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The impacts of fuel price fluctuation on dry bulk cargo market

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Declaration

I certify that all the material in this research paper that is not my own work has been identified, and that no materials are included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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Abstract

With the increase of global trade, at present, surface mail reached 90% of global trade, ships play an important role in modern transportation. After the financial crisis, fuel prices fluctuated, shipping industry faced volatility. This thesis will focus on analyzing to what degree the fluctuation of the fuel affected shipping industry.

This thesis comprises three parts. The first part introduces the current situation of fuel price and dry bulk cargo market with charts and tables, including freight rate, trade volume and ship size. The second part will use a simple linear regression model to present the correlation between the fuel price and other elements and use the result to prove the fuel price does have an impact on the dry bulk cargo market. Finally, the paper will provide detailed suggestions to ship companies.

Through the research of this thesis, there is a strong correlation relationship between the fuel price and dry bulk cargo market.

Key words: dry bulk market, fuel price, fluctuation, regression model

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1. Introduction

1.1 Background and purpose of the dissertation

International fuel prices has fallen sharply since the summer of 2014, from $106 a barrel in June, to as low as $45.15 a barrel by the end of January, which hit the lowest point of five years. The fall of fuel prices made it imperative that the dry bulk transport voyage costs to be lowered in order to improve the efficiency of shipping enterprises. In the short term, fuel prices are expected to continue remaining low. However, as the fuel price hit the equilibrium price of ship economic speed fuel price , supply capacity will be released. At the same time, a fall in fuel prices and freight rate also fell sharply, the dry bulk market and the influence of ship owners will change significantly.

When there is a fall in fuel prices, supply and demand of the market tend to loose. The supply of international crude fuel exceeding its demand is the primary factor. On the one hand, in recent years, China's economic growth slowed down. At the same time, Europe and Japan's economic recovery is also slow. In the US, the ample domestic supply of crude fuel led the decline of crude fuel imports. The overall demand of global market reduced in the past few years. On the other hand, the development of unconventional fuel and gas resources improved its economic efficiency, and the world's fuel production has increased. The shale gas revolution made crude fuel output of record high over the past 30 years. Because of the development and utilization of some new technology such as deep water drilling, people expanded the field of fuel production. After the war, in Libya and Iraq, fuel field became exploitable again. Meanwhile, countries such as Mexico, Brazil and Colombia stared exporting fuel as well. The multi-polarization of fuel supply and the increase of amount objectively can help lower the fuel prices. In addition, some western countries, led by the U.S., suppressed the economy of Russia with fuel price. In response to that, Russia had to increase fuel production in order to make up for the

economic gap. OPEC refused to unilaterally limit the production in order to defend market share value. However suppressed the economy, making up for the economic gap and refusing to unilaterally limit production can lead to the decline in the international fuel prices.

Furthermore, since last year, the U.S. economy started to recover and the US dollar continues to rise, which has given the international fuel prices downward pressure. Financial attributes of fuel enhanced obviously, when the capital market is bearish on the global economy and fuel prices, market fundamentals are amplified, formed the continuous fall in fuel prices. Recent slump in fuel prices has seriously affected the mentality of trading intermediaries, economic malaise in Europe and production capacity increase in the United States make the prospect of importing fuel by this two main energy consuming continents only more negative. In order to reduce the loss as soon as possible and to liquidate, middlemen can only choose to sell.

A fall in fuel prices will not end in a short time. First of all, the United States and OPEC is unlikely to cease fire until their demands are satisfied. What is more, OPEC's members do not have a unified opinion, especially Saudi Arabia. Secondly, even if both parties were to negotiate, America's energy basis is a private enterprise,whether or not relevant government institutions can effectively convey to the enterprise is an open question. At present, the mainstream view of the market is that in the short term prices will hit as low as $40-45 per ton, in the future the price will remain stable at around $70 per ton. A fall in fuel prices go against Russia, Iran and other fuel producers of economic growth, but it will bring the dividend to the commodity importers such as China, Japan. Cost reduction will stimulate consumption growth, and lower inflation will give incentives to set aside space.

From what has been shown above, it can be concluded that significant importance of fuel prices on the global market. Therefore, the purpose of the dissertation is to show what aspects the fuel price affect. In dry bulk market, if the fuel price shows a decrease, it may change the cost of voyage. However, more than often, the relationship between the fuel price and freight rate is dynamic, not static. This thesis shows the impact of fuel price on the cost. On the other hand, with the

volatility of fuel prices or the decline of fuel prices, the volume of dry bulk cargo transported may be changed from time to time. This thesis provides data to analyze the relationship between the volume of dry bulk cargo transported and global fuel price. This thesis presents the relationship between the fuel price and the dry bulk cargo market based on the impact of fuel price on freight rate or cost and that of the fuel prices on the volume of dry bulk cargo transported . This dissertation will answer the question of whether these two aspects have certain influence or not and what are the influences in these two aspects. .

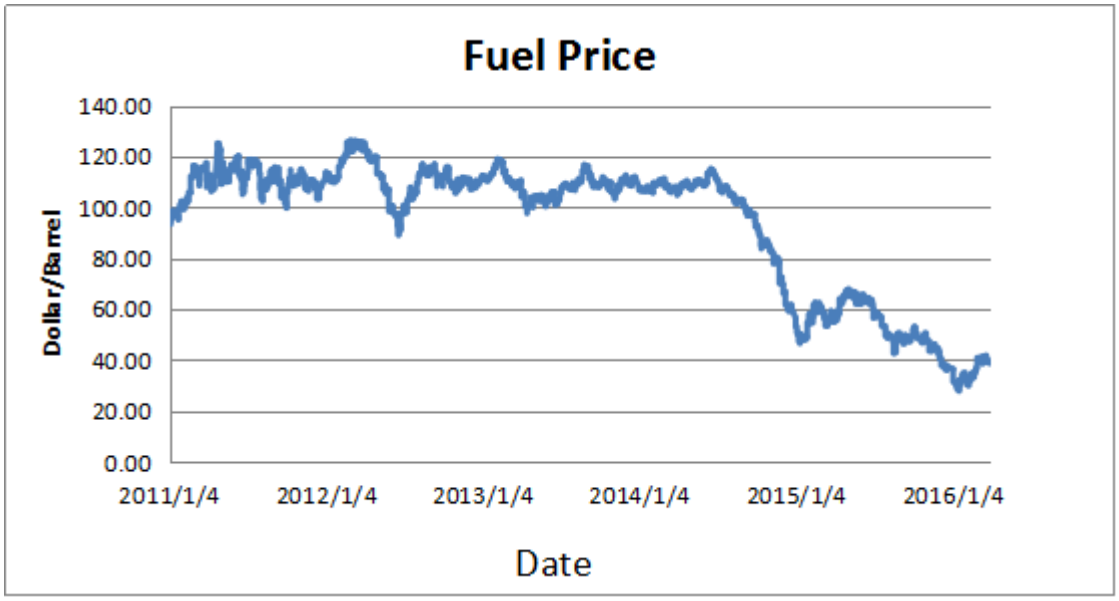


Chart 1-1: the trend of fuel price

The chart 1-1 describes the trend of fuel prices from January,2011 to April, 2016. The chart 1-1 indicates the period from the beginning of 2011 to the ending of 2014,there was not too much fluctuation. However, since the mid 2014 to the beginning of 2015, there was a sharp decline of price in fuel market. There are three to explain this phenomenon. Firstly, the political reason is that American sanctions against Russia help American consolidate its position in the whole world. Secondly, considering the microcosmic factors, the producers led by Arab and Russia increased the production of oil. As a result, the supply of the oil exceeds its demand, which made the fuel price see an acute decline. Thirdly, from a global perspective, due to the

decline in physical volume of international trade and the reduction of global trade, the demand of oil reduced. As a result, fuel price decrease sharply. After the sharp decline, the fuel price decreases slightly and the trend went back to volatility during the period from the beginning of 2015 to present.

