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## Comparative analysis of international Bulk Freight Index

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**WORLD MARITIME UNIVERSITY**

Malmö, Sweden



**Comparative Analysis of International Bulk Freight Index**

By

**Gu WenBo**

**China**

A research paper submitted to the World Maritime University in  
partial Fulfillment of the requirements for the award of the degree of

**MASTER OF SCIENCE**

**(INTERNATIONAL TRANSPORT AND LOGISTICS)**

2019

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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

**Supervised by**

**Professor Sha Mei**

**Shanghai Maritime University**

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Finally, my thanks would go to my beloved family for their consistent support and encouragement. They always give me meaningful advice and help during the writing of the thesis. In addition, they encourage and trust me in my life all the time.

## **Abstract**

**Title of Research Paper: Comparative Analysis of International Bulk Freight**

**Index**

**Degree: MSc**

Bulk shipping is an important part of international shipping, with dry bulk shipping accounting for more than one — third of the world's sea traffic. The Baltic dry bulk freight index is the most influential in the international shipping market, and it has gradually become a comprehensive important index to measure the dry bulk transport market after more than ten years of development. In different periods and different ship types, the freight index will show different characteristics of changes, and its fluctuations are often influenced by political, economic, scientific and technological, military and other factors.

The purpose of this paper is to classify and comprehensively elaborate the bulk freight shipping indicators at home and abroad, and try to find out the dynamic correlation between them and the growth and fluctuation of the international economy through a series of analysis, to provide references for shipping decision-makers. The reasons are analyzed by combining the calculation formulas of different shipping bulk cargo indexes themselves.

**Keywords:** Bulk Freight   Index   Analysis

# Table of Contents

Declaration.....	i
<b>Acknowledgment.....</b>	<b>ii</b>
Abstract.....	iii
List of Tables.....	v
List of Figures.....	vi
List of Abbreviations.....	vii
Chapter I Introduction.....	1
1.1 The Selection Background and Motivation of the Dissertation.....	1
1.2 The Existing Model to Comparative Analysis.....	3
Chapter II. Literature Review.....	6
2.1 Introduction.....	6
2.2 Summary of Bulk Freight Market.....	6
2.3 Summary of China Domestic Bulk Freight shipping index.....	7
2.4 Summary of International Bulk Freight shipping index.....	9
2.5 Achievement of previous study.....	12
Chapter III Methodology.....	16
3.1 Research Contents.....	16
3.2 Research Method.....	16
Chapter IV Establish and Test of Models.....	18
4.1 Introduction.....	18
4.2 Correlation Analysis.....	19
4.3 Linear Regression Analysis.....	20
4.4 Cointegration Analysis.....	20
Chapter V Conclusions.....	23
5.1 Introduction.....	23
5.2 Main Findings.....	23
5.3 Conclusion.....	28
5.4 Limitation of Research.....	28
Bibliography.....	30

## **List of Tables**

Table 1 The result of Correlation Analysis.....	20
Table 2 The result of Linear Regression Analysis.....	21
Table 3 The result of Cointegration Analysis.....	21

## List of Figures

Figure 1-Components of BCI.....	11
Figure 2-Comparison of CCBFI and BDI.....	18



## **List of Abbreviations**

**CCBFI** China Coastal Bulk Freight Index

**BDI** Baltic Dry Index

**BCI** Baltic Exchange Capesize Index

**BSI** Baltic Exchange Supramax Index

**BPI** Baltic Exchange Panamax Index

**BFI** Baltic Freight Index

**OLS** Ordinary Least Square

## Chapter I Introduction

### 1.1 The Selection Background and Motivation of the Dissertation

The modern international shipping market, which we usually talk today, can be divided into the following categories: dry bulk, tanker, and container. The Dry bulk market occupies a very huge part of it and is one of the key foundations for the current existence of world trade. Among these markets, the dry bulk market is the one with the most volatility, which attracts the attention of experts and personnel in the shipping industry. In 2018, affected by many factors, the international dry bulk shipping market showed a turbulent trend. Generally speaking, the dry bulk shipping market performed better in 2018 than the previous year.

We take the BDI index for an instance. As can be seen from the chart, the BDI index, as BDI index(Monthly avg,Jan 2017-Mar 2018)



a key indicator of the dry bulk shipping market, has been in a declining state since the end of last year at the beginning of 2018. On March 9, with the US President Trump formally signed a tariff law, imposing heavy taxes on imported steel and aluminum, opening up a trade dispute between China and the United States, resulting in a series of commodity price fluctuations and affected market confidence, which further aggravated the volatility of the BDI index. However, with the timely measures taken by the Chinese government to release the signal of reform, market anxiety has been greatly alleviated, and the BDI index has been volatile all the way up, reaching a year-high of 1 774 on July 24, followed by a broader fluctuation affected by the escalation of the Sino-US trade war. Affected by the Australian railway accident, it fell rapidly to nearly 1,000 points in early November and then rebounded. At the end of the year, it closed at 1 271 points on December 24,

averaging 1 353 points, up 208 points, or 18.2%, over the same period last year.

Bulk cargo transportation is an important part of international shipping. Dry bulk cargo shipping accounts for more than one-third of the world's shipping volume. Dry bulk cargo refers to bulk, granular and powder cargo that can be shipped directly without packaging, such as ore, mineral powder, coal, bulk grain, salt, sugar, fertilizer, cement, etc. Among them, iron ore, coal, grain, bauxite, and apatite are collectively referred to as the five major dry bulk cargo, and they are the main sources of international dry bulk cargo shipping. It can be seen that most of the goods transported by dry bulk cargo are basic raw materials or primary products.

The international dry bulk shipping market has experienced a period of getting high and low. In 2019, the demand for dry bulk cargo will increase by 2.6% and international capacity by about 3.0%. Influenced by the sulfur policy in 2020, the actual growth rate of dry bulk cargo net capacity is expected to be lower than the demand growth rate. The balance state between supply & demand will continue being weak, which would not be good news. However, the global economic growth rate will decline, and the mining disaster in Brazil will have a greater impact on market confidence, and the volatility of the market will increase. At the beginning of this year, the mining disaster in Valley has severely damaged market confidence. Later, it will be gradually restored. In addition, the Sino-US trade negotiations are expected to reach an agreement. Later, market support factors will increase. In 2019, it is estimated that the bulk market will get low in the first, and then to rise.

After reading the relevant literature, the writer finds that there are limited references on the comparison between China's tariff index and the world's tariff index. Therefore, on the basis of absorbing and digesting the essence of previous studies on freight index, the writer adopts various methods of observation, comparison, and analysis, and tries to do some research on this aspect.

