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Study on bulk market of Panamax carrier in the past 20 years(1998-2018)

Wei Chen

WORLD MARITIME UNIVERSITY

Shanghai, China

STUDY ON BULK MARKET OF PANAMAX CARRIER IN THE PAST 20 YEARS(1998-2018)

By

CHEN WEI

China

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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.

(Signature): ----------------------------

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Supervised by

Professor Gu Weihong

World Maritime University

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Abstracts

Title of Research paper:	**STUDY ON BULK MARKET OF PANAMAX CARRIER IN THE PAST 20 YEARS (1998-2018)**
Degree:	**M.Sc.**

Among the dry bulk shipping fleet, Panamax is one of the most representative kind of ship with a tonnage of tens of thousands, which can pass through the Panama Canal and is the best type to be employed from the Atlantic Ocean to the Pacific Ocean. It mainly transports five major types of cargo, such as iron ore, coal, grain, Bauxite and Phosphate ore.

First of all, this article introduces the general situation of Panamax shipping market. Based on the definition of ship, routes and cargoes transported by Panamax, the paper analyzes the data and summarizes the current situation and characteristics of supply and demand in Panamax shipping market. Secondly, this paper analyzes the main influencial factors of BPI index in detail over the 20 years from 1998 to 2018, which refer to 180cst oil prices, delivery of the Panamax bulk carrier, and the coal and grain shipments. From the data of BPI provided by Clarkson, this paper studies the general fluctuation of BPI index over the past 20 years. Finally, on the basis of considering the demand and supply of Panamax vessels, and the idleness of Panamax carriers on the impact of the freight index, the paper uses VAR model to analyse how influential factors affect the BPI index and the degree of influence.

KEYWORDS: Panamax vessels; Freight rate; VAR；BPI; Coal; Grain

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List of Abbreviations

ADF	Augmental Dickey-Fuller test
ARCH	Autoregressive Conditional Heteroskedasticity model
ARIMA	Auto Regressive Intergral Moving Average model
BDI	Baltoc Dry Index
BPI	Baltic Panamax Index
COSCO	China Ocean Shipping Corporation
DWT	Dead Weight Tonnage
VAR	Vector Autoregressive model

Chapter 1 Introduction

1.1 Background and significance of the topic

The international Panama bulk dry bulk carrier market has obvious volatility and risks. The market is not optimistic after the economic crisis. With the slow recovery of the global economy and trade, the oversupply situation will continue. There is a leverage effect in the international shipping market. When major economic and political events occur, they will amplify the volatility of the shipping market.

According to previous studies, the relevant literature in the field of freight rate in the global shipping market mainly focuses on the research on the volatility of freight in the international dry bulk shipping market or the tanker shipping market as a whole, or the measurement and the future forecast of the freight rate using the econometric model. However, the research on freight rate for a specific ship type market is relatively small, especially in the time span of 20 years.

1.2 Research overview in domestic market and abroad

The topic of my paper is mainly on the freight of Panamax in the global shipping market and its influential factors including market supply capacity and the carriage of goods and their changes in the past 20 years. Therefore, the references in this paper are mainly elaborated from three aspects: the research of panamax shipping market, the selection of forecasting and analyzing methods adopted, and the analysis of panamax tariffs and BPI index.

(1)Research of panamax shipping market

Many experts and scholars at home and abroad have studied the world shipping market. Dry Bulk Outlook will dynamically provide information on the international dry bulk shipping market, analyze their development status, and conduct qualitative analysis and forecast on their future development trends. Foreign Clarkson databases will often analyze different types of ships, and do qualitative analysis and forecast of the status and the development trend of various types of ships. COSCO's Notice on China's Ocean Shipping Service collected a large number of reports on the shipping market and regularly reviewed the shipping market in the past and looked forward to the development trend of the shipping market in the future.

Many domestic scholars engaged in dry bulk shipping market research will also mention the choice of prediction methods. In the analysis of world dry bulk shipping market volume and capacity, Wang Shunjuan outlined the international dry bulk shipping market, analyzed the three main influencing factors of dry bulk shipping market, and made a simple forecast of the future demand with gray forecasting method. In the development trend of the main goods demand in the international dry bulk shipping market, Yin Hong did the analysis of the dry bulk shipping market demand and supply factors, and analysis of the three major import and export of dry bulk countries and regions, and forecasted the future volume of seaborne dry bulk cargoes in the short term using neural networks.

(2)Selection of forecasting and analyzing methods

In 1995, Veenstra and Franses used the co-product process of higher time series econometrics and the unit root test method to establish Vector Autoregressive Model(VAR) to forecast with freight rate index time series (120 months data) on different dry bulk carriers and on different routes by Clarkson.

In 2001, Manolis G. Kavussanos and Alizadeh-M, London Metropolitan University Business School, established the single variable seasonal autoregressive integral moving average model(Seasonal ARIMA model), multivariate seasonal sum product and seasonal cointegration vector autoregressive model(Seasonal Co-integrating) to study the freight index, and summarized the characteristics of seasonal fluctuations in the dry bulk shipping market.

In 2002, He Yingjie of COSCO Bulk Co., Ltd. analyzed the freight index using the time series T*S*C*I and AREMA model, and pointed out the long-term growth trend, cyclical and seasonal fluctuations of the freight index.

(3) Analysis of Panamax freights and BPI index

In his analysis of Panamax shipping market, Song Na analyzed the main kinds of cargoes and capacity of Panamanian ships, mainly using the ARENA model to forecast the fluctuations of BPI.

Jiang Dina used the BP filter method to separate the trends of the BDI index and the cyclical elements and obtain the periodic components of the international dry bulk shipping market. From the cyclical components, we can find that there is a clear trend of mutual interaction of long-term and short-cycle in the international dry bulk shipping market.

Lu Jing, Peter B. Marloe and Wang Hui analyzed the freight fluctuations of different dry bulk carriers (Capesize, Panamax, Handysize) by establishing a GARCH model. Lv Lingying and Zhu Yiqiu introduced the birth and evolution of the Baltic Dry Index (BDI), analyzed the fluctuation and trend of the BDI index from 1985 to 2009, and finally summarized and analyzed the impact of BDI fluctuation factors and literature research on risk management.

In 2006, Liu Jianlin and Xu Gaoping investigated the potential of neural networks for medium term monthly dry bulk freight rates. A comparative study of predictive performance among neural networks, multivariate regression models and ARCH time series models were conducted.

In 2013, Zhang Houbao, Ding Yi and Lin Guolong did a phase space reconstruction to the international dry bulk freight system and obtained the maximum Lyapunov exponent by the Rosenstein method, which is positive. The results showed that the international dry bulk freight system has sensitive dependence on initial and much relevance with the world economy.

1.3 Main research content

Based on the technical characteristics of Panamax vessels, this paper is going to analyze the main cargoes transported by Panamax vessels: the main producing areas, the consuming places and their supply and demand status of coal and grain in detail.

According to the data of the past 20 years, make quantitative forecast of the sea volumes of these two cargoes, then analyze the capacity structure of the Panamanian vessel, review its development characteristics, and also quantitatively forecasts its future supply to determine the supply situation in the coming years. Finally, On the basis of the law of volatility, we use the model analysis to forecast the future trend of the index.

Chapter 2 Analysis on Supply of Panamax Bulk Carrier Market

In the panamax shipping market, analysis of world seaborne volumns of some specific cargoes and capacity of panamax vessels, which are the two basical determining factors of Panamax freight rate in the market.

Panamax shipping market is an important part of the international dry bulk shipping market. As the demand for market capacity continues to change, studying its characteristics and defining its market position is an important prerequisite for formulating and optimizing Panamax fleet development strategies.

In the dry bulk shipping fleet, in order to pursue economies of scale, the trend of large-scale ships is becoming increasingly apparent. Therefore, Capesize bulk carriers and Panamax bulk carriers have always been the best choice for transporting dry bulk cargo. Compared with Capesize bulk carriers, Panamax bulk carriers save a lot of transportation costs and transportation time, and are therefore an important part of the dry bulk carrier fleet. The Panamax bulk carrier mainly transports bulk bulk cargo such as coal, coke, grain, fertilizer, iron ore, miscellaneous minerals, aluminum powder, cement, and sulfur.

The most important influencing factor for route determination is the freight factor, which is determined according to the fluctuations of the main cargo type, cargo flow, flow and cargo flow. Therefore, according to the cargo type and direction of cargo carried by the Panamax ship, the corresponding choice of the main shipping routes for Panamax bulk carriers can be determined. The main types of cargo transported by Panamax bulk carriers are coal and grain. The flow of coal mainly includes: from Australian coast north to Japan; from the east coast of the United States via the Panama Canal; from the east coast of the United States to Western Europe across the Atlantic Ocean; from south Africa Along the west coast of the African continent bypass the Cape of Good Hope to Western Europe; from Australia to Western Europe, from South Africa to Japan, Korea, and Taiwan.

The main export zones of the grain flow are the United States, Canada and some other places, while the main import zones are developing countries, Eastern Europe and the Far East emerging industrialized countries. The cargo flow of coal and grain can be summarized that the typical routes that Panamax bulk carriers mainly engage in include:

(1) from Far East (China, Japan, Australia, Southeast Asia, etc.) to Europe, the Mediterranean, the US Gulf, South America, etc.;

(2) from Europe, the United States, South America, South Africa to the Far East;

(3) from Australia, Southeast Asia to China, South Korea, etc.;

(4) from the west United States and west Canada to China, Taiwan, and Southeast Asia;

(5) from India to China;

(6) from North China to Hong Kong, Taiwan, the Philippines, Japan, Korea, etc.

This chapter firstly will analyze the global Panamanian fleet.

2.1 Features of Panamax ship type

The Panamax bulk carrier is the most representative of all types of dry bulk carriers.

It is the best type of vessel to reach the Pacific Ocean from the Atlantic Ocean through the Panama Canal. The fluctuation of the Panamax-type bulk carrier market is relatively flat compared to the Capesize bulk carrier market, but it is an important reference market for the Baltic Dry Bulk Shipping Index as the seasonal fluctuations are relatively frequent.

Although the trend of large-scale ships in the global dry bulk shipping market has become more apparent, Panamax-type bulk carriers still have the ability to traverse the Panama Canal compared to Capesize bulk carriers, and have a wider range of navigation areas and ports of operation and are more economical. Advantages such as speed, fuel consumption, etc., will still occupy an important position in the global dry bulk shipping market, and there is no substitute for certain routes.

Panamax bulk carriers are responsible for the global shipping of dry bulk cargoes such as grain and coal. Especially in the grain market, Panamax-type bulk carriers are currently the best type of ship. Iron ore and bauxite, fertilisers and other miscellaneous goods are also common cargo types in the Panamax bulk carrier market.

The Panamax bulk carriers can be classified into three types according to tonnage: 60,000 to 70,000 tons of normal, 80,000 tons of kamsar panamax, and 90,000 tons of post panamax. The most widely used is the 80,000-ton kamsar panamax. The main technical parameters of the kamsar panamax are 229 meters long, 32.36 meters wide, 19.9 meters deep, 14.35 meters draft with speed of 14.5 knots. The most important feature of this type of ship is that it has a large draft and a large belly, so it has more cargoes than other bulk carriers and can also pass through the Panama Canal. Therefore, this type of Panamax bulk carrier is the most popular.