Fuel price brought another serious impact to the dry bulk market. For about ten years, dry bulk market was the biggest shipping market in the world. Because of the financial crisis and the fluctuation of fuel price, ship companies which ran dry bulk started losing money in recent years. “For the shipping market, changes of fuel prices, caused by the changed crude oil price, can affect the cost of shipping enterprise’s management. Consequently, enterprise's rate and the rent are affected. In addition, the change of fuel price may influence the world economy as well as shipping trade. It will also affect the freight of shipping companies and rent. ”(Qin, 2015) Chen Jianfei(2011) suggested that the oil price can have a direct influence on the national economic production activities. Meanwhile, it brings a huge impact on our country's shipping industry. Generally speaking, in a shipping company, the fuel expense accounts for the 35~40 percentage of total cost, and about 80% of the variable cost. The fuel price fluctuation influences the cost, which makes the shipping companies become sensitive to it. According to the CIBC shipping company’s data, when the fuel price goes up by 1 dollar, the cost will increase by 1%. Research shows low prices would stimulate the demand as part of the cost sensitive routes, but the commodity importers led by China,there are not many advantages even in competitive oil prices due to the relatively low percentage of goods transportation costs and weak demand. Therefore, it can be concluded that fuel price occupies an important position. This thesis talks from different aspects the impact fuel prices have on the dry bulk cargo market. Does fuel price have an impact the dry bulk cargo market? If there is impact on dry bulk market, how does it influence the market? Or if there is a little impact on dry bulk market, are there other factors which influence the market?

In a word, fuel price fluctuations can have great influence on the whole shipping industry. Fuel price has been unstable for a long time, which made the shipping cost

fluctuate. The situation also influences the global trade. As a result, the development of the whole shipping industry is influenced. To be specific, fluctuation of fuel price influences the container industry, tanker industry, dry bulk cargo market and other related industries. This thesis will focus on the impact of fuel price volatility on dry bulk cargo market. The fluctuation of fuel price can influence the decision of shipping companies as it might become difficult to gain profit for shipping companies. Shipping companies incline to expand their capacity when the fuel price is low. However, if a company increases its investment, the company will see a loss when the fuel price went down. Therefore, the volatility can influence the development of dry bulk cargo market.

The goals of this thesis are:

(1) Understanding the market by analyzing the status quo of the dry bulk cargo market to

(2) Understanding the situations of present and before of fuel price by data calculation

(3) Analyzing to what level of influence fuel price has on the dry bulk cargo market

1.2 Structure and research methodology of the dissertation

The structure of this thesis is fairly clear. There are six parts in this thesis. The introduction is divided into two parts including the background, and the purpose of this thesis. The second part is the literature review. In this section, this thesis presents some methodologies from the previous research. The third part is the main body of this thesis. It introduces the present situation of the dry bulk market and the fuel price. This part also analyses the impact fuel price has on the market. I will start the analysis by looking into the relationship between the fuel price and the freight rate. Next, I will analyze the influence of the fuel price on the volume of dry bulk cargo transport.

Finally, I will use data to analyze the relationship between the fuel price and ship sizes. This three parts of analysis will be used to analyze the impact of the fuel price hase on dry bulk cargo market. In the forth part, I will use linear analysis method to analyze the relationship of the BDI and fuel prices. In the fifth part, I will bring up some possible advice to ship companies. The last part is the summary of this thesis and the future expectations of the market.

In the third part, I used correlation analysis to discuss the impacts of fuel price on freight rate, the impacts of the fuel price on freight volume and the impact of the fuel price on freight capacity. Correlation analysis is also used to demonstrate the relationship between the fuel price and dry bulk cargo market. In the fourth part, I adopted correlation analysis again to analyze the connection between fuel price and BDI. Correlation analysis refers a type of analysis that is to measure the degree of two variable factors relationship when two or more variables are relevant to each other,. Correlation between the elements needs a connection or probability to make correlation analysis. Correlation is not the same as causation. Also, we can see a wide range of related fields.However, correlation is defined quite differently in different fields.Therefore, in the linear regression model, there are some error and coefficient.

(1) Standard Deviation

Standard deviation is the mean square error between estimated value and dependent variable, the formula of the standard deviation is :

$$SE = \sqrt{\frac{\sum (y - \hat{y})^2}{n - 2}}$$

(2) R Square

R Square is an index, which measure the closeness rating between dependent variable and independent variable. It show independent variable to explain the percentage of the dependent variable changing, the formula of the R Square is:

$$R^2 = 1 - \frac{\sum (y - \hat{y})^2}{\sum (y - \bar{y})^2}$$

Another formula of R Square is:

$$R = \left[\frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2} \sqrt{\sum (y - \bar{y})^2}} \right]$$

(3) Correlation Coefficient

Correlation coefficient is another index, widely used to determine goodness of fit. The formula of it is:

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2} \sqrt{\sum (y - \bar{y})^2}}$$

The formula shows that an R Square is the square of the correlation coefficient. But the two methods of measurement provide a complement of information. The closer the +1 or -1 of correlation coefficient, the better fitting degree between dependent and independent.

2.Literature Review

Nowadays, the shipping industry accounts for 90% of global trade. People prefer to choose the sea transportation to transport cargoes. Different theses hold different viewpoints on this issue. People home and abroad have achieved certain progresses in the research of dry bulk cargo market in recent years.

2.1 Research Content

Shi (2014) analyzes two important basic characteristics of the international dry bulk market, namely, long-term imbalance of the relationship between the demand and supply of dry bulk capacity and the high risk caused by the volatility of freight rate. It is found in his study that significant peak fat-tail characteristic is manifested in the dry bulk shipping market freight yields sequence. And the sequence has the characteristic of continuity and leverage effect of information asymmetry. At the same time, the dry bulk shipping market has obvious fractal characteristics. Zhang (2012) makes a comprehensive analysis and discussion on the demand and supply of international dry bulk shipping market, meanwhile, the thesis introduces the capacity index to scientifically reflect the international dry bulk shipping market balance of supply and demand situation. Zhang (2013) does a lot of in-depth analyses and researches on the transport demand of iron ore, coal and grain and market capacity of three types big bulk vessel in the international dry bulk shipping market, including Capesize, Panamax and Handysize respectively. Based on his study, the vessel type with developing advantage is found in each of the three big bulk vessel types in the international dry bulk shipping market. Li (2003) puts forward the dry bulk fleet management strategy and construction, mainly including shipping associated strategy, market freight rate strategy, competition strategy, the fleet structure adjustment strategy, diversification strategy, etc. Through the analysis of the demand and supply