As a derivative demand of world economy and trade, the international trade of dry bulk cargo has to import large quantities of dry bulk cargo resources mainly from foreign countries because of the uneven distribution of resources. The transportation of these enormous quantities of dry bulk cargo resources is basically completed by sea. Meanwhile, these dry bulk resources are mostly used to produce industrial intermediaries, which are closely related to people's lives and play a vital role in the development of the world economy. Thus, It's no longer necessary to say much about importance of dry bulk shipping in the development of the world economy and international economic and trade

cooperation; the rise and fall of dry bulk shipping market are directly connected with the development of the world economy. Dry bulk shipping is more like a completely competitive market, but also a highly sensitive market. The uncertainty of freight price fluctuation brings great operational risks to shipping enterprises, shippers and investors in other industries. Of course, fluctuating freight prices bring risks, but also bring huge profit temptation; how to control risks, ensure profits and remain invincible in the shipping market has become the primary concern of the broad industry. In view of this, it is necessary to study the market development law of the dry bulk shipping industry. We can grasp the situation of dry bulk shipping market accurately, find problems on the basis of exploring business opportunities of dry bulk shipping market in an all-around way, and formulate corresponding strategies to solve the problems, so as to make dry bulk shipping enterprises minimize the risk.

Through comparison and analysis, the author tries to find out the importance of international and domestic bulk freight shipping indicators in the current environment, and try to find out the correlation between them and the international economy. The writer hopes to find out the internal relationship between these dry bulk index through quantitative analysis, so as to provide some suggestions for industry practitioners and investors to invest or engage in related activities.

## **1.2 The Existing Model to Comparative Analysis**

Judging from previous research, The writer would try to use multiple models to run the analysis, to get a more comprehensive result.

First is Correlation Analysis. Correlation analysis is a statistical analysis method which aims to study the correlation between random variables in the same position. The Writer will also do a Linear regression analysis. The correlation analysis can also be used to verify the linear relationship between the two variables. After calculating the correlation coefficient  $r$ , we can know if these variables are linear, whether the linear relationship is strong or weak, and whether they are positive or negative related.

Usually, Correlation Analysis fits for the following occasion: When you have paired numbers; When you draw a scatter plot and find that the data has a linear relationship; When you want to use statistical methods to measure whether the data falls on a line or not.

Although correlation analysis can be done manually, the use of computer software can

make the calculation easier. The general usage steps are as follows.

1. The correlation coefficient  $r$  is calculated by analysis, which is between - 1 and 1.
2. If  $r$  approaches zero, there is no linear correlation between the two variables.
3. If the absolute value of  $R$  is close to 1, the linear relationship between the two variables is very strong.

Linear regression is the analysis method which uses regression analysis in mathematical statistics to determine the quantitative relationship between variables. Its normal expression could be described as  $y = w'x + e$ , and  $E$  is a normal distribution with an error of 0. Ordinary Least Square (OLS) is the most commonly used method for the linear regression model with one variable: the selected regression model should minimize the sum of residual squares of all observed values. ( $Q$  is the sum of residual squares) - that is, the square loss function is used. The principle of the least square method is to determine the position of a straight line by minimizing the sum of squares of residual errors. In addition to the convenience of calculation, the estimator obtained by the OLS has excellent characteristics. This method is very sensitive to outliers.

Typical regression model, for example:

$$Y_i = \hat{\beta}_0 + \hat{\beta}_1 X_i + e_i$$
$$\Rightarrow e_i = Y_i - \hat{\beta}_0 - \hat{\beta}_1 X_i$$

The  $e_i$  is the error of the sample ( $X_i, Y_i$ ).

Second is Cointegration. Cointegration theory was first proposed by Engle and Granger in 1978. Before Cointegration, in order to avoid false regression, people usually used stationary time series to establish a regression model, or first transformed non-stationary time series into the stationary time series, and then made regression. With the co-integration theory, it could be found that there might be a long-term stable relationship between several single-integer time series of the same order, and its linear combination may reduce the single-integer order. In many cases of economic field, we can know that two variables should be co-integration through economic theory. Using co-integration theory, a precise judgment can be given. Basically said, the co-integration test is the test which aims to examine the correctness of the economic theory.

The definition of co-integration is as follows:

Assuming that every component sequence of vector  $y$  of order  $n \times 1$  is a  $d$ -order monolithic process, i.e.  $y_i \sim I(d)$ , if there exists vector  $\beta$  of order  $n \times 1$ , which makes the linear combination sequence  $\beta'Y \sim I(d-b)$ , then we call the components of  $Y_i$  are co-integrated under order of  $D$  and order  $b$ , which is abbreviated as  $Y \sim CI(d,b)$ ; where  $\beta$  is called the co-integration vector, and the elements of  $\beta$  are called co-integration parameters. Cointegration relationship in real economic variables shows that there is a long-term equilibrium relationship between variables, which is the basic concept of co-integration understanding.

## **Chapter II. Literature Review**

### **2.1 Introduction**

In this chapter, the author will introduce the dry bulk shipping indicators to be used and give an overview of the international dry bulk market.

### **2.2 Summary of Bulk Freight Market**

From the definition of international shipping market, in a narrow sense, the international shipping market refers to the place where the demanders and suppliers of shipping services between different countries and regions conduct trade activities, i.e. the shipping exchanges located in different places; in a broad sense, the international shipping market refers to the combination of international shipping services and related industries. Coordination, operation, and other activities and the synthesis of their related relations. This paper refers to the international shipping market in a broad sense. The International shipping market is composed of the main body, object, and carrier. For international dry bulk shipping, the main body of its transaction is international dry bulk shipper and international dry bulk carrier.

The shipper or consignee of dry bulk cargo can act as a dry bulk shipper, such as an enterprise, an individual or a government; the shipowner or a second shipowner, as an international dry bulk carrier, uses his ship to satisfy the transport needs of the trading cargo owner. The international dry bulk cargo maritime transport service is the trading object of the international dry bulk cargo shipping market, which is realized by the ship provided by the ship to the cargo provided by the cargo carrier. The carrier of international dry bulk shipping market is shipping exchange. Shipping exchanges have a great influence on shipping transaction activities, which is reflected in that they leave ample choice for both shipowners and cargo owners as well as shipping lease-related parties in market activities, and can conclude transactions at a reasonable price, thus providing the conditions for direct negotiation and transaction for all parties involved in the transaction, and providing a reference for shipping transaction activities. For places, facilities, information, etc. But its role is not to engage in shipping transactions or to determine the price of shipping transactions. The international dry bulk shipping market is based on the trading relationship between international dry bulk shippers and international dry bulk carriers. These relationships also derive from the relevant charter market,

shipbuilding market, trading market, ship dismantling market, ship repair market, crew labor market, the dry bulk terminal in the international dry bulk shipping market. As well as the related market composed of banking, insurance, agency, and other service-oriented industries. The index studied in this paper is mainly related to the international dry bulk market.

Charter shipping is the main mode of operation in the international dry bulk market. Chartered shipping has the following characteristics:

- (1) Chartered shipping is irregular transportation, i.e. a form of transportation without fixed routes, ports of loading and unloading, voyages and fixed freight rates.
- (2) The charter party mainly carries large quantities of goods in international trade at low prices, which do not require or require relatively simple packing.

Dry bulk shipping trade accounts for a large proportion of world shipping and generally shows an upward trend. According to statistics, the global dry bulk shipping volume increased from 1.698 billion tons in 1994 to 3.47 billion tons in 2011, with an average annual growth rate of 5.51%. The number and tonnage of the corresponding dry bulk carriers also showed an obvious growth trend. Because of its own reasons, shipping market lags behind the development of trade. Generally speaking, the shipping market will be delayed for about a year due to changes in the trade market. But meanwhile, the dry bulk market has a strong sensitivity to climate, political factors, port conditions and so on.

