or the rise of the United States earlier. However, in China this time, a country with more than one billion people has been developing in a relatively short period of time, which has never been seen in history.

In 2008, the global financial crisis was encountered. However, the overall prosperity of China's shipping market in the first half of the year climbed, and the market segmentation was distinct. In the second half of 2008, the financial crisis accelerated its transmission to the real economy, causing the global shipping industry to fall into a dilemma. Taking iron ore as an example, due to high-priced iron ore, China’s iron ore imports have fallen from double-digit growth to double-digit negative growth, causing extreme shrinkage in demand, and it is known as the barometer of the shipping dry bulk market. - BDI fell to the lowest point of the history before 2008 to 663 points, when shipping companies encountered unprecedented risks, some shipping companies had to made the ship laid up and some even applied for bankruptcy protection.

At the end of 2008, in order to deal with the financial crisis, the 4 trillion investment made by the Chinese government injected new power and vitality into the steel enterprises, and some steel mills resumed production and operation. Therefore, in the context of the decline in global steel production, China's steel output is unique with a year-on-year increase. Since 2009, the investment effect of 4 trillion yuan has gradually shown. The Chinese steel downstream industry real estate and automobile have recovered rapidly. The demand for coastal transportation of bulk commodities such as iron ore, oil and coal has increased, and the price of shipping has stabilized. Under the influence of economic recovery and iron ore negotiations, China's iron ore import volume made continuous break through. Under the influence of Chinese factors, the international dry bulk shipping market has rebounded strongly and easily broke through the annual line of 3193 points. The growth rate is nearly four times compared with that at the beginning of the year.

As the global economic liquidity continues to improve, the dry bulk shipping market is unique in the bleak global economy, attracting the participation of many institutions as a freight derivative in the dry bulk shipping market---FFA participants and trading volume gradually increase. Since iron ore has nearly 100 million tons of inventories, even if the current freight rate is already very low, coupled with the rapid rise of China's real estate market in the near future, there is still a lot of room for the increase in steel output. China continues to play in the dominant position in shipping market ,promotes the development of the international shipping market and further accelerates the recovery of the global economy.

4 FORCAST FREIGHT OF CAPESIZE VESSEL

Time series analysis is a study of dynamic data with the statistical regularity of the data processing method, its historical time series data based on the system, mathematical model is established, in order to accurately description of dynamic rule of the system objective, and to predict the future value of the time series.

In this part, based on the time series data of freight of capesize, by Eviews software, a time series model is set up to accurately propose the variation rule and development trend of capesize freight and forecast its trend in 2018.

4. 1 Time series and its related concepts

(1) Time series

A sequence of random variables X1 and X2 in chronological order is called a time series. If you take X_1 and X_2 as random variables the observed value is called x1, x2, observations of X. If I take x_1, x_2 as The observed values of x1,x2,X1, X2. . . is called an implementation or an orbit.

For convenience of expression, the time series X1, X2,. . are represented by {X,}, and the observation samples X1, X2,. . . are represented by {X,}. Or the x1, x2.

(2) White noise sequence :satisfy the relations between

$$E(\varepsilon_t) = 0$$

$$E(\varepsilon_t^2) = \sigma^2$$

$$E(\varepsilon_t \varepsilon_\tau) = 0 \qquad t \neq \tau$$

The sequence is called white noise.

(3) Autocorrelation coefficient

The formula for calculating the time-series X and k-order lagged autocorrelation function is as follows:

$$\rho_k = \frac{\sum_{t=k+1}^{n} (X_t - \overline{X_t})}{\sum_{t=1}^{n} (X_t - \overline{X_t})^2}$$

Where X is the sample mean of the time series.

(4) Partial autocorrelation coefficient

The partial autocorrelation function of time series xi is given xt-1, xt-2. . . Under the condition of xt-k+1, the conditional correlation between xt and xt-k is as follows:

$$\phi_{k,k} = \begin{cases} \rho_1 & k \\ \dfrac{\rho_k - \sum_{j=1}^{k-1} \phi_{k-1,j}\rho_{k-j}}{1 - \sum_{j=1}^{k-1} \phi_{k-1,j}\rho_{k-j}} & k > \end{cases}$$

Partial autocorrelation function measurement does not consider the issue related to k k - 1 period related to the distance, if this autocorrelation can have a lag in the form of less than the autocorrelation of order k, said the partial autocorrelation function value under the condition of order k lag is a zero.