2.2 Development of Global Panama Fleet

2.2.1 The Scale of Global Panamax Fleet

The transportation of dry bulk cargoes is mainly carried out by dry bulk carriers. There are mainly four types of bulk carriers, Handysize of 20,000 to 39,999 DWT, Handymax of 40,000 to 59,999 DWT, Panamax of 60,000 to 99,999 DWT, Capesize of 100,000 dwt and above. Dry bulk fleet have great influence on the expansion of the world fleet. In recent years, the tonnage and fleet size of dry bulk carriers have been increasing, and nowadays the total deadweight tons of dry cargo fleet has exceeded those of tanker fleet.

According to Clarkson statistics, until the end of May 2018, Table 2.1 shows that the number of dry bulk ships in the world is 11,210, with a total tonnage of 828.28million DWT. Among the world's dry bulk fleet, Panamax bulk carriers accounted for 24.62%.

Table 1- Fleet capacity and number of ships of various ship types in world dry bulk fleet in 2018

Ship type	No.	Tonnage(Million DWT)	%
Handysize	3386	96.9	11.73%
Handymax	3589	198.4	24.02%
Panamax	2529	203.4	24.62%
Capesize	1706	327.4	39.63%
Total	11210	826.1	100%

Data resource: Clarkson Research Studies

Table 2- The development of various ship types in world dry bulk fleet

Year	Capesize		Panamax		Handymax		Handysize	
	No.	m.DWT	No.	m.DWT	No.	m.DWT	No.	m.DWT
1998	496	78.72	885	61.39	950	43.31	3082	81.30
1999	483	77.38	906	63.04	989	45.07	2981	78.50
2000	489	79.29	940	65.62	997	45.36	2909	76.73
2001	510	83.12	997	70.02	1018	46.34	2849	75.23
2002	531	86.92	1077	76.27	1099	50.46	2770	73.07
2003	540	89.09	1109	78.98	1178	54.53	2716	71.64
2004	563	93.47	1124	80.22	1233	57.44	2680	70.70
2005	610	102.35	1203	86.31	1312	61.58	2718	72.02
2006	659	111.35	1296	93.56	1416	67.23	2761	73.14
2007	712	120.95	1394	101.47	1508	72.18	2791	73.70
2008	769	131.63	1473	107.89	1606	77.50	2879	75.80
2009	824	143.61	1548	114.21	1724	84.11	2969	77.74
2010	958	170.38	1616	120.23	1882	93.15	3031	78.88
2011	1166	209.72	1787	134.75	2202	111.38	3257	85.61
2012	1366	249.43	1969	151.23	2551	131.46	3338	89.53
2013	1508	279.48	2166	169.32	2820	147.65	3352	91.06
2014	1567	293.58	2338	184.34	3002	158.57	3304	90.44
2015	1637	308.09	2428	192.40	3128	166.79	3314	91.57
2016	1630	309.21	2450	195.21	3321	179.48	3326	92.83
2017	1652	315.17	2447	196.17	3442	188.36	3335	94.16
2018	1693	323.85	2507	201.56	3552	195.98	3362	95.95

Data resource: Clarkson Research Studies

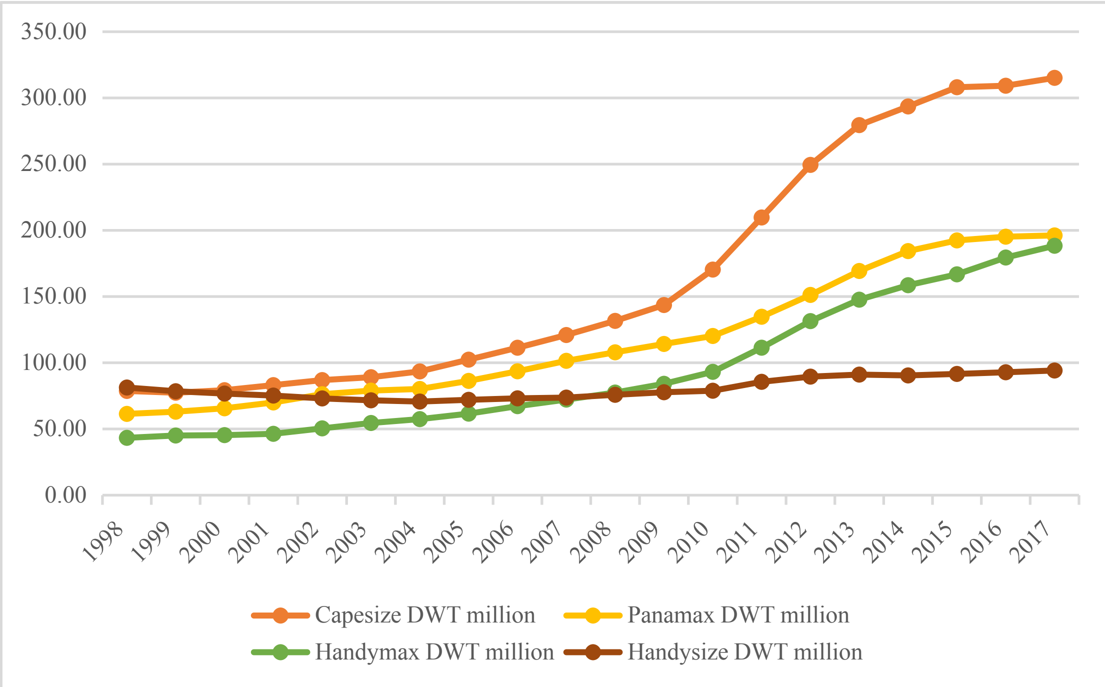

Figure 1 - The change of various ship types in world dry bulk fleet

Data resource: Clarkson Research Studies

It can be clearly seen from the figure that Capesize bulk carriers, Panamax bulk carriers, and Handymax bulk carriers of the world's dry bulk fleet have been growing from 1998 to 2018, with Panamax bulkers steadily growing. It can be seen that Panamax bulk carriers have always been favored by dry bulk carriers. The Panamax shipping capacity will develop more steadily in the next few years. In the next few years, the number of demolition of older ships will increase, but there will be more new ships, so the proportion of the entire dry bulk fleet will increase year by year, and the age of ships will show a young trend.

2.2.2 Age Struture of Global Panamax Fleet

By the end of May 2018, there were a total of 2,529 Panamax bulk carriers, including 203.04 million deadweight tons. See Table 3 for details.

Table 3 - The change of panamax bulk fleet from 1998 to 2018

Year	Deliveries		Demolition		Fleet Growth
	No.	DWT	No.	DWT	%
1998	60	4,430,282	39	2,775,014	2.70
1999	64	4,739,884	30	2,163,270	4.09
2000	63	4,813,357	3	196,098	6.71
2001	115	8,600,646	34	2,290,055	8.92
2002	58	4,423,223	23	1,508,909	3.56
2003	25	1,964,710	9	659,837	1.56
2004	79	6,091,441	0	0	7.59
2005	91	7,076,786	3	196,835	8.41
2006	107	8,508,328	7	474,304	8.45
2007	82	6,617,649	2	141,479	6.32
2008	75	5,985,941	17	1,118,430	5.86
2009	82	6,745,065	32	2,128,956	5.27
2010	172	14,564,038	9	677,849	12.08
2011	258	21,700,218	76	5,233,601	12.23
2012	326	26,925,332	127	8,710,769	11.96
2013	245	19,986,751	74	5,045,789	8.87

2014	159	12,827,789	69	4,772,150	4.37
2015	121	9,916,612	96	6,874,056	1.46
2016	114	9,406,805	116	8,353,430	0.49
2017	109	8,923,168	49	3,529,655	2.75
2018	33	2,749,360	2	144,485	1.77

Data resource: Clarkson Research Studies

Table 4 - Orderbook and delivery schedule

Year	2018	2019	2020	2021+
% Fleet	2.8	4.4	2.2	0.1

Data resource: Clarkson Research Studies

Panamax bulk carriers are responsible for the global dry and bulk ocean shipping trades such as grain and coal. Under the background that the global coal and grain shipping trade is very promising, the scale of the Panamax bulk carrier fleet has grown relatively slowly. Table 3 shows the numbers and tonnages of Panamax-type bulk carriers' deliveries and demolition from 1998 to 2018 (at the end of May) for nearly 20 years and the growth rate of the fleet. As can be seen from the table, Panamanian bulk carriers have been growing for nearly these two decades.

As shown in Table 3, the growth of the Panamanian fleet from 2005 to 2013 was rapid, and the amount of demolition was very low. The boom in the shipping market was the main reason. With regard to the delivery of new ships, the changes over the past 10 years have been considerable. As can be seen from the table, although the financial crisis in 2008 has had a certain impact on the availability of Panamax-type bulk carriers, since the 2008 Panamanian bulk carrier, Panamax-type bulk carriers still maintains a slow growth trend in terms of the number of deliveries of Panamax-type bulk carriers. In 2008, the delivery volume was down to 75, and by 2012, the delivery volume had increased to 326. The growth rate of deliveries has decreased significantly in the past five years, on the other hand, the amount of old ship dismantling reached a peak in the past five years, resulting in a year-on-year reduction in the net growth rate of the fleet.

Table 5 shows the distribution of Panamax bulk carriers and the proportion of different tonnages until May 2018. The Panamax bulk carriers more than 20 years old occupy 7.68% of the entire Panamax bulk carrier fleet. The Panamax bulk carriers, whose age is less than 10 years, occupy 63.75% of the entire Panamax bulk carrier fleet. This shows that Panamax bulk carriers have long been favored by bulk carriers businesses and have continued to the present and prove the popularity of Panamax vessels in dry bulk fleets and their long history. In Panamax bulk carrier fleet, Panamanian bulk carriers of 60,000 to 70,000 dwt accounted for the largest proportion in terms of age over 25 years, accounting for 1.2% of the entire Panamax bulk carrier fleet and the proportion of 80,000 tonnage to 90,000 tonnage Panamax bulk carrier is the smallest. In Panamax bulk carriers of less than 10 years, the largest proportion is 80,000 tons to 90,000 tons, accounting for 36.6% of the total Panamax bulk carrier fleet, and 60,000 to 70,000 tons accounts for the smallest proportion. It can be seen that the Panamax bulk carrier fleet will focus on the development of ships of 80,000 tons to 90,000 tons, reducing investment in 60,000 to 70,000-ton ships.

On the other hand, the number of demolition reached a peak in the past ten years, almost 4.4 times the amount of demolition from 1998 to 2007. At the same time, it is not difficult to be seen from Table 3.4 that the average age of Panamax bulk carriers and dismantling ships is constantly decreasing. By the end of May 2018, the average age of Panamax bulk carriers has decreased from 11.22 in 1998 to 8.92. And the average age of dismantling vessels fell from 24.71 in 1998 to 21.63. The number of vessels for more than 25 years was only 1.89%, and ships under 10 years accounted for 63.75%. With the dismantling of panamax vessels of more than 25 years of age, the entire dry bulk fleet will tend to be relatively young in the coming years.