### **2.3 Summary of China Domestic Bulk Freight shipping index**

The writer gives a summary of the China domestic Bulk Freight shipping index. For China, China Coastal Bulk Freight Index can fully reflect the changes of freight rates in China's coastal transport market and adapt to the reform of water transport price system, new tools are needed to describe the objective market demand of market development and changes. The writer will try to introduce its source and compilation method.

**CCBFI**, as follow:

China Coastal Bulk Freight Index (CCBFI) has been issued by Shanghai Shipping Exchange since November 28, 2001. The release of CCBFI opens a new page in China's index system. As a barometer of the coastal transport market, CCBFI can timely reflect the trend of price changes in the coastal shipping market, help government departments to implement macro-control of the coastal transport market, and help shipping companies, cargo owners, trading enterprises, ports, agents and other relevant units to obtain market



information and grasp market dynamics. The Shanghai Shipping Exchange publishes the index every Friday at 17:00 p.m. on the Shanghai Shipping Exchange website and China Shipping Online. Users can access the latest information of the index through the website of the Shanghai Shipping Exchange.

The basic situation of CCBFI is as follows:

- (1) Sample cargo types: According to the principle of importance, the top five cargo types (coal, metal ore, crude oil, refined oil and grain) listed in bulk cargo throughput of coastal ports in China are selected as sample cargo types.
- (2) Sample routes: Based on the scale of traffic volume, considering regional coverage, combined with market conditions and the development situation of routes, further optimization was made in May 2007. The original 18 sample routes were adjusted to 21 routes, which can be seen from the table.

CCBFI freight information collection is mainly provided by the following shipping companies.

Among them, there are 49 companies that provide shipping price information related to dry bulk cargo in coastal areas (sorted by company name in Chinese phonetic alphabet):

Baoshan Iron and Steel Co., Ltd., Changhang Phoenix Co., Ltd., Changhang Freight Co., Ltd., Dalian Huaxi Trading Co., Ltd., Dongguan Haichang Shipping Co., Ltd., Fujian Guohang Ocean Transport (Group) Co., Ltd., Fujian Shengda Shipping Co., Ltd., Fujian Haitong Development Co., Ltd., Fujian Province Shipping Co., Ltd., Guangdong Shipping Co., Ltd. Division, Guangdong YueDian Shipping Co., Ltd., Guangzhou Development Shipping Co., Ltd., Guangzhou Port Group Co., Ltd., Guangzhou Guangdong and Energy Co., Ltd., Guangxi Fangcheng Port Jinhang Shipping Co., Ltd., Huayuan Star Shipping Co., Ltd., Jiayi Investment (China) Co., Ltd., Jinhui River Shipping Co., Ltd., Jiangsu Shagang Logistics Transportation Management Co., Ltd., Jiangsu Weilun Shipping Unit Ltd., Jiangyin Lidian Coal Transport and Marketing Co., Ltd., Ningbo Beilun Shipping Co., Ltd., Ningbo Port Co., Ltd., Ningbo Shipping Co., Ltd., Ningbo Economic and Technological Development Zone Longsheng Shipping Co., Ltd., Ningbo Energy Group Material Distribution Co., Ltd., Qinhuangdao Port Co., Ruimeotong Supply Chain Management Co., Ltd., Shanghai Baoying Logistics Ltd., Shanghai Changhang International Shipping Co., Ltd., Shanghai International Port (Group) Co., Ltd., Shanghai Ruining Shipping Co., Ltd., Shanghai Times Shipping Co., Ltd., Shenhua Zhonghai Shipping Co., Ltd., Tianjin Port Group Co., Ltd., Tianjin Sustainable Shipping Co., Ltd., Tianjin Yuanhua Shipping Co., Ltd., Tianjin Zhongyun Shipping Co., Ltd., Yangpu

Zhejiang Maritime Transport Co., Ltd., Xiamen International Trade Maritime Transport Co., Ltd., Zhejiang Maritime Transport Co., Ltd., Zhejiang Xiehai Group Co., Ltd., Zhejiang Products Environmental Protection Energy Co., Ltd., Zhejiang New Maritime Transport Co., Ltd., COSCO Bulk Cargo Transport Co., Ltd., China Coal Energy Co., Ltd., Zhoushan Jinqiao Shipping Co., Ltd., Zhoushan Zhongchang Investment Management Co. Li Limited and Zhuhai Qinfa Shipping Co., Ltd.

There are 16 companies providing information on oil-related shipping routes (sorted by company name in Chinese phonetic alphabet):

Dalian Ouyang Shipping Co., Ltd., Yueqing Huayuan Shipping Co., Ltd., Rongcheng Heshun Shipping Co., Ltd., Xiamen Lusheng Shipping Co., Ltd., Shanghai East China Sea Shipping Co., Ltd., Shanghai Jianqiao International Shipping Co., Ltd., Shanghai Shipping Co., Ltd., Changfeng Oil Shipping Co., Ltd., Zhejiang Changrun Shipping Co., Ltd., and Sinopec Sales Co., Ltd. East Branch, PetroChina Dalian Maritime Transport Company, COSCO Maritime Energy Transport Co., Ltd., China Yangtze River Shipping Group Nanjing Oil Transport Co., Ltd., CNOOC Refining and Chemical Co., Ltd., Sinochem Liaoning Company, Zhoushan Zhehua Petroleum Transport Co., Ltd.

#### **2.4 Summary of International Bulk Freight shipping index**

The writer also gives a summary of international bulk freight shipping index. The international common indicator is the Baltic Dry Index (abbreviated as BDI), which is the economic indicator of the shipping industry. It contains the change of the dry bulk trading volume in the shipping industry.

Considering the international bulk freight market, the most representative index is BDI.

**BDI**, as follows,

The Baltic Dry Index(BDI) is weighted by Spot Rate of several major routes, which reflects the spot market. BDI is one of the most widely used tools in the shipping industry and market operation. It can more accurately reflect the fluctuation trend and situation of the international dry bulk freight transport market.

The predecessor of the BDI is the daily freight index (BFI) issued by the Baltic Shipping Exchange in 1985. The index is a comprehensive index composed of the freight rates of several traditional dry bulk carriers, which are reconstructed according to how

important each of them is and how much they have occupied in the shipping market. Initially, BFI was composed of 13 routes at first, and was adjusted to 11 routes later on.

In the past ten years since BFI was established, it has become a barometer of the changes in the world dry bulk shipping market and an indispensable important reference index in the daily operation of the shipping industry. It plays an important role in the analysis and prediction of the dry bulk shipping market and in guiding the charter business of dry bulk carriers. At the same time, BFI is also an important basis for the Baltic International Freight Futures Market to trade and settle freight futures.