(5) Stability

If time sequence Xt' s mean value($\mu_t = E\ (X_t)$), variance （ $\sigma_t^2 = E(X_t - \mu_t)^2$ ） and covariance $\gamma_{t,\ t-k} = E[(X_t - \mu_t)(X_{t-k} - \mu_{t-k})]$ don't change over time, and time sequence X, since the covariance of the only related to the lag order, called time series X, is weakly stationary or covariance stationary, namely X, meet:

$$\mu_t = \mu$$

$$\sigma_t^2 = \sigma^2$$

$$\gamma_{t,t-k} = \gamma_k$$

Where, k is the lag order of time series X.

(6) Stability test

To judge the stationarity of time series, the autocorrelation function of time series can be used. At the same time, EViews software also provides several unit root test methods to judge the stationarity of time series.

1) Use autocorrelation function to judge the stationarity of time series

Time series autocorrelation function can be used to determine the q series stationarity, if a time series is stable, its autocorrelation function will be increased with the increase of lag order number k quickly reduced to zero. Therefore, if the sample autocorrelation function of the time series does not rapidly decline to zero with the increase of the lag order k, it indicates that the time series is non-stationary.

2) Augmented dickey-fuller unit root test

ADF unit root test method the t statistic test, but the t statistic under the null hypothesis is not subject to t distribution, a lot of simulation on Mackinnon, t statistics are given in 1%, 5% and 10% under the test level of the critical value. If the test t statistic value is less than the critical value, the original hypothesis (the sequence has a unit root) is rejected. Instead, accept the original hypothesis.

4. 2 Time series model

As a common method of characterizing time series statistics, time series model is very important in time series analysis.

4. 2. 1 Stable time series model

(1) Autoregressive Model

Because things change before and after the time of relevance and following up, in many cases, X before time t observed value depends on the t of the observed value, and often said to be X_t, relies on the lag value of X_{t-1},X_{t-2},X_{t-3}……, now assumed time sequence X_t, the observed values of $\{x_{t-p}\}$depends on its P a lag item and this dependence relationship characterized by the following linear form of

$$X_t = c + \sum_{i=1}^{p} \varphi_i X_{t-i} + \varepsilon_t$$

Where c ,φ is the unknown parameter, c is a can't direct observation of the time sequence, need according to the x_t in the actual problem, the property is obtained by setting in advance, such as the setting of white noise process. Since the right end of equation contains P lagging terms of x, it is called p-order autoregressive, or $AR_{(P)}$ in short.

(2) Moving Average Model

In practical application, the fitting of stationary time series can be realized by moving average of white noise, which is the moving average model. Commonly known as:

$$X_t = \varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + \ldots + \theta_q\varepsilon_{t-q}$$

Where ε_t is the white noise process, θ_1,θ_2 is an arbitrary constant. The reason why it is called moving average is that in a sense, the right side of equation is the weighted sum of each ε_k, similar to an average term. Because it is composed of the weighted sum of white noise, any moving average model is stable.

(3) Autoregressive Moving Average Model

In order to make the model more flexible in fitting the actual data, sometimes both the autoregressive part and the moving average part are included in the model, which is the autoregressive moving average model. The expression is:

$$X_t = c + \sum_{i=1}^{p} \varphi_i X_{t-i} + \varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + \ldots + \theta_q\varepsilon_{t-q}$$

$\varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + \ldots + \theta_q\varepsilon_{t-q}$ARMA(p,q) for short. Where p and q are the order Numbers of autoregressive part and moving average part respectively, c are autoregressive coefficient and moving average coefficient respectively.

4. 2. 2 Non-stationary time series model

Autoregressive Integrated Moving Average Model

Often encountered in the actual application of time series is stable, for non-stationary time series, the first to be smooth, namely on the d order difference, make it become the stationary time series, and then according to the stationary time series model (ARMA) to analyze it. Therefore, the Autoregressive Integrated Moving Average Model, or ARIMA Model, is introduced.

4. 3 Model established for forecasting capesize fright

In order to find its statistic rule and its system characteristic from a large number of time series measured data, a time series model must be established first. The modeling process includes model type identification, model parameter estimation, and model order determination. The modeling idea (b-j method) proposed by boxes-jenkins can guide the actual modeling process, which includes the following important steps:

(1) to test the stationarity of the original sequence. If the original sequence is non-stationary, d order difference (or other) transformation is made to make it meet the stationarity conditions.