Table 5 - Global Panamax fleet age

Age	60~70,000 DWT	70~80,000 DWT	80~90,000 DWT	90~100,000 DWT	Total	%
25 and above	30	10	2	6	48	1.89
20~24	26	116	2	3	147	5.79
15~19	0	271	12	9	292	11.51
10~14	0	295	117	21	433	17.06
5~9	0	332	508	242	1082	42.63
0~4	0	95	420	21	536	21.12
Total	56	1119	1061	302	2538	100.00

Data resource: Clarkson Research Studies

Table 6 - Average Age of Panamax Bulkcarrier Fleet and Demolition

year	Panamax Bulkcarrier Fleet - Average Age	Panamax Bulkcarrier Demolition - Average Age
	Years	Years
1998	11.22	24.71
1999	11.02	24.64

2000	10.97	26.64
2001	10.73	25.43
2002	10.43	24.88
2003	10.86	27.19
2004	11.32	
2005	11.51	30.08
2006	11.56	27.69
2007	11.72	27.63
2008	12.08	28.51
2009	12.20	28.63
2010	12.25	26.62
2011	11.46	29.31
2012	9.83	28.57
2013	8.66	26.87
2014	8.45	25.13
2015	8.43	23.05
2016	8.34	21.04
2017	8.57	22.35
2018	8.92	21.63

Data resource: Clarkson Research Studies

Chapter 3 Analysis on Demand of Panamax Bulk Carrier Market

On the global dry bulk shipping market, in terms of freight volume, according to Clarkson Research Studies, in 2017, coal seaborne trade accounted for 23.57% of total, grains(including soybean) accounted for 10.09%, iron ore accounted for 28.81%, and minor bulk cargoes accounted for 37.55%.

Table 7 - World Seaborne Dry Bulk Trade in 2017

Cargo Species	Million Tonnes	%
Iron Ore	1473	28.81%
Total Coal	1205	23.57%
Grains	516	10..09%
Minor Bulk	1920	37.55%
Total Dry Bulk	5113	100%

Data resource: Clarkson Research Studies

In recent years, the proportion of coal and grain has remained basically unchanged, minor bulk cargoes have seen a large increase, and the proportion of iron ore has dropped. However, statistics show that although the proportion of iron ore traffic is decreasing, the net transport volume still increases. The type of Panamax-shipped cargo is more desirable than that of angle-type ships, and it is less than that of handy-type vessels. Although iron ore accounts for a large proportion of dry bulk cargo, because of its routes and some other reasons, the capesize bulk carrier has assumed its main transportation volume. The following two sections provide detailed analysis of the supply and demand conditions of the two main cargo coals and grains on Panamax ships.

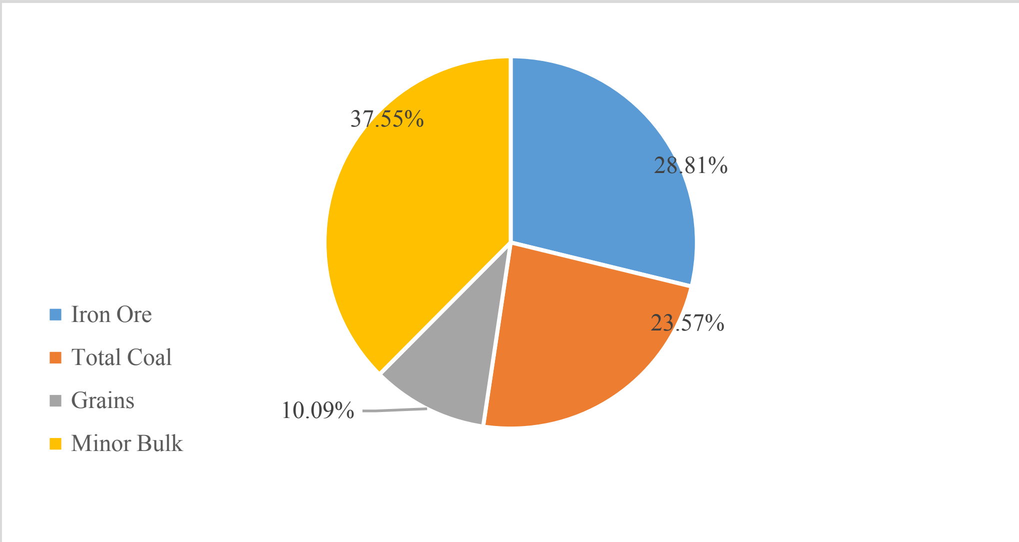

Figure 2 - World Seaborne Dry Bulk Trade in 2017

Data resource: Clarkson Research Studies

3.1 Characteristics of main cargo species of global Panamax market

The main transport cargo types of Panamax bulk carriers are coal and grain. Changes in the demand for coal and grain will directly affect the growth of demand for Panamax-type bulk carriers.

The grain transportation market has been relatively stable for a long time, and it has certain leverage adjustment effects on the international dry bulk shipping market. Panamax-type bulk carriers have a distinct advantage in the grain transportation market. Compared with Capesize bulk carriers, they have a smaller cargo capacity but they can take the Panama Canal to and from the Atlantic and Pacific Oceans, with no need to bypass the Cape of Good Hope to save operating costs (including fuel consumption and voyage time) and no need to be limited by loading and unloading of port terminals and waterways. Due to the small loading capacity of Handysize bulk carriers on the market, unit freight costs are difficult to compete with Panamax vessels. As a result, Panamax bulk carriers account for almost 60% of the grain transportation market and have an absolute advantage.

Coal is the second type of cargo carried by Panamax bulk carriers. In recent years, the volume of coal shipping has been increasing year by year, and Panamax bulk carriers have accounted for more than 40% of the coal transportation market. The demand for Panamax bulk carriers in the coal market mainly comes from the ports of China, South Korea, India, and some European countries that have imported restricted thermal coal (mostly power plants).

The share of Panamax bulk carriers in the iron ore transportation market has gradually shrunk, mainly by the impact of Capesize bulk carriers. Most of the current shipments of iron ore cargo alone are more than 150,000 tons, and Panamax bulk carriers can only make guerrillas on the market. In addition, the Panamax-type bulk carrier industry occupies a certain share in the marine market of bauxite, fertilizers, manganese ore, coke, etc., but the overall flow of these cargoes is not large, and the impact on the market is limited, but there may be more in the future. More shipments appeared.

3.2 Coal

Coal is mainly divided into thermal coal and coking coal. The seaborne demand for thermal coal comes mainly from energy consumption and electricity production, while the seaborne demand for coking coal comes from steel production.

Coal seaborne exporting countries are mainly Australia, South Africa, the United States, Canada and China. The importing regions are mainly Western Europe and Japan. In the Pacific Rim, South Korea, Southeast Asia, and South American countries have also increased their imports year by year. By region, the coal shipping market can be divided into Pacific, Atlantic and Indian Ocean markets. The flow of goods in the Pacific market is mainly north of the Australian coast to Japan, and the eastern coast of the United States is across the Pacific Ocean to Japan via the Panama Canal. The cargo flow of the Atlantic market is to the east coast of the United States across the Atlantic to Western Europe, and the east coast of South Africa bypasses the Cape of Good Hope northward along the west coast of the African continent to Western Europe. The flow of the Indian Ocean market is from Australia to Western Europe, South Africa to Japan, South Korea and Taiwan. Of the three major regional markets, only the Indian Ocean routes have East and West routes, and other markets have only one-way routes.

The two oil crises of the last century forced many oil consumers to use thermal coal as an alternative to petroleum. However, in recent years, due to the improvement of technology and the proportion of the use of sinters, the quality of coke has been improved, and the demand for pig iron coke units has decreased. In addition, with the saturation of iron and steel production, the consumption of steel has also dropped, which has also reduced the demand for coke. As a result, the volume of coal shipped by sea has risen slowly since 1998.

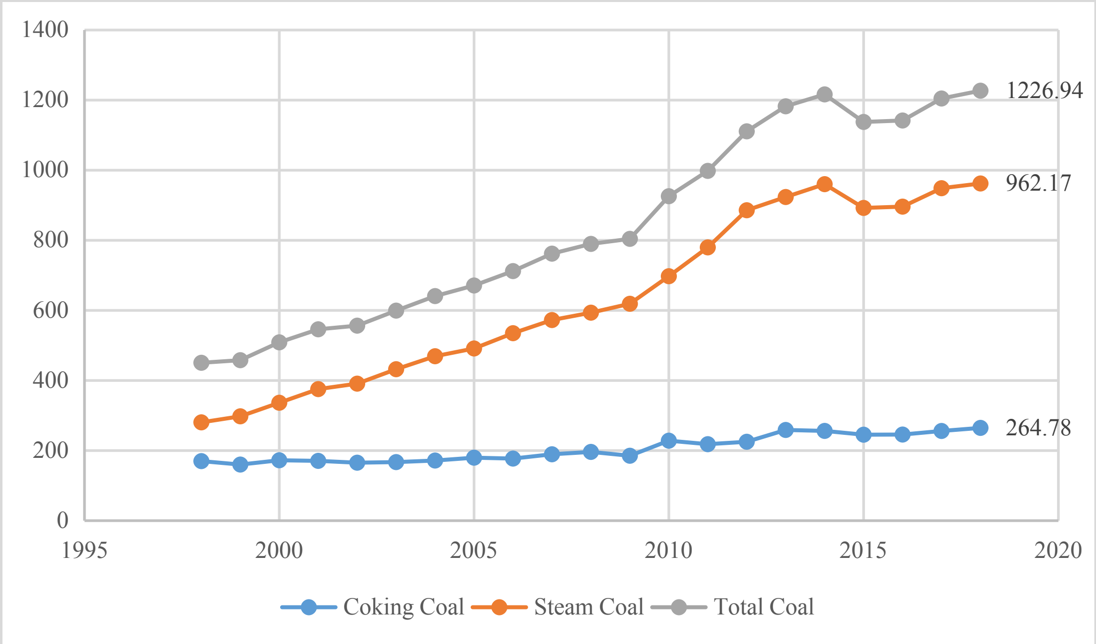

Figure 3 - Global Coal Shipping Volume from 1998 to 2018

Data resource: Clarkson Research Studies

3.2.1 Analysis on Main Importers of Coal

Major coking coal import countries include France, Germany and Italy in Europe, Japan, India, Korea and China in Asia, and Brazil and Eastern Europe. The export volume of coking coal in major countries from 2009 to 2017 is shown in Table 8. As can be seen in Table 8(b), Asia has the largest import of coking coal, accounting for 74% of the world's total coking coal imports, followed by Europe. Japan in Asia almost continued its largest import of coking coal in 2009, and the demand in China and India also showed a rapid expansion, especially China's demand for coking coal. EU's import of coking coal in Europe continues its leading position in recent years. In Europe, Germany's still largest import of coking coal in the European Community, but affected by the financial crisis, the import volume of Germany has fallen compared to the previous year. France, Italy, the United Kingdom, Belgium and other European countries have also reduced their imports of coking coal. France has the largest decline in coking coal. In countries other than Asia and Europe, Brazil's imports of coking coal have been increasing. Despite the financial crisis, Brazil's imports of coking coal have continued to increase.