In the Baltic Shipping Exchange, there is a group of 13 member companies responsible for calculating every day's BFI. Each morning, the thirteen companies submit to the group their respective rates and daily rent levels for each route that they deem feasible for the day. The group multiplied the conversion constants by the average freight rate or average daily rent of each route, which means that the conversion of each route is mature. The result of adding the conversion constants of each route is the Baltic Freight Index published that day. The calculation process can be expressed as follows by a formula:

$$BFI = \sum_{i=1}^{11} I_i = \sum_{i=1}^{11} P_{1i} \times S_i$$

Among them,  $I_i$  denotes the conversion index of route  $I$ ,  $P_{1i}$  denotes the average freight rate of the route  $I$ , and  $S_i$  denotes the conversion constant of route  $I$ . In the formula,

$$S_i = \frac{1000}{P_{0i}} \times W_i$$

$$P_{1i} = \frac{\sum_{j=1}^{11} P_{ij} - \max_j(P_{ij}) - \min_j(P_{ij})}{9}$$

$P_{0i}$  denotes the average base-period freight rate of Route I and  $W_i$  denotes the weight of Route i.

However, there are some limitations in the use of BFI. There are 7 Panamax routes and 4 Capesize routes as sample routes, of which 7 Panamax routes are composed of 4 grain and 3 term charter routes, while 4 Capesize routes are composed of ore (or coal) charter routes distributed in the Atlantic market. Therefore, BFI reflects the changes in the price (or rent) of Panamax and Capesize vessels, mainly reflecting the market situation of large and medium bulk carriers, but not the market situation of convenient bulk carriers, which account for 44% of the world's total dry bulk capacity.

Based on this, the Baltic Exchange began compiling and Issuing the convenient shipping price index BHI on January 7, 1997, which effectively compensated for the blind area of the BFI index. In February 1998, the Baltic Exchange launched another oil tanker tariff index according to the needs of market development. In September 1999, the BFI index reflecting Panamanian and Cape-of-Good-Hope shipping prices was decomposed into BCI and BPI indices, which together with the established BHI, constituted three major ship-type tariff indices, with 24 routes. In November of the same year, BDI, based on BCI, BPI and BHI, replaced BFI and became a barometer representing the trend of the international dry bulk transport market. The BDI index was initially set at a benchmark of 1,000, and has been changing over the years, from tens of thousands to hundreds, sometimes as steep "clear water cliffs" and sometimes as gentle slopes.

Now the BDI considers a total of 24 indices. At this time, the BDI index calculation method is to add BPI, BCI, BHI index, take the average, and then multiply by a fixed conversion coefficient. The BDI applies the average values of BPI, BCI and BHI are adjusted by factors to ensure the continuity of BFI. Next, the author will list the specific 24 routes distribution. These 24 routes can be divided into three parts:

(1)Baltic Capesize Index(BCI).This tariff index includes four time charter routes and six voyage charter routes.

Tubarang-Rotterdam	voyage charter	10%
Tubarang-Beilun	voyage charter	15%
Richards Bay-Rotterdam	voyage charter	5%
West Aus-Beilun	voyage charter	15%

Bolivar-Rotterdam	voyage charter	5%
Gladstone-Rotterdam	voyage charter	10%
Trans Atlantic round voyage	time charter	10%
Trans EU-Far east round voyage	time charter	5%
Trans Pacific round voyage	time charter	20%
Trans Far East-EU round voyage	time charter	5%

(2) Baltic Panamax Index (BPI). The weights to be considered in the calculation of BPI tariff index are mainly four routes: Trans-Atlantic route, Far East route, Trans-Pacific route and Continental-European route. The weight of these four routes is the same, they are all 25%.

(3) Baltic Supramax Index(BSI). The index contains nine routes, but only six of them are used for calculation. They are all voyage charter.

## 2.5 Achievement of previous study

For the shipping enterprises engaged in ocean transportation, it is of great significance to grasp the trend of freight index for the scientific and rational distribution of shipping capacity and shipping operation. In view of this, many researchers reveal the law of freight index change by quantitative analysis and qualitative analysis through the study of freight index, which provides scientific basis for shipping enterprises to make business decisions such as market forecast and transportation capacity layout. The writer summarizes some relevant literature on shipping index.

Sun Yong (2005) set up models for comparing CCFI with Baltic Freight Index. In his paper, co-integration technology and Granger causality are introduced to investigate the long-term dynamic relationship between CCFI, BDI and CCFI sub-route indices, and a conditional heteroscedasticity model of CCFI and BDI return series is established, which

can better explain the non-normal distribution characteristics of return series. The VAR technology, which is widely used at present, is introduced and applied to the risk measurement of CCFI and BDI return series.

Yang(2015) used generalized autoregressive conditional heteroskedasticity(GARCH) model and stochastic volatility(SV) model of international dry bulk freight index volatility study separately, portraying fluctuation characteristics sequence, the results were analyzed and compared. By selecting the data to give the corresponding statistical characteristics, the use of multiple model described in the text and the corresponding, and fitting result obtained by comparing the parameter estimates compare models.

Shi(2014) suggested that the international dry bulk shipping market changes dramatically makes it hard for shipping companies and other market practitioners to make correct and prompt decisions. She said that easy changeable and high risk of the dry bulk shipping market makes market practitioners desperately want to grasp the characteristics of the market, and then have a particular insight into the volatility and varying regulation of the freight rates. These could help them to make perfect operating strategies, minimize the market risk and make considerable profits. Through all this she described and explained from an economic point of view, she has demonstrated the key features of the dry bulk shipping markets; and then she tries to analyze the behavior of freight rates, which eventually define the finished cost of an imported commodity. She focus on four major indexes, the BCI, the BPI, the BSI, and the BHSI, propose some diffusion models(AR,ARCH,GARCH,TARCH,etc)abled to capture the unique feature of its trajectories, namely large swings, continuity, leverage effect and fractal characteristics.

Wang(2018) found that bulk shipping is an indispensable part of international shipping, with dry bulk shipping accounting for more than one — third of the world's sea traffic. The Baltic dry bulk freight index is the most influential in the international shipping market, and it has gradually become a comprehensive important index to measure the dry bulk transport market after more than ten years of development. In different periods and different ship types, the freight index will show different characteristics of changes, and its fluctuations are often influenced by political, economic, scientific and technological, military and other factors.

Zheng (2014) systematically introduces China's coastal (bulk) freight index (CBFI). According to the trend of CBFI in the past eight years, it summarizes the long-term and short-term characteristics of CBFI operation. Through long-term tracking of CBFI, it points out that the main factors leading to CBFI fluctuation are domestic macro-economy, international dry bulk transport market, supply-demand relationship and oil price.

Su, Fan, Liu and Li(2014) announce the opinion that through the reliability and validity analysis on the questionnaires, the maritime power evaluation index system is determined including 8 aspects that are the maritime industry macro-development environment, the development of shipping and its industry chain, ports, shipping fleets, shipping enterprises, talent and technology, laws and regulations, and safety and security. The construction of the index system is of great significance for China to realize a shift from a big maritime country to a maritime power, and also provides theory basis and policy recommendation for the future maritime power construction.

Wu, Xu(2014) analyze the cost composition of dry bulk cargo transportation enterprises, the composition of BDI index and the change of its calculation method, analyses the influencing factors and changing trend of capital cost, operation cost and voyage cost of shipping enterprises in recent years, and constructs the cost model of corresponding rent and freight. By calculating the rent and freight corresponding to the BDI index in 2017, it is concluded that the dry bulk cargo transportation market will achieve slight profit in 2017, and the viewpoint that the reflective degree of the BDI index to the dry bulk cargo transportation market should be treated more rationally is put forward.