(2) analyze the characteristics of the original sequence or the transformed sequence, especially the autocorrelation function and partial autocorrelation function of these sequences. These analyses help to determine the form of the model.

(3) to estimate the parameters of the model, and judge whether the model is stable according to the inverse of the lagged polynomial root. Meanwhile, the fitting effect and rationality of the model should also be judged.

(4) the stationarity test for model residual is mainly to test whether the residual sequence of model estimation results meets the requirement of randomness.

(5) confirm the form of the model. There may be multiple models for which comprehensive evaluation analysis is required to select appropriate, concise and effective models.

(6) use the established model to predict, so as to evaluate the model.

4. 3. 1 Model identification

First, select the data of capesize vessel freight (through January ,2003 to March, 2013), as the time series analysis of sample, shorthand for {price }.

Using the EViews software, see the correlation diagram of sequence {price}, as shown in figure4. 1.

Figur 4. 1 The freight time series

From the time series diagram, this variable is obviously unstable. Because prices don't go up and down in a straight line. (the stationary sequence fluctuates up and down randomly near a constant, which is not satisfied here). In order to further illustrate the instability, the ADF test is adopted, and the results are as follows:

Null Hypothesis: PRICE has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob. *
Augmented Dickey-Fuller test statistic		-2. 684011	0. 0788
Test critical values:	1% level	-3. 466580	
	5% level	-2. 877363	
	10% level	-2. 575284	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(PRICE)

Method: Least Squares

Date: 05/28/18 Time: 17:02

Sample (adjusted): 2003M03 2018M03

Included observations: 181 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRICE(-1)	-0. 045576	0. 016980	-2. 684011	0. 0080
D(PRICE(-1))	0. 437702	0. 067392	6. 494828	0. 0000
C	1740. 958	892. 5648	1. 950511	0. 0527

R-squared	0. 204378	Mean dependent var	-2. 831492

Adjusted R-squared		S. D. dependent var	9171. 884
S. E. of regression	8226. 936	Akaike info criterion	20. 88465
Sum squared resid	1. 20E+10	Schwarz criterion	20. 93766
Log likelihood	-1887. 061	Hannan-Quinn criter.	20. 90614
F-statistic	22. 86219	Durbin-Watson stat	1. 961059
Prob(F-statistic)	0. 000000		

Figure 4. 2 Correlogram of time series

It can be seen that the p value is 0. 0788, which is greater than the significance level of 0. 05. Therefore, it can be considered that there is unit root, i. e. , instability. To make the sequence stable, make the first order difference, and make a time series diagram as follows:

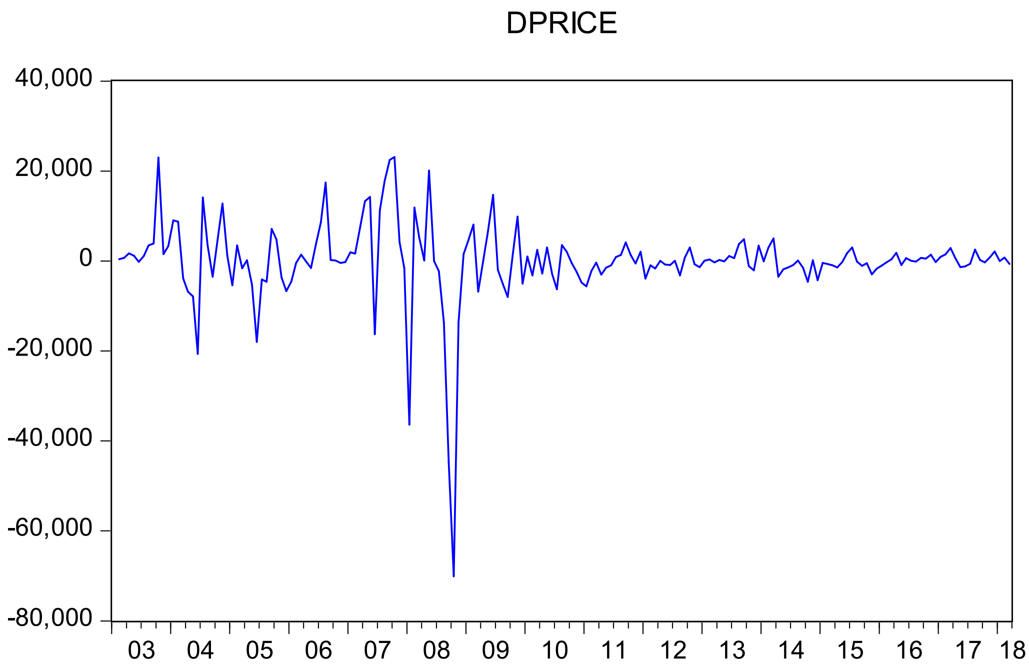

Figure 4. 3 The Dprice figure after first-order difference

From this graph, the time series has no obvious trend and fluctuates up and down randomly between constant 0. In order to determine more accurately whether the first-order difference sequence is stable, the ADF test is used. The eviews results are shown below.

Null Hypothesis: DPRICE has a unit root

Exogenous: Constant

Lag Length: 9 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob. *
Augmented Dickey-Fuller test statistic		-4. 101804	0. 0013
Test critical values:	1% level	-3. 468521	
	5% level	-2. 878212	
	10% level	-2. 575737	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DPRICE)

Method: Least Squares

Date: 05/28/18 Time: 17:11

Sample (adjusted): 2003M12 2018M03

Included observations: 172 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DPRICE(-1)	-0. 639318	0. 155863	-4. 101804	0. 0001
D(DPRICE(-1))	0. 230627	0. 154369	1. 493996	0. 1371
D(DPRICE(-2))	0. 091581	0. 139402	0. 656953	0. 5121
D(DPRICE(-3))	0. 082329	0. 132522	0. 621251	0. 5353

D(DPRICE(-4))	-0. 112135	0. 123639	-0. 906954	0. 3658
D(DPRICE(-5))	0. 045984	0. 115054	0. 399673	0. 6899
D(DPRICE(-6))	0. 016958	0. 099273	0. 170820	0. 8646
D(DPRICE(-7))	0. 074828	0. 089405	0. 836962	0. 4039
D(DPRICE(-8))	-0. 248960	0. 078989	-3. 151813	0. 0019
D(DPRICE(-9))	0. 233150	0. 074680	3. 121975	0. 0021
C	-109. 0461	574. 6845	-0. 189750	0. 8497

R-squared	0. 458613	Mean dependent var	-12. 60901
Adjusted R-squared	0. 424987	S. D. dependent var	9936. 015
S. E. of regression	7534. 442	Akaike info criterion	20. 75417
Sum squared resid	9. 14E+09	Schwarz criterion	20. 95547
Log likelihood	-1773. 859	Hannan-Quinn criter.	20. 83584
F-statistic	13. 63845	Durbin-Watson stat	1. 994647
Prob(F-statistic)	0. 000000		

Figure 4. 4 the result of ADF unit root test on series{D(PRICE)}

It can be observed that the t statistic of the ADF unit root test is -4. 1018, and its p-value is 0. 0013, smaller than the significance level of 0. 05, hence the first order difference of the price set is stationary, and thus can use autoregressive moving average model (ARMA) to model its trend and even prediction.

Before the estimation of model parameters need to confirm the model form, we can through the analysis of the Autocorrelation (AC), and Partial Autocorrelation (PAC) to identify, because each random process has its typical Autocorrelation (AC) and Partial Autocorrelation (PAC).

Table 4. 1 Theoretical model of AC and PAC of time series

Classification of the model	Typical mode of AC	Typical mode of PAC
AR model	Trailing	Truncation
MA model	Truncation	Trailing
ARMA model	Trailing	Trailing

Table 4. 1 lists the theoretical modes of autocorrelation functions (AC) and partial autocorrelation functions (PAC) of time series. AR process autocorrelation function (AC) with a trailing, namely the autocorrelation coefficient has an infinite number of exponential decay or attenuation law of oscillation, and partial autocorrelation function (PAC) is truncated, i.e. It has a finite number of partial correlation coefficient. The autocorrelation function (AC) and partial autocorrelation function (PAC) of MA process have opposite change patterns in t compared with the autocorrelation function (AC) and partial autocorrelation function (PAC) of AR process. The autocorrelation function (AC) and partial autocorrelation function (PAC) of ARMA process are both trailing.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.415	0.415	31.855	0.000
		2	0.105	-0.081	33.897	0.000
		3	-0.059	-0.088	34.544	0.000
		4	-0.167	-0.123	39.772	0.000
		5	-0.064	0.074	40.553	0.000
		6	0.004	0.011	40.557	0.000
		7	0.017	-0.017	40.609	0.000
		8	-0.094	-0.149	42.304	0.000
		9	0.186	0.365	49.024	0.000
		10	0.047	-0.225	49.447	0.000
		11	-0.055	-0.038	50.037	0.000
		12	-0.130	-0.149	53.364	0.000
		13	-0.168	0.087	58.963	0.000
		14	-0.064	-0.042	59.786	0.000
		15	-0.009	-0.010	59.801	0.000