of dry bulk market and the analysis of the freight rate in market, he comes to the conclusions on the developing trend of dry bulk fleet and existing situation of dry bulk market. Wang (2005) discusses on the development situation and trend of the demand and supply of the international dry bulk shipping market. In order to find the mainstream vessel type in dry market shipping market, he makes economy analyses on the operation of each single ship. According to the results of the analysis, the mainstream ship type in the future can be selected. Yuan (2013) also mentioned in her paper that among a variety of factors, fuel price is one of the most important factors. Because the fuel price accounts for a large percentage of the cost, it can affect the shipping market by influencing the price. Sun(2007) even puts forward the opinion that the fuel price is the basis of pricing. Chen(2011) analyzes the impact of fuel price on economy and shipping market to prove the relationship between fuel price fluctuation and the shipping industry. The research indicates that more effective measures should be taken to reduce the impact of oil price fluctuations on the shipping industry, and deep researches are needed on this topic. Che (2013) discusses the seaborne demand and the supply of capacity of international dry bulk cargo market, according to the supply and demand structure of dry bulk cargo market. Meanwhile, the supply and demand situation is discussed to analyze the indeterminacy of dry bulk cargo market. Through the indeterminacy, the author explores the Bullwhip effect of dry bulk cargo market. He also offers some suggestions on reducing cost and control risks. Geng(2015) makes some researches based on the volume of dry bulk cargo and average tonnage per dry bulk ship. On the same route, when the shipping capacity increases, fuel costs will not increase accordingly. Hence the profit for the year is gradually raised.

To sum up, these researches on shipping market mainly concentrate on market volatility, the supply and demand analysis, the influence factors, trend prediction, etc. There are a large number of analyses on the affecting factors, while analyses on the influence degree of measurement are insufficient, especially the influence degree of fuel prices in shipping market.

3.The status analysis of fuel price market and dry bulk cargo market

3.1 Analysis of the dry bulk cargo market

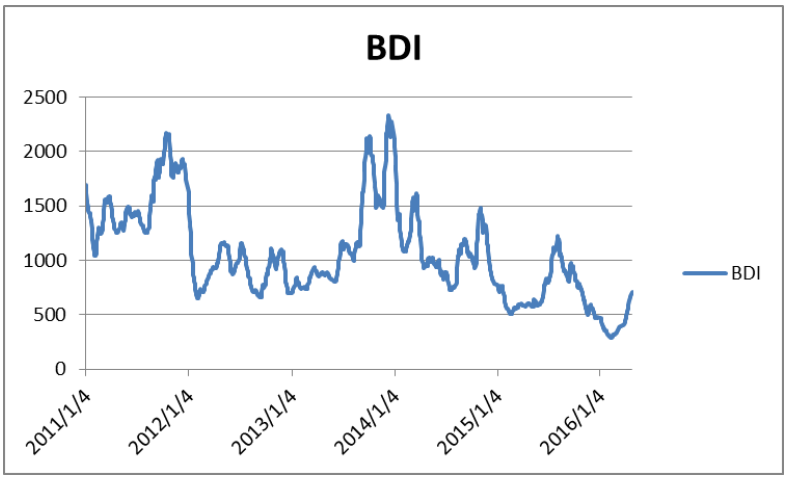


Chart 3-1: the trend of BDI

In May, the international dry-bulk market went on a downward trend. The dollar index had a fourth straight rebound. The joint savings rates in the United States is expected to rise, and the bulk commodity prices fell again. The demand for iron ore and coal remained weak, and export strength of South American grain decreased rapidly on May 10th, as a result of the BDI falling below 600, to 594 points. With bulk commodity prices stabilized in the middle of May, BDI rebounded to its highest level to 643 points. In May, the BDI averaged 620 points, up 2.1% month-to-month and edged up 3.9% year-to-year. During the period of January to May, the BDI averaged 460, falling 24 .1% from last year.

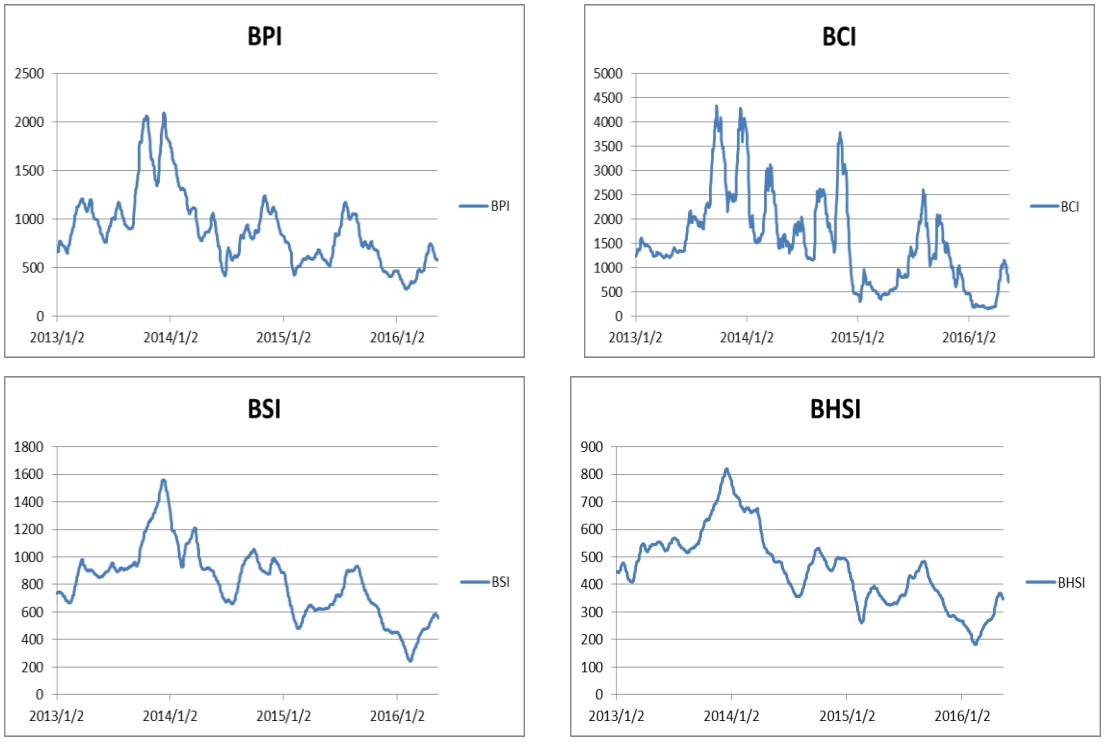


Chart 3-2: the trend of BPI, BCI, BSI and BHSI

Each specific change are as follows: on May 31, the Cape index (BCI) closed at 854 points, higher than the same period last year (810 points), a rise of 5.4%. Supra-max index (BSI) closed at 580 points, in contrast with 647 points at the same period last year, a drop of 10.4%. Handy-sizes (BHSI) closed at 351 points, an increase of more than 6% when compared to the same period last year.

The demand for steel in China's domestic market appears to have made a large change in May. For the demand in the busy season and the off-season, infrastructure projects relating to real estate look pale in the long term. What's more, a shortage of coal tar resources, due to coal prices, led to a decrease in steel price. After regulators cracked down on the speculation of steel futures, steel prices fell sharply, and steel mill profits shrunk dramatically. In May, domestic rebar made the biggest monthly drop, around 23%, the highest since 2009.