Table 8 - Major Importers of Coking Coal and Import Volume from 2009 to 2017

(a) Imports to Europe

	2009	2010	2011	2012	2013	2014	2015	2016	2017
France	3.6	5.0	4.0	5.3	5.7	5.4	4.0	2.9	2.7
Germany	6.9	9.0	9.7	9.5	10.1	11.8	12.7	12.3	12.8
Italy	3.8	6.6	6.6	5.8	4.3	3.2	3.1	3.6	3.2
Netherlands	2.9	3.5	3.6	3.6	3.4	3.5	3.7	3.7	3.9
Spain	2.1	2.8	2.5	2.3	2.5	1.7	1.7	1.8	1.8
Poland	1.1	2.3	1.8	1.0	1.7	1.6	2.1	1.9	2.8
UK	5.5	6.1	5.4	4.9	5.7	6.0	4.7	2.9	2.6
EU	32.4	45.6	45.5	42.2	42.5	42.2	41.1	37.9	39.2
Turkey	5.2	5.5	4.4	4.6	5.1	5.5	5.4	5.1	5.4
Ukraine	0.6	1.0	3.0	3.0	2.3	2.6	3.9	2.9	3.6

(b) Imports to Asia

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Japan	49.5	58.8	54.4	53.9	56.6	53.4	50.9	53.8	53.9
India	29.8	36.3	34.8	37.7	39.6	47.1	51.3	51.1	52.2
China	30.5	32.2	24.6	34.6	58.8	47.2	35.2	35.4	43.2
S.Korea	16.0	18.9	22.0	20.9	21.4	24.4	25.2	24.7	24.7
Taiwan	3.7	9.2	9.3	9.2	10.5	10.9	10.7	11.2	10.6

Vietnam	0.2	0.3	0.0	0.2	0.4	0.5	1.2	2.7	3.1
Asia	130.4	156.6	145.5	157.2	188.4	185.5	176.9	181.2	189.5

(c) Imports to other countries

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Argentina	0.7	1.0	1.0	0.9	0.9	1.1	1.0	0.8	0.8
Brazil	11.5	12.8	12.7	12.4	12.8	14.5	14.0	14.4	14.3
South Africa	0.8	1.5	1.1	1.1	1.0	0.9	0.9	1.2	1.1

Data resource: Clarkson Research Studies

The thermal coal import countries include Germany, Denmark, Italy in Europe, Japan, Korea, China, Taiwan in Asia, and countries such as the United States and Israel. As can be seen from Table 9, Asia's import of thermal coal has been at the top of the list for eight years. In 2017, Asia's import of thermal coal accounted for 80% of the total global thermal coal imports. Japan and South Korea have maintained a steady growth trend in recent years. In 2017, Japan and South Korea accounted for 33% of the total thermal coal imports in Asia. China and India have seen a rapid growth in the import of thermal coal as well. However, in recent two years, India's thermal coal imports have shown a slight decline. China's import of thermal coal has experienced a sharp drop in 2015 and has since grown again.

Table 9 - Major Importers of Thermal Coal and Import Volume from 2009 to 2017

(a) Imports to Europe

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
France	10.1	11.2	9.7	10.9	10.5	7.7	8.4	9.3	11.8
Germany	27.2	28.5	29.5	30.2	36.3	41.2	39.6	39.7	33.3
Italy	14.7	14.8	16.2	19.5	16.1	16.2	16.6	13.8	12.6

Netherlands	10.5	11.4	11.3	10.8	10.3	12.3	14.3	12.9	11.6
Spain	13.1	8.6	12.8	19.6	10.6	14.0	16.3	11.4	16.6
Portugal	4.4	2.7	3.6	5.0	4.2	4.4	5.1	5.2	5.6
UK	31.0	17.2	26.3	37.1	39.6	32.4	17.2	4.9	4.8
EU	129.1	112.7	135.1	147.6	145.1	142.6	130.2	108.4	107.2
Turkey	5.5	6.2	8.5	13.5	11.8	14.0	17.2	18.6	19.6

(b)Imports to Asia

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
China	61.2	109.1	141.0	194.1	204.9	191.4	128.4	164.8	174.0
India	61.4	75.9	94.9	123.8	143.0	177.8	170.7	148.3	150.5
Japan	108.1	119.5	115.5	125.3	129.4	129.9	133.8	130.0	132.6
S.Korea	81.0	92.7	98.2	96.6	96.6	96.4	100.9	100.4	116.5
Taiwan	55.8	54.6	57.5	56.3	57.0	56.0	55.8	54.0	58.6
Malaysia	13.6	20.7	23.3	22.0	22.7	21.2	19.9	24.2	33.9
Thailand	15.9	16.4	16.5	18.4	17.9	20.8	21.7	21.8	22.9
Philippines	8.4	11.1	11.0	11.6	14.7	15.4	16.7	19.8	21.2
Pakistan	4.4	3.8	2.5	3.4	3.4	4.6	4.9	6.7	11.1
Vietnam	1.5	0.8	1.4	1.6	2.1	1.9	3.1	7.5	10.2
Asia	424.0	516.2	575.4	666.9	707.7	737.7	679.4	701.4	754.7

(c)Imports to other countries

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
US	19.2	14.9	10.1	5.9	6.8	8.5	8.3	7.7	6.2
Israel	12.4	12.6	12.8	13.8	13.1	12.3	9.7	8.2	8.6
Chile	4.7	6.6	8.4	9.4	10.4	9.3	9.3	11.2	11.4
Morocco	4.5	5.1	4.7	4.7	4.7	6.6	6.4	6.7	6.8

Data resource: Clarkson Research Studies

The data shows that as Chinese seaborne coal imports increased by 45% year-on-year to 58 million tons in the first quarter of 2018, total coal imports in China fell by 10% year-on-year in April. This shows that China's steam coal imports accounted for 81% of the country's coal imports in the first quarter and began to decline as the winter season began. It is expected that by the rest of 2018, China's thermal coal imports will decline, as it is expected that domestic production will expand, and it is expected that the shortage of natural gas will be eased, and the hydropower generation is expected to rebound after 2017 weakness. Overall, China's current shipments of seaborne thermal coal are expected to increase slightly to approximately 176 million tons in 2018. At the same time, European thermal coal imports are expected to decline again in 2018, with a slight increase for the first time since 2017, which is the first time since 2012.

It is expected that the global seaborne thermal coal transaction will increase by 1% to 962 million tons in the entire year of 2018. Most of the supply side growth is expected to be supported by Indonesia, Australia and Russia. It is expected that Indonesia's exports will continue to be supported by stable growth in demand from emerging Asian countries such as Vietnam, Malaysia, and the Philippines in 2018, while Australia's exports are expected to partially recover from several interruptions in 2017. Russia's exports are expected to continue to grow in 2018, supported by improved infrastructure and railways.

3.2.2 Analysis on Main Exporters of Coal

The world's three largest coal producers are Australia, South Africa, and the United States. Countries such as the United Kingdom, Spain, Germany and France in Western Europe, and India, Indonesia and China in Asia are also coal-producing countries. Coking coal is mainly exported to Australia, Canada, the United States, China and other countries.

As can be seen from Table 10, the export volume of coking coal in Australia has been the leading position in the past eight years, and its coking coal exports accounted for more than half of the total world coking coal exports. Affected by the financial crisis, the export volume of coking coal in Canada and the United States declined in the middle of the year. Table 11 shows that in the total export of thermal coal in the world, the proportion of exports from Australia and Indonesia is close to the total amount. The export of coking coal in China in the past few years was very large, but it has declined rapidly in recent years. In recent years, China's exports of coking coal have declined. It can be seen that almost all of the coking coal produced in China is used in domestic production and is not exported. In 2017, China only exported 35,000 tons.

In 2018, Australia's export of coking coal will continue to grow. It is predicted that the export of coking coal will reach 153.1 million tonnes by the end of the year. The United States will reduce the import of coking coal in 2018. In the first half of the year, the volume of seaborne shipments from the United States dropped to 44.1 million tonnes of tonnes, a decrease of 5% year-on-year.

Table 10 - Export Data of Major Coking Coal Exporters from 2009 to 2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Australia	114.8	134.3	111.3	114.5	138.0	149.9	150.6	154.5	144.5
Canada	20.6	26.1	26.3	29.8	34.4	30.4	27.2	27.3	27.8
US	31.6	47.8	59.3	59.0	56.4	53.2	37.9	33.4	46.4
Russia	8.6	14.7	12.7	11.5	15.3	15.2	14.0	15.4	18.5
Mozambique	0.0	0.0	0.0	1.6	2.4	2.6	3.6	2.8	5.0
Total	185	228	218	225	259	256	245	246	256

Data resource: Clarkson Research Studies

Table 11 - Export Data of Major Thermal Coal Exporters from 2009 to 2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Australia	143.8	156.2	161.1	194.2	210.2	228.5	229.4	229.1	220.8
Indonesia	232.3	298.5	353.3	384.0	415.5	416.6	365.0	363.3	386.0
US	11.1	13.4	31.6	48.6	43.4	31.5	23.7	16.1	36.7
S.Africa	66.6	70.1	68.6	75.0	72.7	76.3	77.4	75.9	81.5
Russia	59.4	56.3	65.3	76.3	80.0	95.6	96.9	105.0	118.4
Colombia	63.4	69.2	76.1	79.4	76.9	80.5	82.0	87.1	85.5
China	18.5	13.5	6.7	4.5	3.4	2.5	1.1	3.7	3.5
Total	619	698	780	886	924	960	892	896	949

Data resource: Clarkson Research Studies

3.3 Grain

Grain transport is of outstanding importance. For Panamax vessels, grain transportation is an exclusive maritime transportation business. Capesize vessels, although carrying a relatively large amount of cargo, cannot access the Panama Canal across the Pacific Ocean in the East Asian region. Only through the Cape of Good Hope, the freight costs of the cargo owners are high, and It also needs to be restricted by the loading and unloading of port terminals and waterways. On the other hand, the shipment volume of Handymax ships is relatively small, and unit freight costs are difficult to compete with Panamax ships. However, at present, the Panama Canal has already undergone a major expansion plan, and soon the Capesize can pass through the Panama Canal. There may be significant changes in the shipping requirements for Panamax grain shipments.

At present, cereals and grain goods in international trade are mainly divided into wheat, coarse grains and soybean according to European and American habits. Wheat is divided into hard, soft, winter wheat and spring wheat, while coarse grains include corn, sorghum, barley and oats.

The most prominent feature of the grain transport pattern is that U.S. exports account for an overwhelmingly dominant position. In the past few years, U.S. exports far exceeded other major exporting countries such as Australia, Argentina, Canada, and the European Union; Mainly in Africa and Middle East countries.

Another characteristic of grain transportation is that due to the different seasons and climate changes in the northern and southern hemispheres, the peak harvest periods of major exporting countries are all different, and the amount of available exports often varies greatly. The seasonality of grain transportation is relatively strong. Usually the seasonal peaks of grain transportation in South America and North America are in January and July each year. This time has a greater impact on the supply and demand relationship of transport capacity. Most grain transportation is long-distance transportation, such as US Gulf/Japan, South America/China and so on.