Figure 4. 5 Correlogram of series{D(PRICE)}

From figure as you can see, the sequence of c AC autocorrelation coefficient and partial autocorrelation coefficient of the PAC is trailing, therefore consider the c established ARIMA model, because the sequence {DPRICE} after first order difference transformation has been stable, so the d = 1. Due to the partial sequence {DPRICE} autocorrelation function (PAC) on the lag order 1, order 4, order 5 and order 8 showed statistically a point, after the lag order 4 sequences (PRICE)} {D partial autocorrelation function (PAC) is small, it is proposed that the ARIMA model may be 4 order autoregressive process, i. e. p = 4; It can be observed from the plot of partial autoregressive coefficients, the first-order difference sequence of data truncates after 4partial ACF and 4 ACF, which is the feature of ARMA(4,4). After a series of ARMA model analysis, the final model are as follows:

Dependent Variable: DPRICE

Method: Least Squares

Date: 05/28/18 Time: 17:28

Sample (adjusted): 2003M06 2018M03

Included observations: 178 after adjustments

Convergence achieved after 11 iterations

MA Backcast: 2003M02 2003M05

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0. 485637	0. 069547	6. 982888	0. 0000
AR(4)	0. 294204	0. 088442	3. 326534	0. 0011
MA(2)	-0. 147645	0. 060215	-2. 451966	0. 0152
MA(4)	-0. 695050	0. 076292	-9. 110408	0. 0000

R-squared	0. 295564	Mean dependent var	-22. 89326
Adjusted R-squared	0. 283419	S. D. dependent var	9247. 802
S. E. of regression	7828. 368	Akaike info criterion	20. 79111
Sum squared resid	1. 07E+10	Schwarz criterion	20. 86261
Log likelihood	-1846. 409	Hannan-Quinn criter.	20. 82011
Durbin-Watson stat	1. 984883		

Inverted AR Roots	. 90	. 11-. 71i	. 11+. 71i	-. 64
Inverted MA Roots	. 95	-. 00+. 87i	-. 00-. 87i	-. 95

Figure 4. 6 The estimation of the model

4. 3. 2 Model test

Both the model of constructing stationary time series and the model of non-stationary time series have an important assumption that the residual series is white noise. But in judging the established time series model is reasonable, the need to model the residuals for white noise test, if residuals can pass inspection, show that the model is reasonable, otherwise, will need to choose other suitable model. The inspection process of the model is generally divided into two steps:

(1) compare and analyze the sample autocorrelation function of the original sequence with the autocorrelation function of the sequence generated by the model. If there is a significant difference between two autocorrelation functions, the validity of the model should be questioned and the model should be reconfirmed

(2) if the sample autocorrelation function of the original sequence and the autocorrelation function of the model generated sequence doesn't obvious difference, it should be the model of residual error sequence is white noise inspection, the inspection of residual error sequence randomness: for lag k > _1, inspection sample autocorrelation function of the residual sequence is approximate to zero

The white noise test of residual sequence is commonly used for Q statistics. The original hypothesis of test is residual series s, and there is no autocorrelation. Sample autocorrelation function of residual sequence is:

$$\rho_k(\varepsilon_t) = \frac{\sum_{t=k+1}^{n} \varepsilon_t \varepsilon_{t-k}}{\sum_{t=1}^{n} \varepsilon_t^2} \qquad k = 1,2,3,4\ldots\ldots\ldots m$$

Where, n is the sequence observation quantity calculated P and m is the maximum lag order number. If there are more observed values, m can take [n/10] or [$\sqrt{n}$]. If the sample size is small, then m is generally taken as [n/4]. Thus, the inspection statistic Q is constructed:

$$Q=n(n+2)\sum_{k=1}^{m}\frac{\rho_k^2}{n-k}$$

Under the premise of the original hypothesis, q progressively follows the X^2 distribution of degree of freedom m-p-q. If the corresponding probability value of the statistic Q is greater than the test level, the original hypothesis is accepted. Otherwise, the rejection residual sequence does not have the original assumption of autocorrelation.