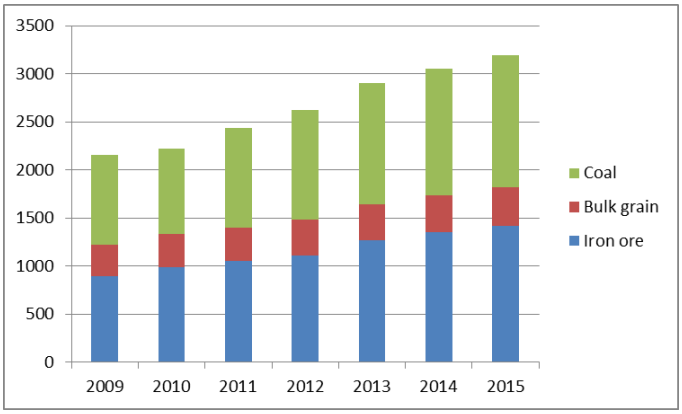


Chart 3-3: the trend of global trade volume of dry bulk cargo

From chart 3-3, we can see that the global trading volume of dry bulk cargo increased year-to-year. From chart 4, the growth appears a considerable increase in the period from 2011 to 2013. The trade volume of iron ore ensure a sustained growth in recent year. But there is almost no growth on trade volume of bulk grain. At the same period, the trade volume of coal decreased between 2009 and 2010, then, the volume increased after 2010.

Goldman Sachs predicts the global iron ore market oversupply situation will be even more serious in the future. Domestic iron ore port stocks break through one hundred million tons mark again, prices of 62% grade iron ore, shipped to Qingdao port of China, fell 24.1%, or decline is likely to set a minimum since 2012, in the last ten-day of a month, benchmark iron ore prices fell below $50 / tons, its lowest level since February. With is expected to increase iron ore inventories, prices may fall below $40 per ton. In April, 83.92 million tons of iron ore imports in China, fell 1.85 million tons, compared with the same period in last year, grow 4.6%. From January to April, accumulative total import 325 million tons, up 6.1% from a year earlier. According to ship tracking data, the amount of import may be about 325 million tons in May, slightly higher than in April, but lower than March 85.77 million tons.

This year, India is Asia's largest export market of coal for Colombia, Colombian thermal coal exports of 6.79 million tons in April, compared with the same time in last year, import growth of 20%. Asian exports increased to the highest since April 2012, 1.4 million tons, exports North America an increase of 200000 tons hit to 1.9 million

tons, exported to Europe fell by 600000 tons depress to 3.3 million tons. From January to April, the gross of coal exports is 27.05 million tons in Colombia, up 2% from a year earlier; including 2.25 million tons, exports to India in the next five months will ship 3.1 million tons. Among them 2.25 million tons export to India, in the next five months, it will ship 3.1 million tons.

Although excess supply of the international market and the price decline, import still have the advantage of transportation cost which face to area in Asia , therefore since this year the Chinese coal exports contrarian increased significantly. Export 520000 tons of coal and lignite in April. From January to April, the number of cargo for exporting is 3.3 million tons, to achieve an increase of 161.4% than last year. Main exports to South Korea, Japan, China Taiwan and other countries and regions. But imports continued to decline, at the same time, China's domestic hydroelectric power generation has maintained a strong momentum, the demand of thermal power shrink further. Import 18.8 million tons of coal, in April. Compared to last year reduce 1.15 million tons, down 5.76%. During the period from January to April, import 67.25 million tons; fell 2.5% year-on-year.

With temperatures rise step by step, coal consumption of society will increase, but the global coal supply is still in a relatively saturated state. Each big power plant obviously wants to clean up the inventory. Furthermore, countries such as Britain and America reduce power generation by coal, instead, efficient clean energy. Demand of coal market is still weak as a whole.

Since this year, Brazil loads and transports 32.23 million metric tons of soybeans to global market. The whole South America can transport 8 million in May, less than level in April and the same period in last year. After May, vessels waiting for loading in port reduce 20%, according to the statistics of Williams. In June, Brazilian soybeans loading capacity is 5.11 million tons. The Brazilian association of oilseed processing (Abiove) estimate producing 98.6 million tons soybeans this year, the figure will hit a record. At the same time, it is expected to export 55.3 million tons, the number still will set a record. China imports soybean in April, the number is 7.07 million tons, compared with the same period in last year, increase 33%. Imports is

23.33 million tons from January to April, grow 11% from a year earlier. In June and July, the number of expectation of soybeans which will load in port will arrive 8.8 million tons. The profit of crushers is considerable; it will stimulate the rate of operation to rise.

Delivery speed of capacity slowed further. Hand over 30 new ships, total carrying capacity is 2.5 million DWT. The cumulative delivery, since the beginning of this year, is 274 new vessels and 22.65 million DWT. Predict delivering 607 new vessels and 50.18 million DWT in the whole year 2016, 2.9% more than last year. Up to now, disassemble 262 ships, a total of 20.236 million ton. Among them, amount of dismantling of Cape-size is already more than 10 million DWT; achieve 62 ships and 10.59 million DWT.

1.1 Status analysis of fuel price

Since the middle of 2014, the international oil prices ended the high and volatile market, began to fall continuously. Ample supply, weak demand, lose supply and demand in crude oil market, is the primary reason of the current round of oil price decline. Before 2014, the continuous high operation of international oil prices stimulated a lot of oil resources to translate production into the crude oil market, but the global economic recovery is too weak to fully digest this abundance of production, leading to progressive excess supply of crude oil. From the beginning of the first quarter of 2014, the international crude oil market changed from the original tight supply and demand state to the excess supply state, the condition of supply exceeds the demand is expanding. In order to adapt to the new market structure, the international oil prices need to find a new equilibrium point. Therefore, from the middle of 2014, the international oil prices entered a new round of decline channel.

In 2015, the pattern of loose global crude oil market supply and demand fundamentals have not changed, the international oil prices continue to fall. But from the running condition, the annual oil price movements can be divided into two stages.

Before June 2015, China's implementation of the RRR cuts and interest rate cuts enhanced the crude oil consumption growth expectation, the Middle East geopolitical crisis aggravated the tension in the market, and investors in the futures market were bargain approach, showed the superposition of multiple positive factors, promoted international oil prices rebound in shock. In spite of this, due to the global crude oil market was still in a relaxed state, the stimulatory effects of geopolitics on oil prices was gradually fading, resulting in not only the lack of such a rebound, but also difficult to lasting. Therefore, after June, the international oil prices resumed fall trend, although there have been a slight rebound, the overall trend has always maintained downward.

In recent years, the global demand for crude oil is in the doldrums, the growth rate is slow, and the average annual growth rate from 2011 to 2014 is only 1%. By 2015, the data from IEA, EIA and OPEC three organizations showed that global oil demand growth has accelerated, in terms of mean, the global demand for crude oil is 93.748 million barrels/d in 2015, an increase of 1.69%, and the increase speed is a new high since 2011.

Global oil demand growth is closely related to the world economic growth. From the historical data, the global demand for crude oil demand growth and the global GDP growth showed a close positive correlation, the correlation coefficient is about 70%. Especially after the world financial crisis in 2008, crude oil demand growth and the global GDP growth was basically synchronous operation. But in 2015, the situation has changed. Although there was a further slowdown in world economic growth, the global crude oil demand growth has accelerated, and the demand market showed a pickup trend, from the data of IEA can see the global demand for crude oil increased 1.79 million barrels/d than in 2014. The author believes that the main reason is that, on the one hand, low oil prices stimulate the demand for crude oil for raw materials industry; on the other hand, low oil prices provide a good opportunity for crude oil consuming country to reserve crude oil.