Currently only less than one-third of Panamax ships are used for grain transportation. However, due to the fact that most of grain transportation is long-distance transportation, such as the US Gulf/Japan, South America/East Asia, etc.. therefore, the demand for transportation capacity based on the turnover volume is much greater. About 85% of the current global grain shipments are carried by Panamax vessels, and 45% of its total revenue comes from grain transportation operations. However, judging from the data for the past ten years, the annual grain growth has been limited. The following is a detailed analysis of the major export and import areas of the World Grain.

3.3.1 Analysis on Main Importers of Grain

The main grain import countries and regions in the world are relatively scattered, with Japan, other parts of Asia, the Middle East, Eastern Europe and Western Europe, Central America and South America, and Russia and some CIS countries. The grain grain import volume of all regions in the world from 2009 to 2017 is shown in Table 12.

Although grain imports are relatively scattered, from Table 12, it is not difficult to find that Asia is the largest grain importer, accounting for nearly 33.2%, followed by Africa and the Middle East. Import demand in Asia mainly comes from Japan and South Korea. The country with the largest import volume in Africa is Egypt, which accounts for almost all of Africa's total imports, followed by Algeria and Morocco. The demand for imports from the Middle East is mainly from Iran and Saudi Arabia, and other countries are even. Countries with large import volumes in South America are mainly Brazil, Colombia and Venezuela. In Europe, the CIS countries account for the majority of imports. Import demand in Central America is mainly from Mexico.

Table 12 - Major Importers of Grain and Import Volume from 2009 to 2017

(a) Imports to Europe

	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18(F)
CIS	5.8	6.3	8.6	7.9	8.0	8.1	7.6	7.6	7.5
EU	7.7	13.3	13.8	16.7	20.3	15.7	21.4	19.7	22.4
Other	2.2	2.2	2.4	2.3	2.8	2.7	2.8	2.9	2.9
Total	15.7	21.8	24.8	26.9	31.1	26.5	31.8	30.2	32.8

(b) Imports to Asia

	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18(F)
Japan	25.4	24.7	23.1	24.3	23.4	21.9	22.1	23.2	22.5
China	4.0	4.8	10.1	9.4	18.3	25.7	22.9	20.4	20.2
S.Korea	12.2	12.5	12.0	13.5	13.4	14.2	14.1	13.5	14.6
Taiwan	5.8	5.7	5.9	5.7	5.5	5.4	6.0	5.5	6.5
Indonesia	6.5	9.6	8.0	9.5	10.9	11.2	12.5	10.7	12.9
Philippines	3.1	3.3	4.2	3.7	4.2	5.6	5.5	6.3	6.3
Malaysia	3.8	4.6	4.3	4.4	4.9	4.8	5.3	5.3	5.6
Bangladesh	3.9	4.1	2.1	2.8	3.8	4.0	5.4	6.5	7.6
Pakistan	0.2	0.1	0.1	0.0	0.4	0.8	0.4	0.1	0.1
Sri Lanka	1.2	1.1	1.0	0.7	0.9	1.2	1.1	0.9	1.1

N.Korea	0.1	0.2	0.3	0.3	0.2	0.2	0.2	0.1	0.2
Thailand	1.8	2.3	2.7	1.8	2.1	3.9	5.2	4.0	3.8
Vietnam	3.4	3.7	4.0	3.2	4.9	8.0	10.3	14.4	13.3
Total	75.5	80.2	80.9	82.7	96.8	110.6	117.1	122.4	120.1

(c)Imports to Middle East

	09/10	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**	**17/18(F)**
Iran	7.6	4.2	7.3	11.0	12.2	13.7	10.6	10.0	11.0
Iraq	3.9	3.5	3.9	4.0	3.1	2.2	2.4	2.7	3.7
Yemen	3.1	3.1	3.1	3.7	4.0	3.8	3.7	3.8	3.9
Israel	3.1	3.0	3.3	3.0	3.6	3.1	3.1	3.4	3.6
Saudi Arabia	10.8	9.0	13.4	12.5	15.1	15.0	17.7	15.1	15.8
Jordan	1.7	1.8	1.7	1.9	2.3	2.7	2.8	2.8	2.9
Turkey	4.0	4.0	5.1	5.2	5.7	8.8	6.1	6.1	7.2
Total	42.5	34.9	45.7	48.3	54.0	56.7	55.8	53.5	59.9

(d)Imports to South America

	09/10	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**	**17/18(F)**
Brazil	8.0	7.3	8.0	8.8	8.3	6.8	7.6	11.3	8.9
Colombia	5.2	5.5	5.4	5.8	6.5	6.0	6.8	6.9	7.3
Ecuador	1.0	1.1	1.1	0.8	0.8	1.1	1.1	1.3	1.1
Peru	3.5	3.9	3.6	3.8	4.4	4.7	4.9	5.3	5.6
Venezuela	3.6	2.8	3.8	3.7	4.5	3.6	3.4	2.3	2.9
Total	23.9	23.1	24.8	25.8	27.9	25.9	28.0	31.0	30.6

(e)Imports to N/C America

	09/10	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**	**17/18(F)**
Cuba	1.5	1.5	1.5	1.7	1.7	1.7	1.7	1.8	1.7
Mexico	14.2	13.4	18.2	11.6	15.1	15.6	19.3	20.1	21.7

Others	11.0	11.7	8.7	11.8	11.4	10.1	9.9	9.9	11.3
Total	29.2	27.7	29.7	32.8	32.8	33.4	37.2	37.5	40.5

(f)Imports to Africa

	09/10	**10/11**	**11/12**	**12/13**	**13/14**	**14/15**	**15/16**	**16/17**	**17/18(F)**
Egypt	15.6	16.3	18.4	14.0	17.9	18.9	20.7	19.6	22.0
Algeria	7.5	9.2	9.7	9.6	11.7	12.6	13.2	13.3	12.6
Zimbabwe	0.5	0.4	0.4	0.5	0.7	0.6	0.9	1.1	0.1
Ethiopia	1.1	0.4	1.4	1.3	0.6	1.0	2.4	0.9	1.5
Libya	3.2	2.3	2.2	3.0	3.4	3.1	3.1	3.6	3.2
Morocco	4.4	6.1	5.3	5.8	6.4	6.6	7.2	7.7	7.1
Sudan	2.2	1.8	2.7	1.9	2.8	2.8	2.2	2.6	2.7
S.Africa	1.7	1.8	2.1	1.5	2.1	2.1	5.0	3.8	2.2
Tunisia	2.3	3.1	2.4	2.9	3.3	3.0	3.6	3.7	3.4
Total	52.6	53.1	58.6	55.5	65.2	67.3	76.2	75.9	76.0

Data resource: Clarkson Research Studies

According to temporary customs data, China's soybean imports fell by 4% to 28 million tons from January to April in 2018, year-on-year trends indicating a decrease in imports from the United States and strong imports from Brazil. Although this may partially reflect the more competitive pricing and higher protein content of Brazilian soybeans and US soybeans, recent reports show that with the proposed US soybean import tariffs, China has reduced its purchases of the United States. Whether tariffs will be implemented and when they are implemented, and if the potential impact of the implementation of tariffs on soybean trade volumes remains uncertain.

3.3.2 Analysis on Main Exporters of Grain

The main grain export countries are the United States, Canada, Argentina, Brazil, Australia and France. The amount of grain exports per year for all countries and regions in the world is shown in Table 13.

As can be seen from the following table, the United States is the world's major grain exporter, accounting for 27.6% of the total grain exports of the world. EU, Canada, Australia, and Argentina's four regions and countries have a similar number of exports, occupying a market share that is not the same. The major difference is that the EU, Canada, and Australia mainly export wheat, and wheat exports account for the majority, especially Australia and Canada.

Table 13 - Export Data of Total Grain Exporters from 2009 to 2017

	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18(F)
Argentina	20.0	26.1	31.5	35.2	17.4	26.8	30.7	38.4	42.5
Australia	18.0	23.2	30.2	27.2	25.6	23.5	22.0	31.9	25.1
Canada	21.4	21.0	21.7	23.4	28.0	29.1	26.2	24.8	26.8
EU	23.6	28.1	21.9	28.3	40.0	48.1	47.0	34.6	30.5
US	79.2	87.7	72.6	49.8	78.6	79.2	76.7	97.4	83.2
Russia	22.0	4.3	27.2	15.5	25.3	30.6	34.6	35.9	48.9
Ukraine	21.0	12.2	21.5	23.0	32.2	34.1	39.4	44.3	41.2
Others	35.2	40.1	43.0	68.3	62.8	50.7	69.1	44.9	63.5
Total	240	243	270	271	310	322	346	352	362

Data resource: Clarkson Research Studies

3.4 Other Factors Affecting the Freight Rates of Panamax Bulk Carriers

Other non-economic factors related to the international shipping industry are also important factors causing price fluctuations. Changes in climate in the four seasons of the natural world have an effect on the surface environment reflected in the ocean, more intense than in any other area. In different seasons, ships sailing on the sea face different natural conditions, resulting in differences in the cost of navigation in different seasons and the differences in seaworthiness of ships in different seasons. This determines the seasonal shipping costs and capacity of shipping capacity in different seasons. Seasonality thus arises. In general, the cold and windy season increased freight rates, while the summer season was just the opposite. The activities of the consumers transporting labor services are also seasonal. The production, storage, trade, and consumption of various physical goods have obvious seasonality, which makes the demand for shipping goods inevitably seasonal. The seasonality of both supply and demand activities in the shipping market inevitably leads to seasonal fluctuations in freight rates. However, the consumption and production of commodities, such as grain, coal, and ore, which are mainly carried by dry bulk shipping vessels, have a more intense seasonality, leading to seasonal fluctuations in international dry bulk shipping prices.

International political and military incidents are the causes of random fluctuations in freight rates. International political and military incidents mainly include sudden changes in international relations, wars between nations, coups and civil wars in one country, changes in the government of one country, and nationalization of one country. These events may affect the growth of the world economy, or change the flows of trade relations and goods, or change the average distance, or change the trade volume of individual commodities, and thus affect shipping demand. Their impact on shipping demand has emergent characteristics, which in turn cause fluctuations in freight rates.

As an important part of the international market, the international shipping market is in the complex environment of the world economy and international trade and is affected by many factors. The characteristics of the completely competitive market in the international dry bulk shipping market make it more open and competitive, and the factors that affect the market are more complex. The next chapter discusses how these decisive factors influence the freight of Panamax bulk carriers specifically.

3.5 Research on BPI fluctuation law

The freight rate is a "barometer" reflecting the supply and demand of dry bulk shipping, and is an effective lever to adjust the shipping capacity of dry bulk shipping market. Due to the non-linearity and uncertainty of the freight system for dry bulk shipping market, as a kind of price index, the freight index is an important method for analyzing the freight system of dry bulk shipping market, and the freight rate in the shipping market. Study the fluctuation law of the freight index and explore its development trend has been increasingly valued by people.

The dry bulk freight index is the average freight rate for selecting a number of major routes, which means a comprehensive index calculated based on different weights reflects the freight rate of the international dry bulk shipping market. The Baltic Shipping Exchange has successively issued a series of dry bulk freight rates, such as the BFI (BDI in 1999), which include the Handsize Freight Index(BHI), the Panamax Freight Index (BPI), and the Capesize Freight Index (BCI). Its ups and downs to a certain extent indicate the trend of economy and trade. Therefore, using an effective method to analyze how influential factors affect freight index is of great significance to both the ship operators and the cargo shipper.