The estimated residuals of ARIMA model were examined by autocorrelation. First, the residual sequence of ARIMA model is generated and named c. Then, the correlation graph and Q statistics of residual sequence C were observed, as shown in figure

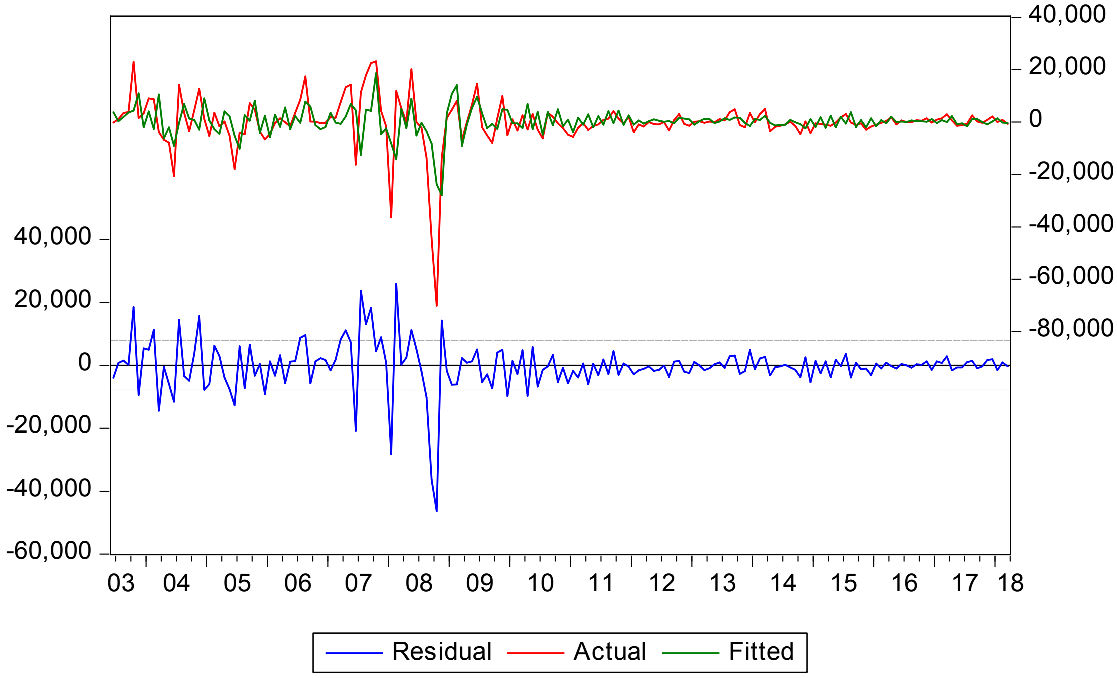

Figure 4. 7 The fitted trend of the actual circumstance

The residual is near zero, so the curve fits well.

The coefficients are all significant, hence the final model is:

$$d(price)_t = 0.4856 * d(price)_{t-1} + 0.2942 * d(price)_{t-4} - 0.1476 * \varepsilon_{t-2} - 0.6951 * \varepsilon_{t-4} + \varepsilon_t$$

Where $d(price)_t = price_t - price_{t-1}$

4. 4 Prediction

According to the above analysis, the ARIMA(4,1,4) model established is suitable, so it can be used for prediction. The following table shows the value of prediction in 2018.

Table 4. 2 The prediction of capesize vessel freight

Date	Prediction of freight ($/day)

JAN 2018	19666. 87
FEB 2018	18964. 92
MAR 2018	19698. 89
APR 2018	18277. 5
MAY 2018	18151. 85
JUN 2018	18204. 22
JUL 2018	18765. 99
AUG 2018	18978. 66
SEP 2018	19092. 56
OCT 2018	19421. 34
NOV 2018	19897. 29
DEC 2018	20080. 09