Kostas Andriosopoulos, Michael Doumpos, Nikos C. Papapostolou c, Panos K. Pouliasis c, (2012) tries to use these evolution algorithm and genetic algorithm to solve the index tracking problem. To test the performance of heuristic algorithms, they examined three different trading scenarios: rebalancing annually, quarterly and monthly, and calculating transaction costs when necessary. Competitive portfolios are also evaluated through predictive ability tests. Overall, the proposed investment strategy is less risky than the tracking benchmark index, and provides investors with the opportunity to effectively replicate the performance of stock and physical shipping indices in the most cost-effective way.

Javier Fernández-Macho, Pilar González, Jorge Virto considered that the design of shipping management policy and the assessment of the importance of marine economy need some experience and data support to provide basic data for decision-making process. In the form of a composite index, they proposed an index to measure and compare the importance of the Euro-Atlantic region. The index score can be used to assess the location of each Atlantic region for comparison among policy makers. Using this index to analyze the marine economy can provide guidance for formulating economic policies and identify regions with great potential for growth. This not only helps to raise people's awareness of the importance of marine economy, but also helps to improve the utilization of marine waters at the socio-economic level.

Ye, Cao and Zhang(2019) explore the correlation between the shipping price fluctuations of China's coastal and inland dry bulk markets, to promote the development of China's regional dry bulk shipping market, combined with the actual situation of China's shipping market, select the Yangtze River Freight Index and relevant data of Shanghai Stock Exchange. Establish a vector autoregressive model for empirical analysis. The results show that there is a linkage between the inland river and coastal dry bulk shipping market freight rates, and there is a lag between the two markets; the price fluctuations of the inland river and coastal dry bulk shipping markets are affected by seasonal factors; The dry bulk market has a greater impact on the price fluctuations of the inland dry bulk market; factors such as fuel prices and coal freight rates have a greater impact on the inland river and coastal dry bulk shipping markets. Based on this, this paper draws policy implications for promoting the development of the inland river and coastal dry bulk shipping market.

Zhang(2012) based on the above mentioned background and collecting amounts of data, research on supply-demand balance of International dry bulk shipping market. First of all, from the situation this paper discusses and introduces the relevant factors and main operation, as well as summarizes characteristics and the law of development. Then he tries to establish a simple model to particularly analysis demand, supply and freight index respectively of international dry bulk shipping market. Next, he tries to go through quantitative and qualitative, and the combination of a variety of prediction method, respectively forecast the demand, supply, and freight index of International dry bulk



shipping market. And finally, based on above, he summarizes the strategy and puts forward the attention of shipping enterprise strategy in the implementation.

## **Chapter III Methodology**

### **3.1 Research Contents**

The research contents of this paper mainly focus on internal relations and consistency between domestic and international Dry Bulk Index. First of all, this article will start with the introduction of the current global economic background. It will introduce the shipping indicators used in this paper in detail. It will have a certain understanding of their data collection, compilation methods and the derivation of the results. Subsequently, the relevant analysis of these indicators to identify their internal links. Finally, the author will comment on the internal links between these indicators.

### **3.2 Research Method**

In this paper, multiple models are used for quantitative analysis.

Correlation analysis is a statistical analysis method to study the correlation between two or more random variables at the same location. The analysis needs to select the relevant variables artificially. For example, the relationship between body height and weight, and the relationship between relative humidity and rainfall in the air are all problems of correlation analysis. There are some differences between correlation analysis and regression analysis. The main difference is that regression analysis focuses on the dependence between random variables in order to predict another variable with one variable, while correlation analysis focuses on finding different correlation characteristics and regression analysis. In the application of real life, correlation analysis has been applied in many fields, such as shipping, agriculture, astronomy, meteorology, social economy and biology.

In macroeconomic econometric analysis, the co-integration method proposed by Granger (1987) has become one of the most important tools to analyze the quantitative relationship between non-stationary economic variables, and the linear adjustment mechanism among economic variables is characterized by the linear error correction model (ECM), which is called the linear co-integration method.

With the development of economic theory, especially in the economic analysis of transaction costs and policy responses, the traditional linear cointegration analysis is no

longer an appropriate method. The co-integration relationship between time series variables was first proposed by Engle-Granger, and has been developed and perfected in a series of subsequent steps. The basic idea of this method is that if two time series variables are non-stationary, but their linear combination shows stationarity, then there is a long-term stable relationship (co-integration relationship) between these variables. In economic sense, if this co-integration relationship exists, the change of the horizontal value of another variable will be affected by the change of other variables. On the contrary, if there is no co-integration relationship between variables, other variables have no conditions and basis to influence other variables.

Engle-Granger's two-step method is based on the following single equation:

$$y_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \dots + \beta_n x_{nt} + v_t$$

And then a test was used to test whether the regression residual  $v_t$  was stable. If stationary, then it shows that there is indeed co-integration between variables, so the equation is co-integration equation, which also represents the long-term stable relationship between variables.

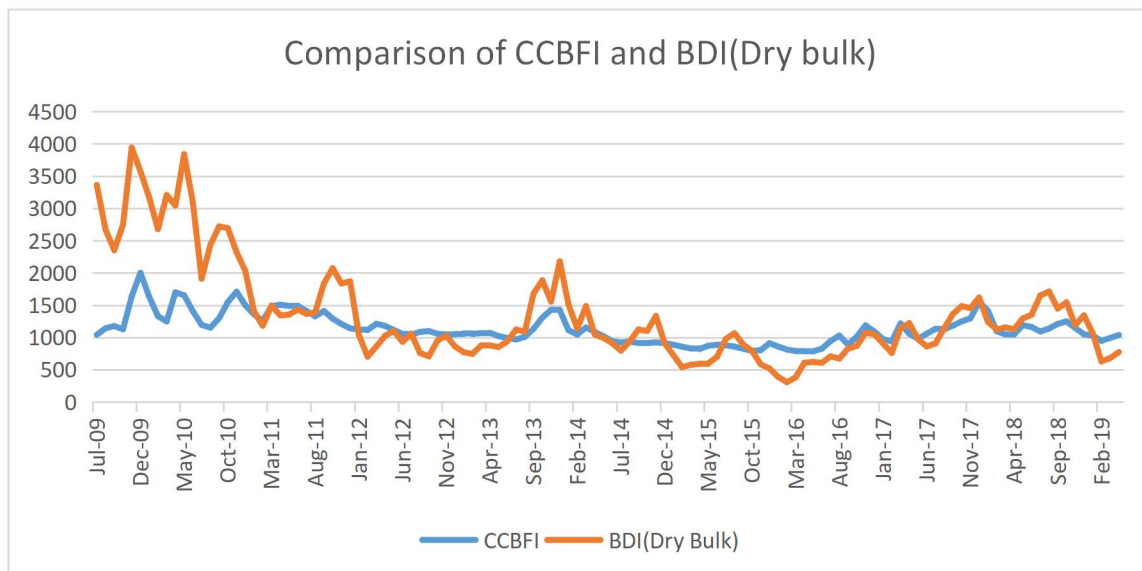
## Chapter IV Establish and Test of Models