In order to grasp the economic cycle fluctuations in a timely and accurate manner, monthly or quarterly data are generally used for analysis and forecasting. For each monthly or quarterly time series of economic indicators, this paper selects 242 data spans 20 years from May 1998 to May 2018 to study its regularity. The data curve is shown in the figure.

Figure 4 - BPI from May 1998 to May 2018

Data resource: Clarkson Research Studies

From the index charts of the past two decades, the BPI began to rise in 2003, especially in 2007 and 2008, and reached the highest point in history in October 2007. It has risen by nearly 10,000 points in less than two years. The main reasons for this are the improvement in the economy and the continuous increase in supply of ships, which helps the index grow crude oil to rise and the cost of bulk carriers to increase.

As a result, freight rates rose upwards to traditional peak seasons for bulk shipping, such as increased demand for coal in the winter in the northern hemisphere and a positive value for cereals. Harvesting season will also increase the price of bulk shipping. In addition, there may be war factors, the supply of bulk ships during the war is bound to reduce, resulting in a substantial increase in bulk freight rates.

However, in 2008, the index volatility was extremely high. From the beginning of the year 2008, the slow and steady transition of the index once rose to the high point of May 2008, and since then BPI has continued to decline quickly. This is mainly due to the impact of the global economic environment, which caused the renters of Panamax boats to significantly reduce the demand for chartering on grain, iron ore and coal pallets, especially in the Atlantic region due to the overcapacity, resulting in the modern round-trip Chartered and voyage chartered rentals have fallen to their lowest level since the beginning of the year. Even during the historical downturn in 2008, the daily rent on the Atlantic round-trip flight remained at a relatively high level. In this context, shipowners of the Atlantic region have already prepared for the market to continue to sharply lower their psychological preparations, and brokers said that some grain trade predators in the region, such as companies, will use their market-leading forces to further promote the market downwards. It will drive more renters to wait and wait to postpone the transaction. Given the increasing risk of sudden bulk cargo shipments, market participants pointed out that more coal and grain operators use their own vessels and carry their own cargoes to avoid the huge market risk and may become the new pattern of dry bulk cargo transportation in the future.

In addition, the factors causing severe fluctuations of BPI in 2008 were the decrease in demand for iron ore in China and the delay in the US government ' s failure to implement a financial rescue plan, which made the market even less optimistic about the prospects of dry bulk shipping industry. During the Beijing Olympics, many factories were suspended, resulting in trade volume declining, and due to the global financial crisis, many factories have not fully restored the sound field. The Chinese steel industry has continued to lack of demand, coupled with stagnant production of the golden week, leading to major iron ore exporting destinations such as Brazil and India. Due to the drop in steel prices, some Chinese steel companies cut production and wait to see prices rise.

The fluctuation of BPI reflects the fluctuation of the Panamax bulk carrier market. In figure 4, it can be observed that the volatility from January 2009 to September 2010 is relatively unstable, but from the overall trend, BPI has gradually emerged from the bottom of the financial crisis, and gradually tends to turn for the better. From this, it can be seen that although the Panamax-type bulk carrier market has undergone major changes in market fluctuations, the Panamax-type bulk carrier market has gradually emerged from the trough.

Looking at the long-term cycle, BPI has returned to a more stable state after the sharp rise and fall before and after 2008. The reason is that the Panamax bulk carrier market has been relatively stable, except for big fluctuations resulting from global economic and financial behavior. Moreover, with the rising of developing countries in the future and the influence of China's "One Belt One Road" policy, the Panamax bulk carrier market is still expected to climb again.

Chapter 4 VAR Analysis on Panamax Bulker Market

This chapter mainly uses VAR model to describe the relationship between BPI and some of its influencing factors, and analyzes the degree of impact.

4.1 Analysis model

4.1.1 Introduction of VAR model

The Vector Auto-Regressive (VAR) model is a multivariate data analysis method first proposed by Sims (1980). The model is not based on economic theory. It directly considers the relationship among various economic variables in the time series, adopts the form of multiple equations, and regards each endogenous variable in the system as a function of the hysteresis value of all endogenous variables in the system to construct the model. In each equation of the model, the endogenous variable to the regression model of the regression model of all the endogenous variables, and then estimate the dynamic relationship of all endogenous variables and make predictions, which becomes one of the mainstream models of macroeconomic research. The general form of the model is:

$$Y_t = \alpha + \sum_{1}^{p} \beta_i Y_{t-i} + \zeta_t$$

Among this, E(ζ_t) = 0, E(ζ_t , Y_{t-i}) = 0, i = 1, 2...p; Y_t is a homoskedastically stationary linear stochastic process consisting of (n*1) vectors , and β_i is coefficient of a (n*n) matrix. Y_{t-i} is an i-order lagged variable of a vector Y_t. ζ_t is a random perturbation term that satisfies the classical assumptions of zero mean, homoscedasticity, no autocorrelation, and no explanatory variables.

4.1.2 Selection of data and variables

This article selects the 180cst oil prices, the delivery of the Panamax bulk carrier, and the coal and grain shipments as the four independent variables, average of the four major routes BPI index as a dependent variable for analysis. All data is selected from January 1998 to May 2018 by month.

4.2 Unit root test of variables

Time series analysis requires that the relevant time series must be stationary, otherwise, it may lead to "pseudo-regression" problems. And the estimated coefficient of each variable obtained by least-squares method is also not an optimal linear unbiased estimator, so the prediction based on this prediction will lost its effectiveness. In view of this, before performing various statistical analysis of the statistics, the time series must be tested for stationarity. The most common and most effective test method is the Unit Root Test. This article uses the most commonly used ADF (Augmented Dickey-Fuller Test) unit root test method to determine the smoothness of each time series.

The ADF test method controls higher-order sequence correlation by adding the lag differential term of the dependent variable y_t to the right of the regression equation.

$$\Delta y_t = \eta y_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta y_{t-i} + u_t, t = 1,2,\ldots,T$$

$$\Delta y_t = \eta y_{t-1} + \alpha + \sum_{i=1}^{p-1} \beta_i \Delta y_{t-i} + u_t, t = 1,2,\ldots,T$$

$$\Delta y_t = \eta y_{t-1} + \alpha + \delta t + \sum_{i=1}^{p-1} \beta_i \Delta y_{t-i} + u_t, t = 1,2,\ldots,T$$

Test hypothesis : $H_0 : \eta = 0$;

$H_1 : \eta < 0$

The original hypothesis is that there is a unit root in the sequence: the alternative hypothesis is: There is no autocorrelation in the sequence. In order to eliminate the possible heteroscedasticity of the original data sequence, this paper takes the logarithm of the original data and denotes them as LNY, LNX1, LNX2, LNX3, and LNX4. So, in the text below, LNX1 means the value of 180cst oil prices after taking the logarithm, LNX2 means the value of the delivery of the Panamax bulk carriers after taking the logarithm, LNX3 and LNX4 means the value of the coal and grain shipments after taking the logarithm. And LNY means the value of BPI index after taking the logarithm. The unit root test results are shown in Table 14.

Table 14 - Unit Root Test Results

Variables	Test form (C,T,K)	T-test value	Critical value of inspection			P value	Is it stable
			1%	5%	10%		
LNY	(C,T,1)	-2.936676	-3.997250	-3.428900	-3.137898	0.1529	no
DLNY	(C,T,0)	-12.32300	-3.997250	-3.428900	-3.137898	0.0000	yes
LNX1	(C,T,2)	-1.974802	-3.997418	-3.428981	-3.137946	0.6116	no
DLNX1	(C,T,1)	-9.756206	-3.997418	-3.428981	-3.137946	0.0000	yes
LNX2	(C,T,3)	-2.451791	-3.997587	-3.429063	-3.137995	0.3520	no
DLNX2	(C,T,2)	-15.67262	-3.997587	-3.429063	-3.137995	0.0000	yes
LNX3	(C,T,2)	-1.349948	-3.997418	-3.428981	-3.137946	0.8727	no
DLNX3	(C,T,1)	-17.18076	-3.997418	-3.428981	-3.137946	0.0000	yes
LNX4	(C,T,12)	-2.850446	-3.999180	-3.429834	-3.138449	0.1810	no
DLNX4	(C,T,11)	-5.142144	-3.999180	-3.429834	-3.138449	0.0002	yes

Note:

1.C indicates that the test form contains an intercept term; T indicates that the test form contains a trend item, and if there is no trend item, it is represented by 0; K indicates the lag order.

2. DLNM0, DLNB represent first-order difference of LNM0 and LNB.

3.P value is automatically selected by Eviews8.0 software according to SIC criteria.

From the test results in the above table, we can see that according to the SIC criterion, the unit root test value of all variables is greater than its corresponding critical value at a confidence level of 5%, so the original sequence is non-stationary at the 5% level of significance. However, after the first-order difference, the original hypothesis was rejected at a confidence level of 5%, showing a smoothness, that is, all the variables were first-order integer I(1). From the test of stationarity, we can see that each time-variable sequence has the same order monotonicity and satisfies the cointegration test conditions. Therefore, the cointegration relationship of the dynamic systems composed of them can be analyzed by cointegration theory.

4.3 Johansen Cointegration Test

When the time series is of the same order, the cointegration test can be used to determine whether there is a long-term stable equilibrium relationship between the sequences. Cointegration test methods mainly include E-G two-step method and Johansen test. The E-G two-step method uses the unit root test of the residuals of the regression equation to determine whether the residual sequence is stable, and then analyzes whether there is a cointegration relationship between the dependent variable and the explanatory variable. The Johansen test is a method based on the VAR model to test regression coefficients proposed by Johansen in 1988 and Juselius in 1990. It is a better way to perform multivariate cointegration tests, which can overcome the defect that the E-G two-step method may test different cointegration vectors, and can also accurately test the number of cointegration vectors when doing multivariate tests. Therefore, the Johansen test method is used to perform cointegration tests in this text.

Before conducting the Johansen test, we must first establish a VAR model:

$$y_t = \Phi_1 y_{t-1} + \cdots + \Phi_p y_{t-p} + Hx_t + \varepsilon_t, t = 1, 2, \cdots, T$$

Among them, y_t is a stable first-order single integer sequence, and x_t is a definite d-dimensional exogenous variable, and represents a constant term, a trend term, etc., and ε_t determines the perturbation vector. Transform the equation difference between the above formula and can be obtained:

$$\Delta y_t = \Pi y_{t-1}\text{-}1 + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + Hx_t + \varepsilon_t$$

Among them, $\Pi=\sum_{i=1}^{p}\Phi_i - \mathrm{I}$, $\Gamma_i = -\sum_{j=i+1}^{p}\Phi_j$

Because the process $\mathrm{I}(1)$ is transformed into the process $\mathrm{I}(0)$ through difference, ie, Δy_t , Δy_{t-j} $(j=1,2,\ldots,p)$ both are vectors of variables $\mathrm{I}(0)$, then as long as Πy_{t-1} is a vector of $\mathrm{I}(0)$, that is, there is a co-integration relationship between $y_{1,t-1}, y_{2,t-1},\cdots y_{k,t-1}$, then Δy_t is a smooth process. The key to using the Johansen test lies in the rank of the matrix Π .