From different regions, in 2015, OECD national crude oil demand was 46.167 million barrels/d, an increase of 485,000 barrels/d, non-OECD national crude oil

demand was 48.385 million barrels/d, an increase of 1.305 million barrels /d. Non-OECD countries are the main driving force for global oil demand growth, and its contribution ratio exceeds 70%. Among them, China and India led the global demand for crude oil growth, an increase of 6.03% and 6.91% respectively. China's crude oil demand reached 11.251 million barrels/d, an increase of 639,000 barrels/d, and demand growth rate rose again after 4 consecutive years falling. The first reason is that China's GDP growth rate is 6.9%, although it is the lowest value in 25 years, still belongs to the high growth rate, driven the growth of crude oil consumption; the second reason is that the Chinese government used the historical opportunity of low oil prices to accelerate the crude oil reserves, China's crude oil imports in 2015 reached 6.71 million barrels /d, an increase of 8.8%, hitting a record high.

Since 1980, the average annual growth rate of global demand for crude oil is 0.92%, since 2000, the global demand for crude oil is growing at an average annual rate of 1.19%. Contrast historical data, in 2015, global crude oil demand growth has been a relatively fast growth rate. Especially under the environment of the slow recovery of the global economy, demand for crude oil keep fast growth, shows that global oil consumption market is gradually recovering due to low oil prices, helps speed up the digestion of excess production of the global oil market. It can be said that the demand side is not the main reason for the international oil prices continue to fall in 2015.

Compared with the demand of crude oil, the global crude oil production still maintained a rapid growth rate. From the data of three organizations, in 2015 the world's crude oil production growth rate has been accelerated. Mean shows that in 2015 the world's crude oil production was 95.58 barrels/d, an increase of 2.7%, the highest value of production growth rate since 2005. There is no doubt that the rapid growth of crude oil production led to the global crude oil supply and demand more relaxed, which is the main reason for the low price of international oil prices in 2015. From the data of IEA, in 2014 the global supply and demand balance of crude oil is 918,000 barrels/d, while in 2015 the global demand for crude oil increased 1.79 million barrels /d; in other words, if the supply of crude oil maintained the level of

2014, demand pickup would enough to digest excess production, the global crude oil market has been rebalancing, and changed the pattern from loose supply and demand to balanced supply. However, crude oil production in 2015 did not reduce because of low oil prices, but with a faster growth rate, leading to a more global supply of crude oil surplus, supply and demand deficit expanded to 1.728 barrels /d.

From OPEC countries and non OPEC countries, respectively, the data from three organizations showed that in 2015 OPEC crude oil production growth rate was significantly faster than non-OPEC countries. Mean showed that in 2015 OPEC crude oil production growth rate was 3.3%, and the growth rate of crude oil production in non-OPEC countries was 2.3%. Although global crude oil production is growing, OPEC countries have become the main force in global production.

From the 2015 quarter of crude oil production trends point of view, non-OPEC countries crude oil production remained at the same level in each quarter, little declined in the fourth quarter. This showed that the continued decline in crude oil prices have impact on the production of non-OPEC countries, some countries have begun to cut the high cost production. OPEC national crude oil production has maintained a steady upward trend, in the fourth quarter has reached 38.50 million barrels/d, far more than 3000 barrels/d of production ceiling. Rely on the cost advantage of crude oil, OPEC countries led by Saudi Arabia determined not to cut production, adhered to the low price in exchange for market share, resulting in its production continued to rise. Due to the rise in production, the remaining capacity of OPEC has dropped to 1.586 million barrels/d, the lowest value for the 2009. Saudi Arabia determined not to cut its crude oil production, which has lost its role of crude oil "Mobile producer", also damaged the global crude oil market stability mechanism to a certain extent.

In non-OPEC countries, the change of crude oil production in the United States and Russia is particularly a matter concern. As a result of technological progress to efficiency promotion, the U.S. crude oil production continued to rise until July 2015, reached 9.60 barrels/d, close to its highest yield in history; but then, the continued oil prices decline ultimately made some of the American Oil Companies embarrassing

burden and bankruptcy, resulting in U.S. crude oil production fell to the current 9.20 million barrels/d. Hughes Beck data showed that since the beginning of 2015, the number of U.S. drilling rigs has been declining, which was also reflected low oil prices do affect the U.S. oil and gas investment. As of January 8, 2016, the number of U.S. drilling rigs has dropped to 664 units, compared with the same period in 2015 decreased by 62%. Russia's crude oil production has little change, according to OPEC data, Russian crude oil production was 10.79 million barrels/d in 2015, an increase of only 1.1%.

As mentioned earlier, the supply side is the main reason for the 2015 international oil prices low-price operation, but further analysis shows that the non-OPEC national crude oil production has been slowing growth by the impact of low oil prices, but OPEC national crude oil production remained faster growth. Therefore, the rapid growth of the supply side of the OPEC national output is the main reason for the 2015 international oil prices continued low-price operation.

As we all know, before the oil and gas field production, need to invest a lot of capital in the exploration, development, construction and other aspects. This part of the capital investment will be in depreciation, depletion and amortization (DD&A) allocated to each year according to a certain rule, after the whole life cycle of oil and gas fields are put into operation. However, if from the perspective of cash flow, the initial capital investment has been recovered in the end of the investment recovery period. In terms of those oil and gas field project who has been over the investment recovery period, accounting treatment will increase the cost of oil and gas field in the year after the oil and gas field is put into operation, in fact, as long as oil prices can make up for the cost of oil and gas fields each year, the project of oil and gas field has profitability.

Take Norway petroleum, ConocoPhillips, Occidental Petroleum, Anadarko EOG, Devine, Chesapeake, the 7 oil companies as example. The reasons for choosing the 7 oil companies are: first, the 7 oil companies are ranked in the top 50 of "Petroleum Intelligence Weekly" (PIW), with a representative; second, the 7 oil companies are independent exploration and development of oil, there is no downstream hedge, more

sensitive to the oil price fluctuations and barrels of oil costs; third, it is able to more fully obtain the financial information of the 7 oil companies. Due to the oil companies in addition to engage in oil and gas field exploration, development and production, also engaged in crude oil trade and oil and gas and financial services. Therefore, in order to more directly describe the problem, choose the five barrels of oil costs directly related to oil and gas production to analyze. Five barrels of oil costs include OPEX, DD&A, abandonment and disposal charges, SG & A, other taxes in addition to the income tax.

From the analysis results can be seen in the first three quarters of 2015, the five barrels of oil costs of the 7 oil companies average cost is $ 26.74, excluding DD&A, the average cost is down to $14.21. This means that the "ultimate cost" of the oil companies to maintain production and operation is very low, the current level of oil prices do affect their profitability, but they still have the profitable space. That is to say, the petroleum enterprise must have the stronger survival ability than the imagination. In this case, in order to increase profits, improve production is a better strategy for oil companies, so oil companies have more power to increase production. The selected 7 crude oil companies' production growth rate year on year reached 10%. This can also be considered an important reason for low oil prices, but the global crude oil production has not been affected, and continues to maintain a rapid growth rate.