### 4.1 Introduction

Firstly, the data of CCBFI and BDI from July 2009 to Feb 2019 are used to calculate. The reason for taking data from July 2009 onwards is that the BDI index was calculated by a new calculation method from July 2009. When calculating the index, the component routes were adjusted, and the freight of the original voyage charter was adjusted to the rent of the fixed-term charter. The new BDI takes into account the futures market index of Capesize, Panamax, Supramax, HandySize ships, each of which accounts for 25% of BDI. The new concrete calculation formula is as follows:

$$BDI = ((\text{CapeSizeTCavg} + \text{PanamaxTCavg} + \text{SupramaxTCavg} + \text{HandysizeTCavg}) / 4) * 0.113473601$$

The TCavg in the formula means Time Charter average value. The adjustment of the



calculation formula results in that the BDI values calculated by the existing formula are lower than those calculated by the previous formula under the same branching index. After this treatment, the voyage costs such as oil price and port operating cost in voyage charter were excluded from the index (the cost of different voyage routes is not comparable), which makes the index more reflect the construction of ships. Shipping and operating costs. Therefore, the BDI index obtained before and after the adjustment of the

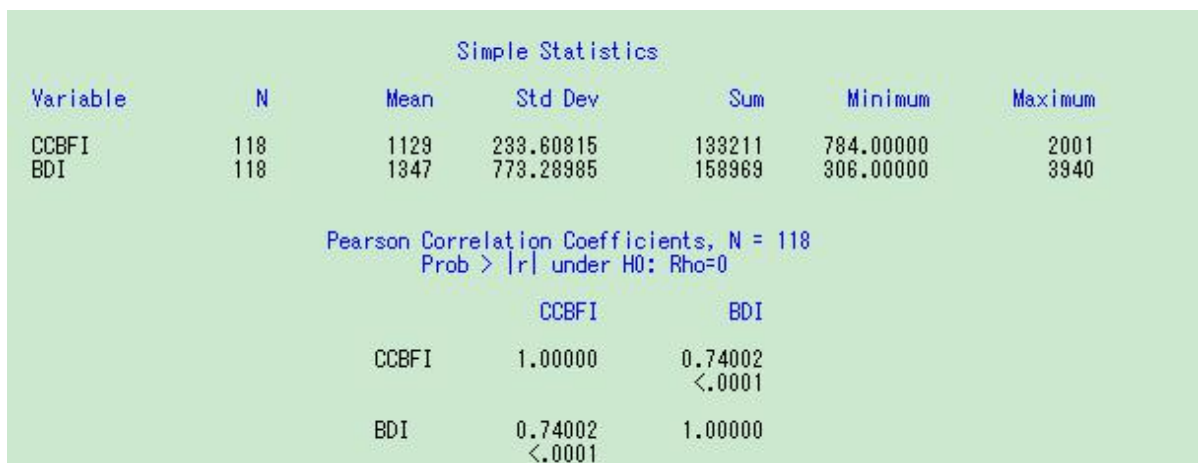
calculation method is not comparable. In terms of the trend performance of the index, the index calculated by the new method has a significant reduction in the numerical value.

The writer integrated the data of the two indicators to get the following chart.

It should be known that in July 2009, the BDI index was calculated by a new calculation method. When calculating the index, the component routes were adjusted, and the freight of the original voyage charter was adjusted to the rent of the fixed-term charter. After this treatment, the voyage costs such as oil price and port operating cost in voyage charter were excluded from the index (the cost of different voyage routes is not comparable), which makes the index more reflect the construction of ships. Shipping and operating costs. Therefore, the BDI index obtained before and after the adjustment of the calculation method is not comparable. In terms of the trend performance of the index, the index calculated by the new method has a significant reduction in the numerical value. Therefore, the writer selected the data from July 2009 to March 2019 to get more meaningful results.

#### 4.2 Correlation Analysis

From the above chart we have known that this is some relationship between these indexes, now we will check them in a numerical way. The author tried to collect data from July 2009 to March 2019, using CCBFI as independent variable and BDI as dependent variable. First, the correlation analysis was carried out. The results are as follows:



Variable	CCBFI	BDI
CCBFI	1	0.74002
BDI	0.74002	1

It can be seen from the analysis that  $|r| > 0.7$ , which means there is a highly linear

correlation between CCBFI and BDI.

From the analysis results of the program, we can find that CCBFI and BDI have a certain correlation. This result is predictable considering their respective compilation methods described above. Obviously, the change of international dry bulk shipping market will affect the freight rate of China's coastal dry bulk market, which is evidently reflected in the change of indicators.

### 4.3 Linear Regression Analysis

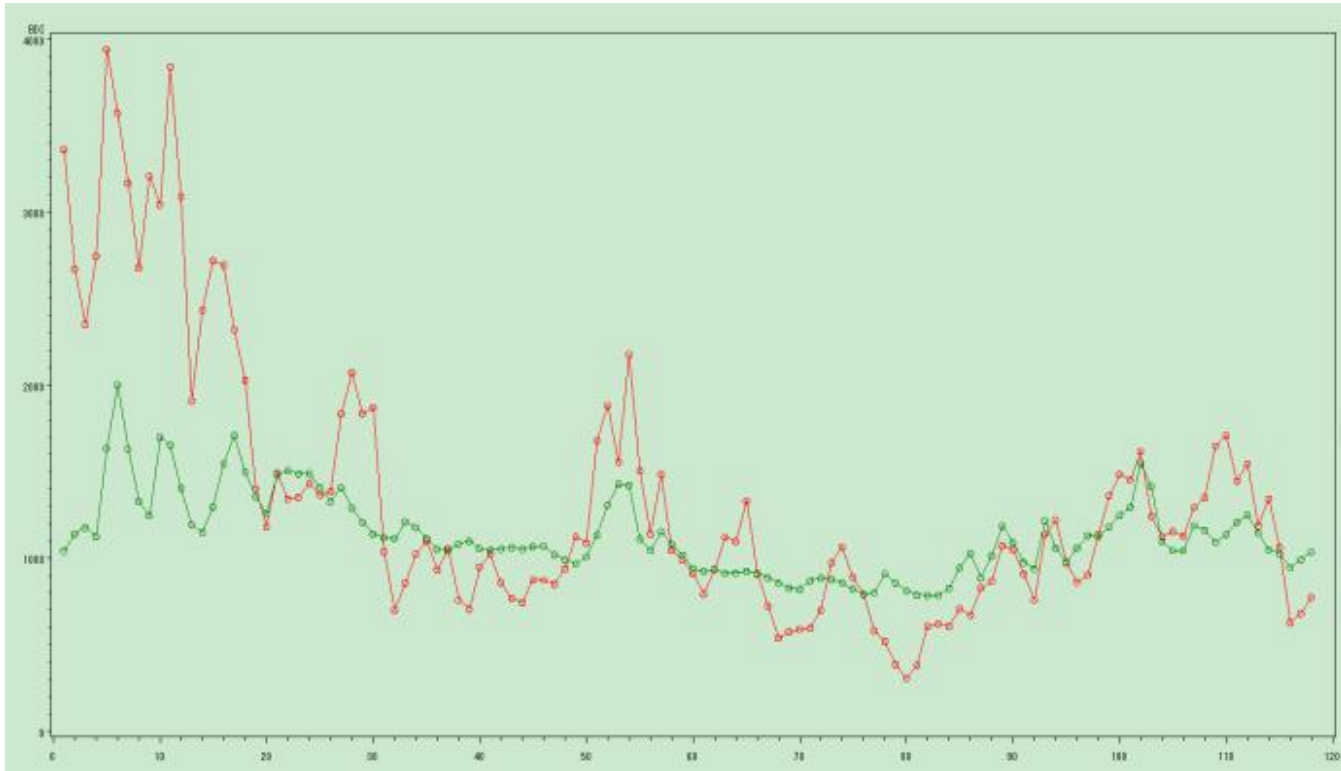
Then, the author carries on the OLS linear regression to this group of data.