Structure and Statistics:

$$\eta_r = -T\sum_{i=r+1}^{k}\ln(1-\lambda_i), r=0,1,\cdots,k-1$$

Where r is the number of hypothetical cointegration relations, K is the number of time series variables, T is the sample size, and λ_i is the maximum eigenvalue of step i; η_r is called feature root statistics. Propose a hypothesis:

$H_{r0}: \lambda_{r+1} = 0$;

$H_{r1}: \lambda_{r+1} > 0$; $r=0,1,\cdots,k-1$

According to the above formula, the significance of this series of statistics is examined in turn. If we know that H0 is accepted, then there are r co-integration vectors in this group of variables.

After the VAR model is established, the optimal lag order is required. The determination of the lag order not only requires the lag order to fully reflect the dynamic characteristics of the model, but also to reasonably control the estimated parameters and model degrees of freedom. This article is based on LR, FPE, AIC, SC and HQ 5 commonly used indicators to choose. The results of the selection of model lag order are shown in Table 15. The test results can be found that the three indicators of LR, FPE, and AIC all choose the optimal value of K as 4. Therefore, the optimal lag period is 4.

Table 15 - Optimal lag period selection result for VAR model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	437.5740	NA	1.73e-08	-3.681481	-3.607872	-3.651805
1	1577.768	2222.165	1.31e-12	-13.17249	-12.73084	-12.99444
2	1682.692	200.0256	6.63e-13	-13.85270	-13.04301*	-13.52627*
3	1721.839	72.96348	5.88e-13	-13.97310	-12.79537	-13.49829
4	1747.270	46.31604*	5.87e-13*	-13.97676*	-12.43099	-13.35358

Based on the above analysis, the cointegration test was performed on the independent variables and the dependent variable. The results of the specific cointegration test are shown in Table 16.

Table 16 - Results of Johansen cointegration test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.128715	73.86433	69.81889	0.0229
At most 1	0.073487	41.48463	47.85613	0.1737
At most 2	0.047029	23.54768	29.79707	0.2202
At most 3	0.028749	12.22755	15.49471	0.1463

From the results in Table 16, we can see that the trace statistic test results show that at the 5% significance level, the original hypothesis of "no cointegration equation exists" is rejected, and "no more than one cointegration equation exists" is not rejected. Assume that there is at least one kind of cointegration relationship between explanatory variables, that is, there is a long-term stable cointegration relationship.

4.4 Model Stability Test

Stability is the key to constructing the VAR model and is also one of the important criteria for determining the optimal lag period of the VAR model. The stability of the VAR model has a great influence on the standard error of the impulse response function. If the reciprocal of all the root modes of the estimated VAR model is less than 1, that is, it is located inside the unit circle, it can be determined that the constructed VAR model has stability. Conversely, if the model is non-stationary, its converted VAR model will be invalid, so that pulse function analysis cannot be performed, or the result of pulse function analysis is invalid. Therefore, the stability of the model must be checked before model analysis is established. By using Eviews8 software, we found that the reciprocal distribution of the root model of the VAR model established in this paper is shown in Figure 4.1, and all reciprocals of the root model are within the unit circle, indicating that the established model satisfies the stationarity condition.

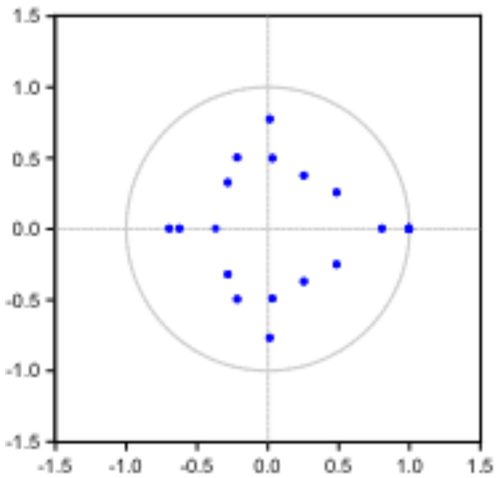

Figure 5 - VAR model stationarity test results

4.5 Establishment of Error Correction Model (vecm)

Engle and Granger combined the cointegration with the error correction model to establish a vector error correction model. As long as there is a co-integration relationship between variables, an error correction model can be derived from the autoregressive distribution lag model. The error correction model is a VAR model with cointegration constraints. The error correction term reflects the correction of short-term fluctuations by the long-term equilibrium.

Assume that there is a first-order autoregressive distribution lag model as follows:

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \beta_3 y_{t-1} + \varepsilon_t, t = 1,2,\cdots,T$$

The model shows that the y-value of the t- period is related to x of the t-1 period. The two ends of the above equation are subtracted y_{t-1} at the same time and are added or subtracted $\beta_1 x_{t-1}$ at the right end. Then it can be calculated as:

$$\Delta y_t = \beta_0 + \beta_1 \Delta x_t + (\beta_1 + \beta_2) x_{t-1} + (\beta_3 - 1) y_{t-1} + \varepsilon_t$$

即 $\Delta y_t = \beta_0 + \beta_1 \Delta x_t + (\beta_3 - 1)\left(y - \frac{\beta_1 + \beta_2}{\beta_3 - 1} x_{t-1} \right) + \varepsilon_t$

This formula is called the error correction model, where $y - \frac{\beta_1 + \beta_2}{\beta_3 - 1} x_{t-1}$ is the error correction term. If there is a long-term equilibrium between the variables y and x, then the equilibrium value y^* and x^* has the following equilibrium relationship:

$$y^* = \frac{\beta_1 + \beta_2}{\beta_3 - 1} x^*$$

According to the above theory, using the software Eviews 8.0 to establish the VAR model, the error correction model can be expressed as:

D(LNY) =-0.021*(LNY(-1) + 0.07*LNX1(-1) + 2.14*LNX2(-1) - 5.18*LNX3(-1) + 7.74*LNX4(-1) + 2.04) + 0.19*D(LNY(-1)) - 0.101*D(LNY(-2)) + 0.079*D(LNY(-3)) + 0.72*D(LNX1(-1)) + 0.027*D(LNX1(-2)) - 0.39*D(LNX1(-3)) + 0.044*D(LNX2(-1)) + 0.049*D(LNX2(-2)) + 0.0015*D(LNX2(-3)) - 0.281*D(LNX3(-1)) - 0.26*D(LNX3(-2)) - 0.11*D(LNX3(-3)) + 0.018*D(LNX4(-1)) - 0.11*D(LNX4(-2)) - 0.0785715276055*D(LNX4(-3)) + 0.002

The error correction model LNY(-1) + 0.07*LNX1(-1) + 2.14*LNX2(-1) - 5.18*LNX3(-1) + 7.74*LNX4(-1) + 2.04 is an error correction term. The coefficient is -0.021, which means that when the short-term fluctuations deviate from the long-term equilibrium, the unbalanced state will be pulled back to the long-term equilibrium state with -0.021. The difference term reflects the dynamic effect of the dependent variable itself and the independent variable on the dependent variables. Among them, the LNX1 lag phase I has the greatest influence on the dependent variable, the influence coefficient is 0.72, and the smallest is LNX3 lag phase III, with an influence coefficient of 0.0015, indicating that under other circumstances unchanged, when the LNX1 lag phase and the LNX3 lag phase change by one unit respectively, then the LNY increase correspondingly by 0.72 and 0.0015 units.

4.6 Impulse response

The impulse response function characterizes a one-time impact on the disturbance term and analyzes its impact on the current and future values of the endogenous variable. The impulse response function can be used to identify the standard information response between variables. In order to reveal the dynamic response process between the two sides, the results of the analysis of the impulse response function are shown in Figure 6, the horizontal axis represents the lag order, the vertical axis represents the response of the endogenous variable to the shock, and the solid line represents the estimated impulse response function.

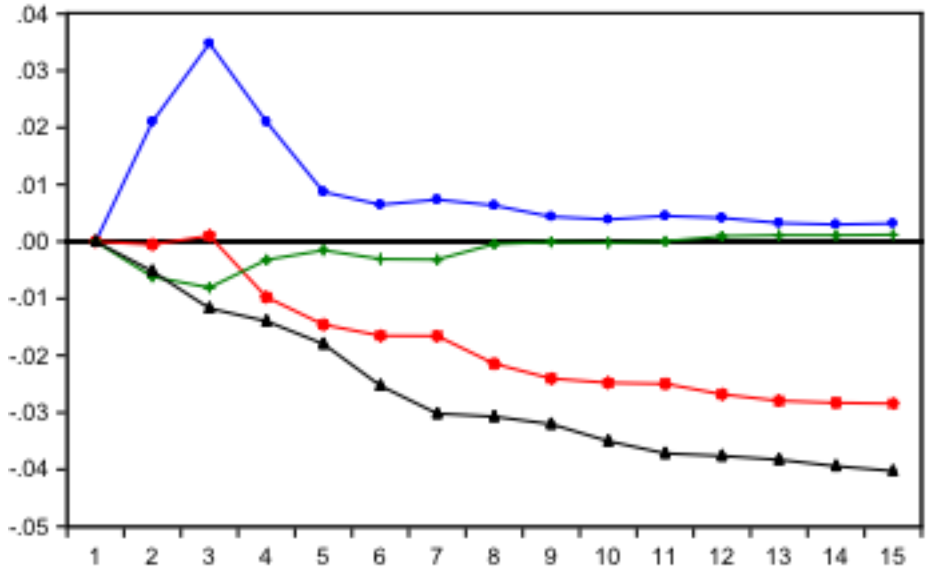

Figure 6 - Impulse Response Graph

As can be seen from Figure 6, when LNX1 has a positive impact on LNY, LNY has been subject to a positive impact from the first period, and the 1-3 period of impact has gradually increased and reached the maximum in the third period, and after the third the period, the degree of impact was gradually reduced. After the fifth period, the impact remained basically stable. In the long term, when LNX2 had a positive impact on LNY, the impact on LNY from the first period to the third period was small. After the third period, it was negatively impacted, and the degree of impact gradually increased. After the 12th period, it remained basically stable. In the long term, LNX2 had a negative effect on LNY. When LNX3 has a positive impact on LNY, LNY receives a gradually increasing negative impact in the first three phases, and the third phase impact degree reaches a maximum, and the impact degree after the third phase gradually decreases. After that, it stays around 0. In the long run, LNX3 has a small impact on LNY. When LNX4 has a positive impact on LNY, LNY receives a negative impact that increases gradually. In the long run, LNX4 produces a gradually increasing negative impact on LNY.