It should be noted that, even if for the oil and gas field has spent the payback period, it is necessary to increase new investment each year to maintain production scale; at the same time, the new oil and gas projects of oil companies will be subject to low oil prices and slow down, so if the oil prices is in downturn for long-term, it will have an impact on oil production. In addition, 7 selected typical companies in this paper are industry leaders, its level of management, cost control and other aspects are the leader in the industry, if in terms of the whole industry, cost level must higher than the mean values of seven companies, for low prices will also be much weaker, so it can be seen that global production growth is more slowly than the mean value of seven companies.

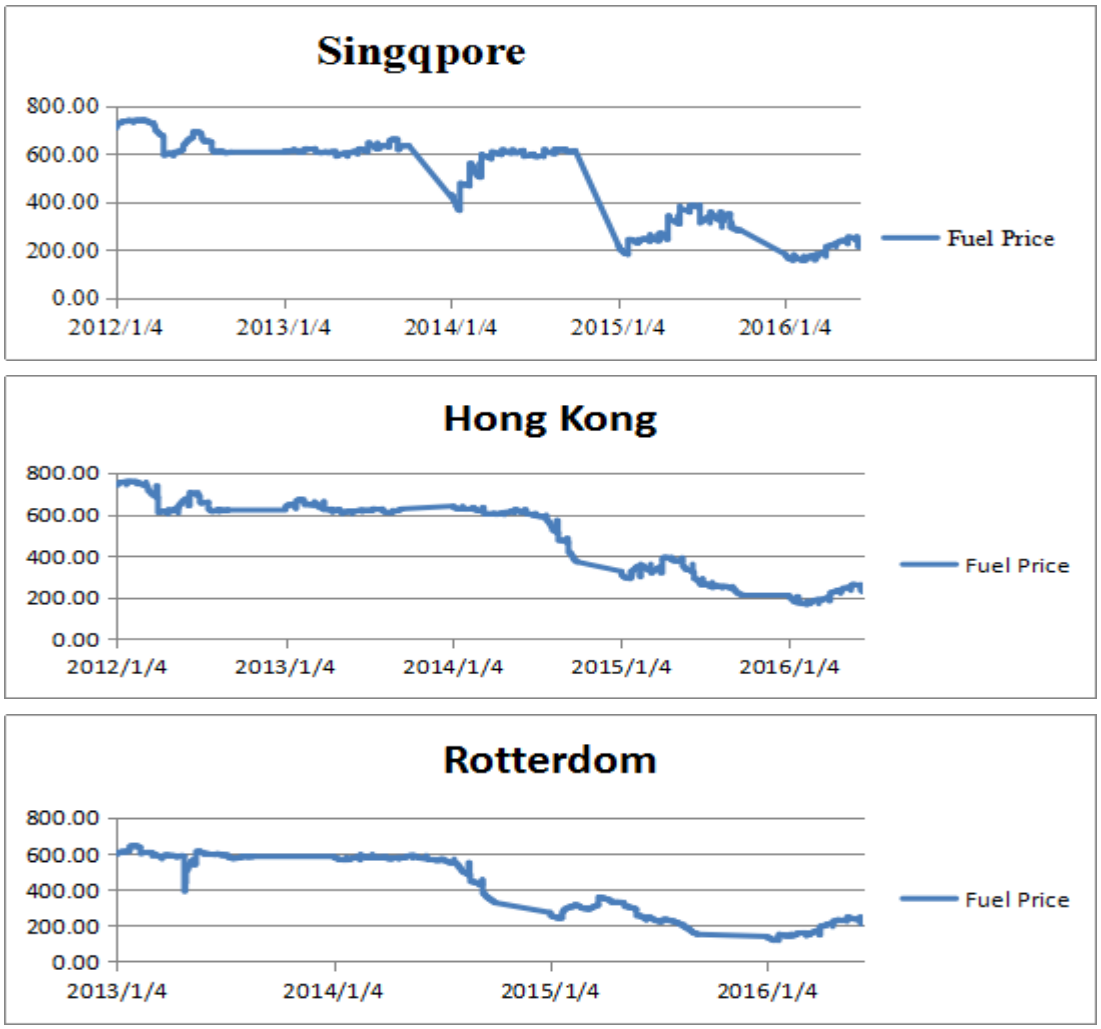


Chart 3-4: the trend of fuel price in each port

Different port has different fuel prices. According to the chart 3-4, it can be seen that the trend of fuel price in each port is similar. The fuel price had a sharp decrease since the middle of 2014.

3.2 The impacts of fuel price on dry bulk cargo market

3.2.1 The impacts of fuel price on the freight rate

For the dry bulk market, decline of fuel prices will inevitably bring the transport cost reduction, but the relationship between fuel prices and freight is dynamic, not static. For this reason, the question focused on the material benefits will be how to dynamically allocate between owner and owner. Compared to the highly utilized, owner fragmented container market, the dry bulk market supply is weaker. Under “one ship one single” bargaining mode, the owner's bargaining power is stronger, decrease in oil prices generally directly caused by the fall of freight rate so that cargo owner can gain benefits.

As for prices, freight is made up of two parts, one is voyage operating costs, and the other is owner returns. The owner income is mainly decided by the market supply and demand situation. At present, the dry bulk market is under a seriously imbalanced situation, and owner's profit is low, the voyage part is close to zero. Vessel operating costs mainly contain three factors, port disbursement, fuel surcharge and fixed cost, re. (shipping cost of capital, depreciation, the crew wages, food, Marine insurance, operation and management cost, etc.). In ship management,the operating cost of ship voyage costs is a variable cost. Therefore, it is often the rate of final bottom line. If the rate is below the voyage costs, the owner can only choose anchor suspension. Because of the difference of dead-weight tonnage size of dry bulk cargo, ships are huge. The capacity of the smallest dry bulk cargo vessel, a type of handy-size, is only thousands of dead-weight tonnage, but the biggest dry bulk cargo is 400000 dead-weight ton VLOC. Ships with different sizes have different routes. Consequently, in the dry bulk cargo ships, it is difficult to estimate the proportion of fuel costs occupying the voyage costs, and it is not reasonable as well. In a practical view, the proportion of fuel costs accounts around 30-90% of voyage costs, sometimes even more than 90%. For example, in 1.8 million dead-weight tons of cape-size ships, the variable cost is mainly composed of light fuel, overloading fuel costs as well as the port of destination port disbursement. On the round trip China – Brazil, fuel costs accounted for the proportion of the variable cost can reach 92%. But on the route from China to the western, it is only about 60% of the cost of change.

Since 2008, the overall international oil prices remain high. In June 2014, the

international market crude oil prices reached $106 a barrel, but the end of January in 2015 the international crude oil prices fell to $45.15 a barrel, oil prices fell nearly 58%. There is no denying that a fall in oil prices reduces the voyage costs, but in the case of imbalance between supply and demand, the fallen oil prices will also lower the freight rate directly. Here we demonstrate three cape-sized ships, one is from Brazil Tubaro to China Qingdao C3 freight index and another is from western Australia to China Qingdao C5 freight index, the indexes as objects to compare can be seen from chart 2.The tendency of C3 freight movements or C5 freight movements is similar with crude oil prices. If oil prices are down for a long time, status quo, the shipping fee is bound to decline. But the rise in oil price cannot drive the growth of freight rate. This also indicates that at present, the dry bulk shipping market supply exceeds demand, owners are in a weak position in negotiation.