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	38313856	38313856	140.43	<.0001
Error	116	31649476	272840		
Corrected Total	117	69963332			
	Root MSE	522.34119	R-Square	0.5476	
	Dependent Mean	1347.19661	Adj R-Sq	0.5437	
	Coeff Var	38.77245			
Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	-1418.18509	238.26530	-5.95	<.0001
CCBFI	1	2.44961	0.20672	11.85	<.0001

From the results of program regression, the regression equation  $F = 140.43$ ,  $P < 0.0001$ , the overall significant,  $R^2 = 0.5476$ , Adjusted  $R^2 = 0.5437$ . Therefore we can come to the result that the approximate regression equation is:  $BDI = -1418.18509 + 2.44916 * CCBFI$

### 4.4 Cointegration Analysis

According to the data, the author draws a scatter plot to run the cointegration analysis.



The scatter plot shows that the trend of scatter plot curves of CCBFI and BDI is relatively consistent, and the cointegration relationship between them is preliminarily judged.

(RED=Curves for BDI Green=Curves for CCBFI)

After running residual error test of regression equation to verify long-term cointegration, the writer draws the following chart:



The scatter plot of the residual of the regression equation shows that the residual does not

expand outward with time, and there is no heteroscedasticity. The regression cointegration is proved preliminarily.

The writer also runs the unit root test. Unit root test is the test to make sure if sequence is in stable. If the stability of sequence is not tested, direct OLS will easily lead to false regression. In this case, the writer found out that further unit root test of the residual shows that the P value is less than 0.05, rejecting the hypothesis that the residual does not exist unit root and the regression equation is co-integrated.

## **Chapter V Conclusions**

### **5.1 Introduction**

In this chapter, the author will summarize the results of data analysis in the previous chapter and try to find out the reasons behind it.

### **5.2 Main Findings**

From the analysis of the above results, the author believes that they are closely related to each other to a certain extent. Although the scale and environment of shipping market are different and the degree of economic development is different, CCBFI and BDI reflect the freight rate of dry bulk market.

As a derivative market of international trade, the capacity demand of dry bulk shipping market is closely related to the world economy: the growth of the world economy will promote the increase of Global trade volume, so that the demand for dry bulk cargo capacity will increase, and the freight index will rise; the recession of the world economy will make the international trade volume shrink, and dry bulk cargo. As demand for power declines, the freight index becomes depressed. For the dry bulk freight price index, the main factors affecting the index change in the market are transportation cost, market structure and supply-demand relationship. As a barometer of price fluctuation in China's coastal transport market, CCBFI often affects the transport cost of raw materials for maritime transport, thus affecting the BDI itself. The price trends of BDI and CCBFI in the international market depend on the global economic and commercial conditions, and the expansion and contraction of the global economy. As the main index of freight cost and the standard index of commodity trading volume, BDI index and CCBFI index interact with each other.

The author believes that CCBFI and BDI are closely related to each other for several reasons:

First of all, these bulk freight index have similar attributes. Similar attributes are first reflected in the way they are compiled. As mentioned in the author's previous introduction, the formulation of CCBFI index is based on the collection of freight information provided by many domestic shipping companies. Today's BDI is also the result of comprehensive calculation after weighted by BPI, BCI and BHI routes. The daily freight rates of these



routes are also the daily figures obtained by numerous shipping companies after continuous competition. Therefore, there is a certain relationship between the two indices in the first place. From the writer's perspective, for the dry bulk freight price index, the main factors affecting the index change in the market are transportation cost, market structure and supply-demand relationship, etc.

Transportation cost consists of many factors. It mainly includes fuel price, ship depreciation, employee salary and port usage fee. These transport costs have more or less affected the fluctuation of the dry bulk freight price index, which is mainly manifested by affecting the operating costs of enterprises and further affecting the dry bulk shipping market freight index. When transport costs rise (possibly due to one of the factors mentioned earlier, or possibly due to multiple factors), the international dry bulk price index also rises. Transportation cost should be positively correlated with both international and domestic dry bulk freight price index, we can see the fact from similarity of these exponential changes.

Secondly it comes to market structure, the dry bulk market is very similar to a fully competitive market, with a large number of ship owners and small scale. Most of the goods transported are primary products, so the freight rate is low and the requirements for shipowners who provide transport services are not high. In other words, dry bulk market transactions are relatively open and free. It is relatively easy for shipowners to enter and exit the market with high liquidity, which leads to the instability of the dry bulk market, which affects the change of the dry bulk index to a certain extent. Both domestic and international market have the similar attributes. The demand for dry bulk cargo transportation has rigid and obvious regional characteristics. The allocation of domestic and foreign transport capacity is limited, and there is no direct and effective risk transmission channel. Therefore, China's coastal bulk cargo transportation market is relatively independent and is not vulnerable to short-term shocks. Nevertheless, the demand for dry bulk cargo transportation along the coast of China will be affected by the systemic risk of demand and the change of the overall capacity of the industry, so it will be impacted for a long time. China's coastal dry bulk cargo transport market, as a part of the international dry bulk cargo transport market, has the channel to transfer risks to the international market. However, the limited market size determines the weak risk transmission capacity and limited influence on the international market. To sum up, China's coastal dry bulk cargo transport market has a strong independent pricing power, and needs to develop freight derivatives market hedging risk. In order to improve the

pricing power of dry bulk cargo shipping in China, on the one hand, we need to expand the scale of international dry bulk cargo ships and establish a distribution center of transport capacity resources, which will directly affect the international dry bulk cargo price; on the other hand, we need to create competitive derivatives of international dry bulk cargo price, relying on financial capital and influencing them through the derivatives market. Pricing in the cargo market, thus establishing a trading and pricing center of shipping financial derivatives. As a digital representation of the dry bulk market, the dry bulk index itself has linkage. Similar market structure will bring about similar changes in the index

In terms of supply and demand, we can see that when the index is at its peak, it means that the shipping price is higher at this time. The international dry bulk market is a highly competitive market. And so does domestic one, according to the theory of economics, the price of a perfectly competitive market is determined by both supply and demand. Firstly, the demand of international dry bulk shipping market is inelastic, and the influence of freight rate on international dry bulk trade is negligible. However, contrary to the lack of demand elasticity, the supply of capacity in the dry bulk market will have a strong response to freight rates. This is because shipping companies can adapt to changes in freight rates by storing capacity and reducing the supply of capacity. At the same time, there is a certain lag in the supply of transport capacity. At this time, due to the delay of shipbuilding time, the supply of transport capacity will lag behind the demand, resulting in higher freight rates.