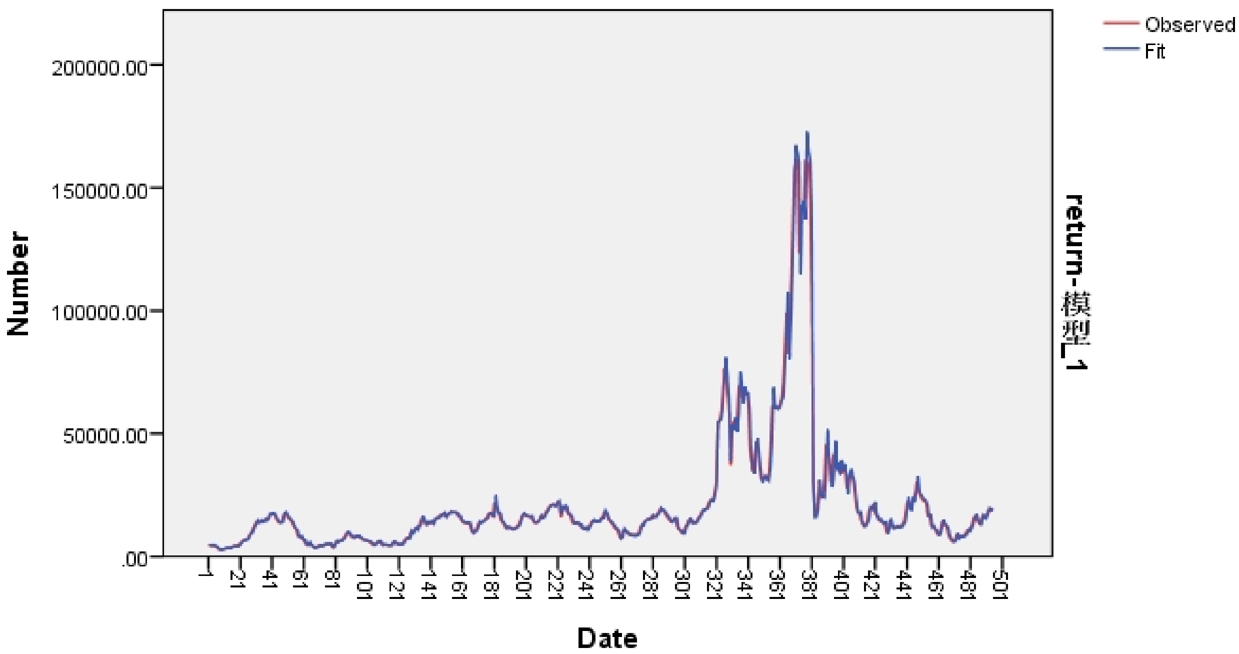

Figure 4. 8　The return model of the capesize freight.

As can be seen from figure 4. 8, the predict curve fit the observed curve very well. So I think the model can be used for predicting the freight of capesize vessel.

5 CONCLUTION

5. 1 The main work of this paper

The work done in this paper and conclusions as following:

(1) Analysis the operating mechanism of Capesize shipping market and illustrated the demand and supply factors which influence the capesize vessel freight.

(2) Analysis the fluctuation and periodic characteristic of capesize vessel freight and the factors that influence the trend goes like this.

(3) The qualitative analysis and quantitative analysis methods are used in the research process. The qualitative research mainly analyzes the supply and demand conditions in the international dry bulk shipping market. The quantitative research focus on constructing prediction model based on ARIMA. The model plays the role and make it come into effect. The results of this study show that the construction of the model is a good way to grasp the development trends and internal laws, and its prediction results are also ideal.

(4) With a total of 180 monthly time charter rates from January 2003 to December 2017, the law of fluctuations of the capesize freight can be reflected. In the experimental research, it is finally determined that the difference order of the ARIMA model is first-order, which make the sequence more smooth and easy to analyze. The resulting signal can better reflect the direction of the original signal. The test shows that using the model for prediction is also more accurate.

5. 2 Further study in future

（1）This article only selects one-dimensional time series as the prediction sample, and some other factors not taken into consideration, such as the price of new buildings, the price of second-hand vessels, and the voyage charter of the market price, etc. Therefore, the model constructed has a large prediction error. In many aspects, improvement is needed. Perhaps multi-variable and multi-step prediction should be used to improve prediction accuracy. Therefore, it is very important to study how to improve the prediction accuracy in the international dry bulk shipping market.

（2）The next step in the study can be to apply the methodology developed in this study to other freight index or freight rate forecasts in order to further verify the reliability of the model.

（3）The accuracy of the prediction can be compared in the short-term and long-term, and the more appropriate stage of the model constructed in this paper can be found out.

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