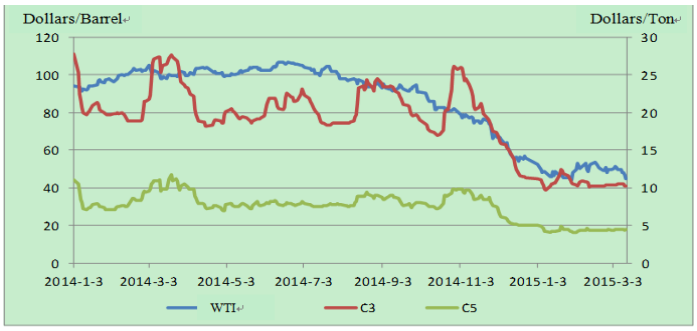


Chart 3-5: the trend chart of oil price, C3 and C5

As shown above, from 2012 to 2014, when BDI index reached the lowest of the year, the price difference of C3 and C5 comes from the shipping fee. However, in December of 2014, C3,C5 hit the lowest since the financial crisis due to the fall in oil price.

Table 3-1: BDI annual minimum corresponding rate and oil prices from 2012 to 2014

	BDI	BCI	C3	C5	TC Avg BCI	WTI
Feb-12	647	1436	19.42	7.43	5251	102.26
Jan-13	698	1237	16.40	6.95	4864	94.83
Jul-14	723	1191	18.30	7.83	8486	102.39
Dec-14	782	474	11.41	5.11	3670	55.84

3.2.2 The impacts of fuel price on the trade volume of dry bulk cargo

From the previous section we can know the fuel price takes large proportion in the operating costs. Therefore, fuel price influences the freight rate directly. At the same time, the fuel price have impacts on other factors of dry bulk cargo market as well such as the volume of dry bulk cargo transported. The increase and decrease of fuel price can make the trade volume of the world face changes. In other words, there is a correlation relationship between the fuel price and freight volume. I will demonstrate the correlation relationship using three correlation analysis,iron ore, bulk grain and coal.

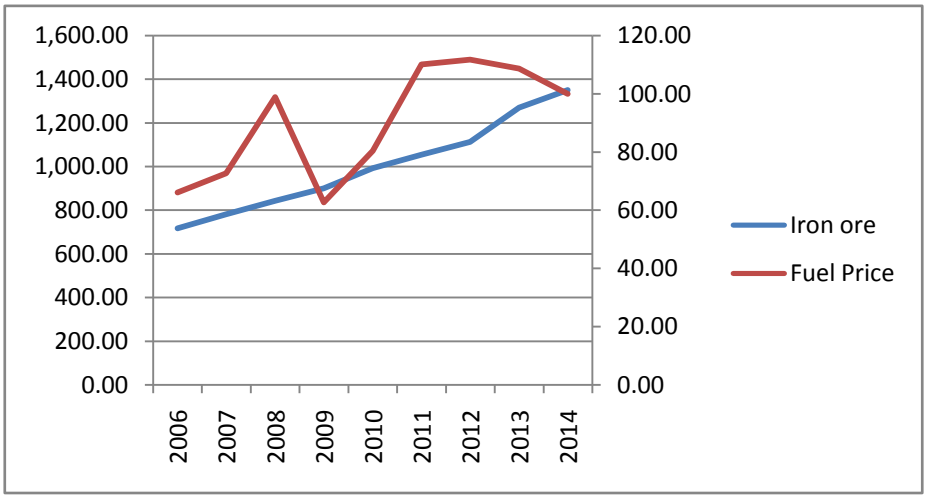


Chart 3-6: the trend of trade volume of iron ore and fuel price

According to the chart 3-6 we can see the trade volume of iron ore increase year by year. Although there was a financial crisis between the middle of 2008 and the end of 2009, the volume did not reduce. On the other side, there was sharp decrease between the middle of 2008 and the end of 2009. It is fairly obvious that the cause was the financial crisis. The crisis put a lot of industries in trouble, including shipping industry. After the financial crisis in the end of 2009, the fuel price rebounded. Finally, the trend stabilized since the middle of 2011. Compared the red line to the blue line, from time to time, the trend of the fuel price and the trade volume of iron ore were similar. The trend suggested there was a correlation relationship between the fuel price and the trade volume of iron ore.

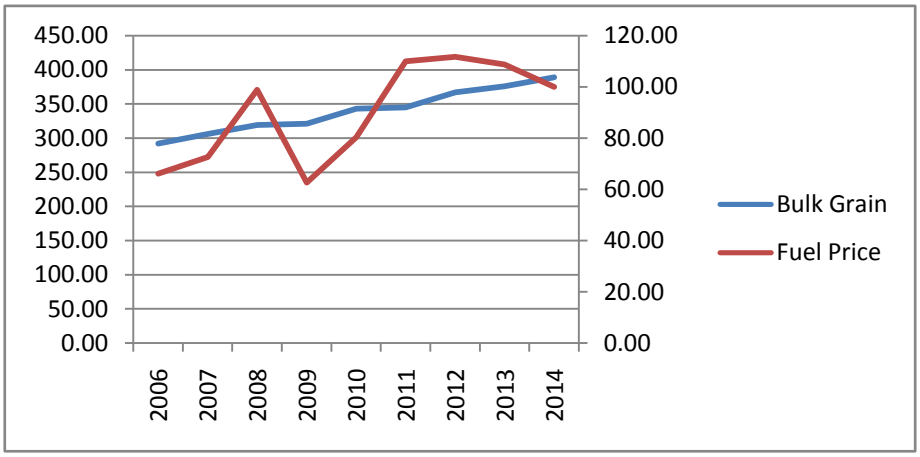


Chart 3-7: the trend of fuel price and trade volume of bulk grain

There are two lines in the chart 3-7, one is the trend of fuel price, and another is the trend of bulk grain. Unlike the trend of trade volume of iron ore, it experienced a smooth variation when the financial crisis happened. During this period, trade volume of bulk grain was nearly unchanged. However, the whole trend of trade volume of bulk grain is increase from 2006 to 2014. Compared with the trend of fuel price, the two trends are some similar as well. Thus it can be seen, it exists a correlation relationship between the fuel price and the trade volume of bulk grain.

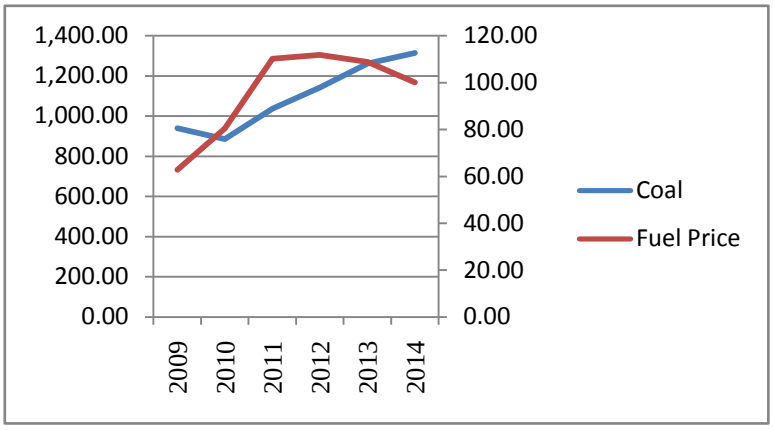


Chart 3-8: the trend of fuel price and trade volume of coal

The chart 3-8 shows that the financial crisis influences the trade volume of coal, because of the short decrease between the middle of 2009 and the end of 2010. In the chart 9, there is a similar tendency of fuel price and the trade volume of coal in the period from the end of 2010 to the middle of 2013. Although the similarity degree between fuel price and trade volume of coal does not bigger than the degree of iron ore and bulk grain, it can also see that there is correlation relationship between the two elements.