At this time, increasing the number of ships, that is to say, increasing the capacity, can obtain more benefits. In this context, more people tend to expand their supply by buying ships, etc. As a result, the supply of ships in the whole market rises rapidly, resulting in the imbalance between demand and supply. Because the increase of transportation capacity is lagging behind the demand. Therefore, when the demand in the market falls, as the supply of transport capacity continues to enter the market, it will lead to excess capacity. At this point, the dry bulk index will fall because of oversupply. On the contrary, when freight rates are low, most speculators will try to reduce their investment in the market or withdraw from the dry bulk shipping market in order to reduce losses. In this case, the loss rate of capacity in the market is much faster than the growth rate of demand. Such imbalance will lead to less supply than demand, leading to an upward trend in freight rates. However, in a short period of time, it is difficult for new capacity to be put into the market, so freight rates will keep rising until a new batch of capacity is put into

the market.

What's more, rising international dry bulk cargo prices promote coastal vessels to enter the international market, thus driving up the price of coastal dry bulk cargo; while international ships can't enter freely into China's coastal transport market, the coastal freight rate cannot drive up the international freight rate from the level of transport capacity supply, which has a certain relationship with China's transport policy. On the contrary, the falling price of dry bulk cargo in coastal areas has promoted coastal transport vessels to enter the international market, but the limited size of China's market has limited impact on international freight rates. However, with the deepening of economic globalization, we can see that in the near future, the falling price of international freight will affect China's coastal transport market.

China's demand for bulk goods is the main factor affecting international shipping. At present, China has put forward supply-side reform, and the policy of iron and steel industry has been adjusted, which has a direct impact on the demand for commodity goods. With the development of China's "The Belt and Road" strategy, other non-ferrous metals and products of technological content will gradually affect bulk freight changes. Therefore, in this case, both domestic and foreign dry bulk index will inevitably be subject to similar fluctuations.

Another factor that we need to take into consideration is the changes in iron ore industry. Iron ore is a very important link in dry bulk cargo transportation. Iron ore transportation occupies an important position and share in the world dry bulk cargo transportation. According to relevant statistics, in recent years, the sea transportation of iron ore accounts for about 30% of the total dry bulk cargo transportation, and it is one of the most important dry bulk cargo. China is a huger importer of iron ore, which will do significance influence on world iron trade, and furthermore, the bulk market. International iron ore prices began to decline gradually after rising. The main cargo type of bulk cargo ship transportation is iron ore. The demand of iron ore shipping market largely influences the freight level of bulk cargo ship. The large dive of BCI means that the freight (rent) of Cape vessels has dropped dramatically during this period, and we know that in any market environment, the price is mainly affected by the supply-demand relationship. And this relationship affects every dry bulk market, from big to small, from west to east. Therefore, the change of dry bulk index will show a certain convergence.

Shipbuilding industry is also an important factor affecting the dry bulk freight price index. New shipbuilding is the source of shipping market capacity, and shipbuilding is an

important upstream enterprise in shipping industry. The capacity of shipyards directly affects the ability of new shipbuilding market to provide ships, thus affecting the relationship between supply and demand in shipping market, and ultimately affecting the freight level. Shipyard capacity refers to a certain area (enterprise) in a certain period of time and socio-economic and technological level. Under this condition, the output capacity of shipbuilding can reach a certain level relatively steadily, which is formed by the input of many comprehensive factors produced by shipbuilding. However, in the shipping downturn, the shipping market has excess capacity supply. Shipping enterprises will require shipyards to delay the delivery of new shipbuilding or cancel new shipbuilding orders directly. At this time, the actual output of shipyards is often lower than their existing new shipbuilding capacity. The ratio of actual output to shipbuilding capacity of a shipyard can be defined as the capacity utilization ratio of a shipyard. Shipbuilding. With the high utilization rate of plant capacity and the high delivery of new shipbuilding, the supply of shipping capacity in the shipping market will increase accordingly, which will reduce the freight index.

But apart from the overall trend, we can see from the comparison chart of the two groups of data that they still have different trends in a certain time period. For example, between May 2010-Oct 2010, we can see that while BDI shows an upward trend, CBFI is gradually declining. The author believes that the main reason for this is the particularity of China's coastal transport market. Long-term transport contracts signed by shipping companies and cargo owners account for the majority of the total volume, which leads to insufficient sensitivity to market fluctuations.

The international dry bulk shipping market is a global market, so the operation of the dry bulk shipping market is bound to be affected by uncertainties such as wars, disputes, strikes and natural disasters. Several major wars and crises in history have exerted tremendous impact on the dry bulk shipping market, such as the oil crisis triggered by the Middle East War in 1973, which led to a sharp rise in the shipping market price, and the global golden birthday crisis in 2008, which has led to a gradual decline in the whole economy and trade, a continuing downturn in international freight transport business, and so did dry bulk freight index. For the occurrence of these situations, the dry bulk index also inevitably shocks. The author selected the period from 2009 to 2019, which is the period of deepening global economy and closer contacts between different regions. Any international event will lead to changes in the index, thus affecting China's domestic market like a "butterfly effect".

Close ties with the international shipping market will also bring some adverse consequences. For example, the lack of pricing power seriously restricts the construction of China's shipping center. In addition, the volatility of freight rates makes dry bulk cargo transport vulnerable to the impact of the international market, and increases the operational risks of shipowners and cargo owners. These are all issues that shipping companies have to consider in their daily operations and related industry investors' activities.

### **5.3 Conclusion**

After the world financial crisis, with the increasing international dry bulk cargo capacity, the international dry bulk cargo shipping market has changed from the past condition of peace, to the more intense situation. And the fluctuation of the market is also more intense. In the face of such a situation, shipping enterprises in the international dry bulk market need to take appropriate business models and strategies according to their own development goals and changing market situation. Of course, the first prerequisite for adopting strategies is to be able to obtain information from appropriate channels in a timely and accurate manner. In order to improve the competitiveness of shipping enterprises and enhance their market value, it is necessary for shipping practitioners to pay close attention to the changes of shipping index in the market. As an indispensable part of shipping, dry bulk index will continue to attract people's attention and become one of the important criteria for investors to make relevant decisions. Through comparative analysis of dry bulk index, the author hopes to be able to do some help to the decision of leaders in the industry and related investors.

To sum up, based on the above analysis, the writer proves the concrete relationship between international dry bulk cargo from the numerical point of view, and discusses the reasons for the internal connection to a certain extent.

### **5.4 Limitation of Research**

Firstly, the data collected is from 2009-2019. It may not be meaningful to study the data before 2009, because BDI has changed the way it is compiled. Therefore, the author selected the data from July 2009 to make the analysis more meaningful. In addition, the number of data values used for observation may be too small, which may affect the results of data analysis. In the analysis of international dry bulk index, more studies are carried out through the analysis of external market data, lacking the integration of internal

industry reality. In future research, it may be possible to focus on taking some specific shipping enterprises as examples, from macro data to micro performance, to strengthen the visits and surveys of shipping enterprises, to find out more practical influencing factors, so as to have a more intuitive understanding of the relationship between shipping indicators and the impact of shipping indicators on enterprises.

Secondly, there are several other models for analyzing the factors that influence the bulk freight index, this paper does not guarantee that the result from the current using model is the most accurate.

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