4.7 Variance decomposition

In order to further accurately determine the process and degree of action of the independent variables on the dependent variable, the dynamic variance decomposition of LNY is performed by using the Cholesky decomposition method. Variance decomposition analyzes the contribution of each variable by the mean square error of the variable, that is, the system's mean square error is decomposed into the contribution of each variable's impact, and the mean square error of a variable impact is decomposed into random variables of the system variables. The impact of the impact is then calculated and the relative importance of the impact of each variable is calculated. The empirical results are shown in Figure 7. In the figure, the horizontal axis represents the number of lag periods and the vertical axis represents the index contribution degree. Combining with Table 17, it can be seen that the dependent variable LNY has its own influence in the first period of 100%, while the independent variable has no contribution to the dependent variable in the first period. Since the second period, the contribution of the independent variable to the variance of the dependent variable has increased. The contribution of the independent variables LNX2 and LNX4 has gradually increased. After the fifteenth period, they have reached 3.65% and 7.54%, respectively. The contribution of the independent variables LNX1 and LNX3 increased first and then decreased. After the fifteenth period, they reached 1.41% and 0.08%, respectively. In contrast, the independent variable LNX4 has a large contribution to the dependent variable LNY, followed by LNX2 and LNX1, and LNX3 has the smallest contribution to the dependent variable LNY.

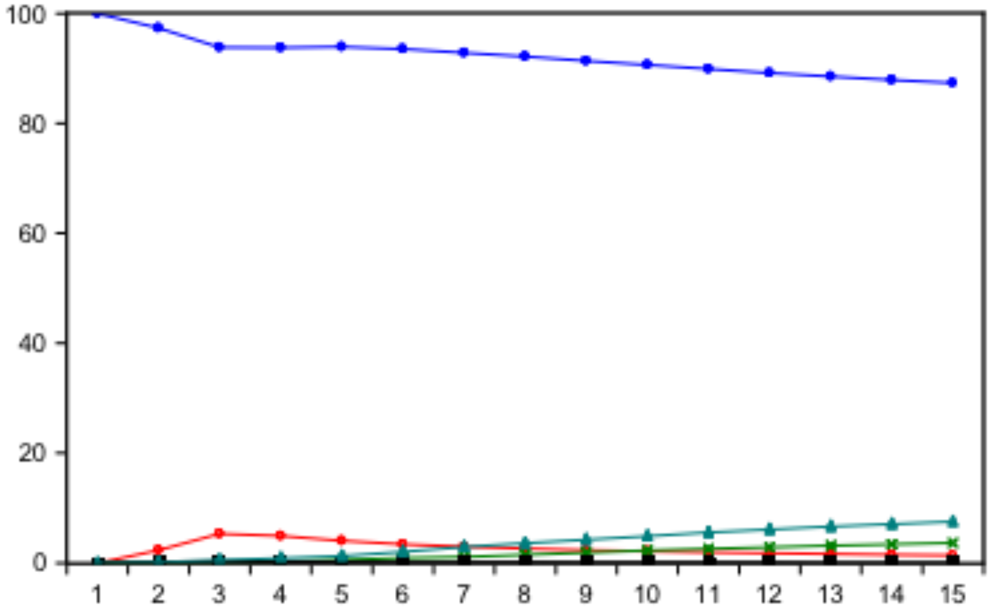

Figure 7 - Variogram decomposition

Table 17 - Variance decomposition table

Period	S.E.	LNY	LNX1	LNX2	LNX3	LNX4
1	0.087290	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.138332	97.34590	2.310183	0.001485	0.199722	0.142715
3	0.176069	93.79828	5.330722	0.004228	0.334802	0.531969
4	0.206512	93.75339	4.910329	0.225775	0.267429	0.843077
5	0.232103	93.91614	4.028915	0.573112	0.216060	1.265777
6	0.255689	93.50989	3.384249	0.888762	0.192530	2.024570
7	0.277161	92.84830	2.950200	1.113603	0.176705	2.911198
8	0.296708	92.11901	2.620005	1.494399	0.154376	3.612207
9	0.315130	91.37891	2.341718	1.906226	0.136860	4.236284
10	0.333156	90.61460	2.108781	2.258887	0.122487	4.895245
11	0.350431	89.86866	1.922319	2.549082	0.110712	5.549231
12	0.366908	89.16040	1.766339	2.858393	0.101633	6.113232
13	0.382795	88.50107	1.630021	3.159202	0.094201	6.615507
14	0.398270	87.88680	1.511529	3.423211	0.087801	7.090662
15	0.413242	87.31868	1.409884	3.652899	0.082401	7.536132

Cholesky Ordering: LNY LNX1 LNX2 LNX3 LNX4

4.8 Granger Causality Test

Based on the above analysis, Granger causality test is used to perform Granger causality test on variables to further reveal the dynamic relationship between variables. The results are shown in Table 18 below.

Table 18 - Granger Causality Test of LNY and Independent Variables

Null Hypothesis:	Obs	F-Statistic	Prob.
LNX1 does not Granger Cause LNY	236	6.20201	0.0005
LNY does not Granger Cause LNX1		2.28824	0.0793
LNX2 does not Granger Cause LNY	236	2.54766	0.0567
LNY does not Granger Cause LNX2		0.85989	0.4626
LNX3 does not Granger Cause LNY	236	1.18819	0.3150
LNY does not Granger Cause LNX3		4.42962	0.0048
LNX4 does not Granger Cause LNY	236	1.35213	0.2583
LNY does not Granger Cause LNX4		1.64312	0.1802

From the table above, we can see that under the 10% confidence level, the original assumptions of LNX1 does not Granger Cause LNY and LNY does not Granger Cause LNX1 are not rejected, indicating that LNX1 is the Granger cause of LNY, and LNY is also the Granger cause of LNX1. At the same time, the original assumption of LNX2 does not Granger Cause LNY is not rejected, and the original assumption of LNY does not Granger Cause LNX2 is rejected, indicating that LNX2 is the Granger cause of LNY, and LNY is not the Granger cause of LNX2. Similarly, it can be known that: at the 5% level of significance, LNY is the Granger cause of LNX3. LNX3 is not the Granger cause of LNY; LNX4 is not the Granger cause of LNY, and LNY is not the Granger reason of LNX4. .

Chapter 5 Conclusion

5.1 Summary

This article has carried out more detailed research on the needs and supply of Panamax vessels. It can help companies engaged in Panamanian transportation to understand this market more profoundly, and overcome difficulties and solve existing problems according to the characteristics of the market and the conditions of the enterprise itself, and formulate practical business strategies and scientific development strategies. Of course, the Panamax ship market studied in this article is not very comprehensive, and with the development and changes in the world economic situation, there may be new and different situations.

The demand for coal and grain, the main cargo transported by Panamax vessels, will develop more steadily in the coming years, and the import and export regions will be relatively fixed. The demand for coal and grain in the world will grow steadily in the next few years. This is mainly due to the economic recovery in Asia, especially Japan, which makes the demand for coal grow year by year. Due to factors such as industrial upgrading, the demand for coal of the traditional industrial countries such as the United States, Europe, and Japan remains stable.

Since the first season in 2018, the United States frequently announced the increase of tariffs on China, then consecutively on Canada, Mexico and the European Union. In particular, the United States has announced that it will impose a 25% tariff on approximately $50 billion of goods imported from China. The US trade protection behavior has been counterattacked by China, the European Union, and Mexico. The unilateral trade protectionism of the United States and the trade frictions it caused have affected the global economy, trade and shipping industry. Once the trade war between the two countries starts, the tariffs will increase, directly hitting the export enthusiasm of the goods companies in the list, which will inevitably be accompanied by a decrease in trade orders. The reduction in trade orders means a reduction in shipping demand, which has brought down expectations for the global shipping market. According to the demand situation of iron ore and coal in the world, the demand for Panamax ships will be relatively determined in the next few years. There will be no major changes and the market will be relatively stable. As grain is used for energy production and the world's population is increasing, grain demand will also grow steadily.

Looking at this article, the following conclusions can be drawn：

(1) The Panamax shipping capacity will develop more steadily in the next few years. In the next few years, the number of demolition of older ships will increase, but there will be more new ships, so the proportion of the entire dry bulk fleet will increase year by year, and the age of ships will show a young trend. In addition, Panamax-type bulk carriers also have a trend of increasing in size, and 6-7 million tons of Panamax-type bulk carriers have only 20 years old ship left, and will gradually withdraw from the market. The construction currently underway is that of ships carrying more than 80,000 tons. In general, Panamax ships tend to be large and young.

(2)In terms of coal, thermal coal is expected to remain the driving force behind the growth of dry bulk shipping demand in the coming years. By 2018, coke coal will account for only about 20% of coal's ocean freight volume. Global seaborne steam coal trade is projected togrow 1% to around 962mt in full year 2018, with themajority of supply side growth expected to be met by Indonesia, Australia and Russia.

(3)At present, the major grain exporting countries in the world are mostly concentrated in developed countries, while the food importing countries are mainly in developing countries. This imbalance leads directly to China's disadvantageous position in the international grain transportation market. The developed countries have absolute control over the formulation of grain tariffs. Faced with this situation, China should adopt a policy of decentralized and batch purchase of food, and should not rely on the food supply of developed countries, establish its own price mechanism, make full use of information on various freight indices such as BDI, and conduct a detailed analysis of information such as delivery volume and ship dismantling of various types of ships inthe international market, so as to reasonably estimate freight rates and capacity, adopt appropriate trade policies, effectively avoid risks, and maintain the stability of the domestic grain transport market.

(4)In addition, there are many uncertain factors, such as the high price of oil, the Iranian nuclear issue, the uncertainty of the exchange rate of the U.S. dollar, and the continued appreciation of the renminbi, which will affect the future dry bulk shipping market.

(5)The Granger analysis shows:

a. BDI and 180cst oil prices constitute a two-way Granger causality, but there is no Granger causality relationship with BDI and grain shipments. There is a one-way Granger causality between BDI and Panamax-type bulk carrier deliveries and coal shipments.

b. The impact of the international crude oil market on BPI has a positive impact in the first three phases, while the impact of the third phase has gradually diminished.

This is in line with the general laws of the market. Rising oil prices will lead to higher shipping costs, which will lead to higher rates for Panamax bulk carriers.

c. The impact of fleet delivery on BPI had little impact in the first three periods, and there was a more significant negative impact after the third period, and the degree of influence gradually increased, tending to be flat after the 13th period. For a long time, fleet delivery has a negative impact on BPI and there is a certain lag. This is also in line with the law of Panamax's dry bulk market. When the delivery volume of the fleet increases, the total capacity of global Panamax ships rises and supply exceeds demand, which naturally leads to a drop in freight rates.

d. The impact of coal shipping volume on BPI has a gradually increasing negative impact in the first three periods, and then the impact is reduced. After the eighth period, the impact is approaching zero. From a long-term perspective, coal shipping volume has little effect on BPI. This is due to the fact that in the international market, not only Panamax-type bulk carriers, but also capesize bulkers, are transported by coal, and capesize bulk carriers have a stronger transport capacity and are the main ship type of coal transportation. Therefore, the increase in coal shipping volume may have a greater impact on capesize bulkers, and the impact on Panamax bulk carriers is minimal.

e. The volume of grain shipping has a gradually increasing negative impact on BPI. This may be caused by its competitive ship type. When the volume of grain shipments rises, charterers prefer the bulk of capesize bulk carriers because they have lower unit tariffs rather than Panamax bulk carriers. In fact, the volume of grain shipments has changed little in the actual market.

5.2 Defects

There are still many deficiencies in this paper. For example, in the establishment of the VAR model, only the oil price of 180cst diesel fuel was considered, and other types of diesel fuel prices were not taken into consideration; and the independent variables used were relatively simple when establishing the VAR model. These may all have a certain influence on the conclusions drawn.

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