From the above, the fuel price influence the trade volume of iron ore, the trade volume of bulk grain and the trade volume of coal, respectively. From the research can see the fuel price impacts the trade volume of dry bulk cargo. In the next chapter, the thesis will use the data of fuel price and the trade volume of three dry bulk cargoes to figure out the degree of correlation by simple linear regression model.

3.2.3 The impacts of fuel price on the ship size

Dry bulk cargo is one of the main cargoes of world shipping. According to the data of the year 2009, the dry bulk trade of volume occupies more than 53% of the trade volume of bulk. The trade volume of iron ore accounted for 17% of the dry bulk trade. Similarly, the fleet size of the global bulk cargo is the most great in the three sea transport fleet. The global bulk fleet accounted for more than seventy percent of the

world's total capacity. Nowadays, the main bulk ship types are Handysize, Handymax, Panamax and Capesize. The carrying capacity of the four types are 10000 to 35000dwt, 35000 to 59000dwt, 60000 to 80000dwt and 80000 and over, respectively.

Table 3-2: the growth of global dry bulk carrier capacity

	2006	2007	2008	2009	2010	2011	2012	2013	2014
Growth	6.67%	6.52%	6.89%	8.50%	14.80%	15.20%	12.30%	5.60%	5.30%

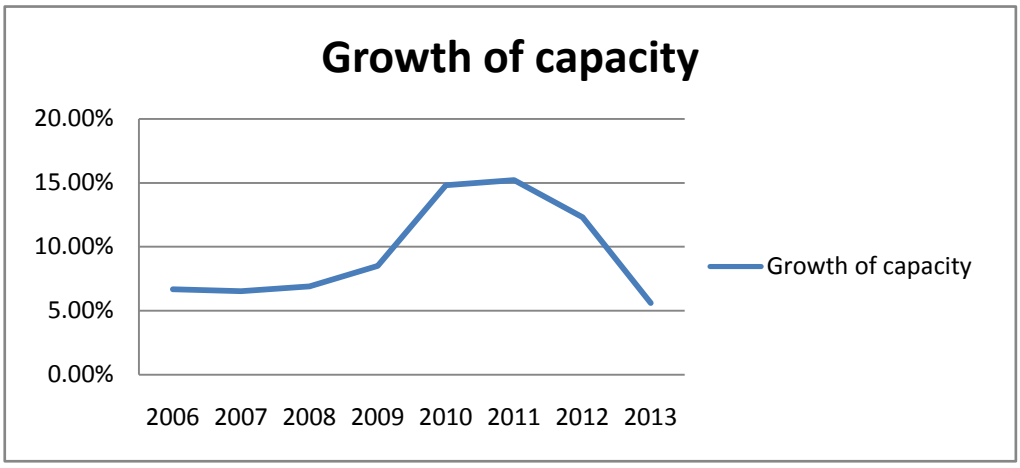


Chart 3-9: the trend of growth of global dry bulk carrier capacity

Contrast the development of the ship in recent year, ship's large-scale trend is obvious. According to the chart 3-9 and table 3-2 can see that, after the financial crisis in 2008 and 2009, the capacity increase so fast. The reason is ship companies dry bulk cargo market appeared more and more large cargo ships. That means the proportion of the Capesize and the vessel, whose capacity is more than the Capesize, in the rises continuously in the global ship fleet. Thus it is not hard to see, the development of the dry bulk shipping market in recent years shows more and more strong trend of manufacturing big vessels undoubtedly. The reason of this trend is not only the global trade, but also the fluctuation of fuel price.

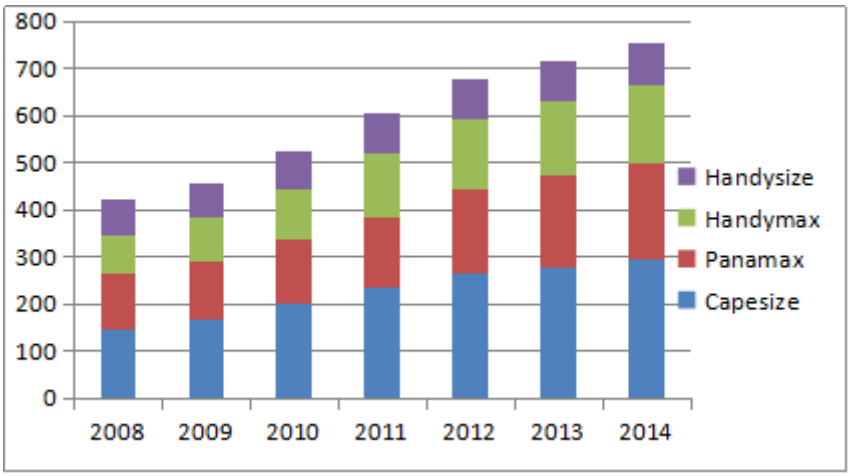
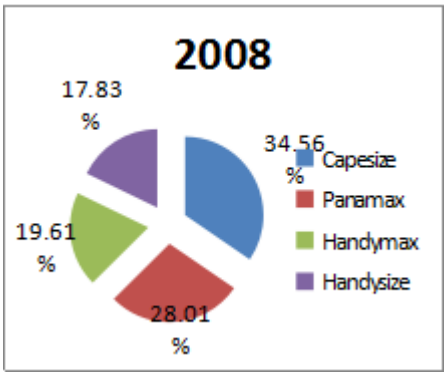
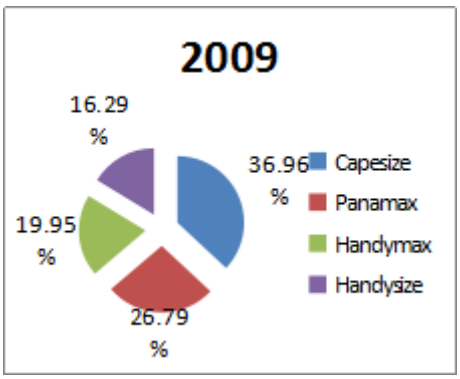
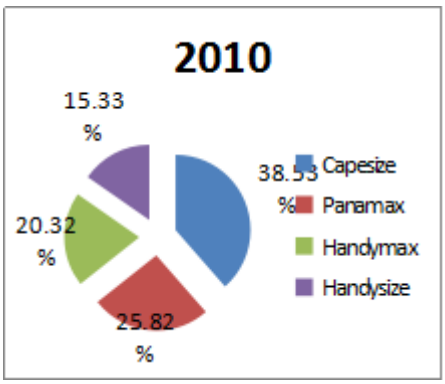
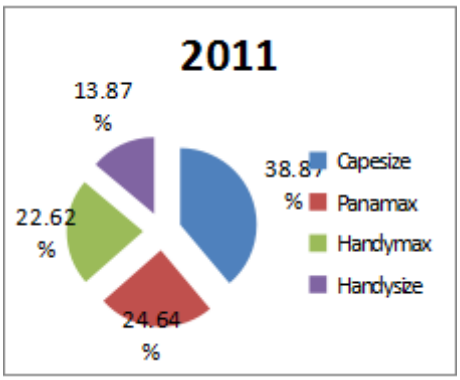


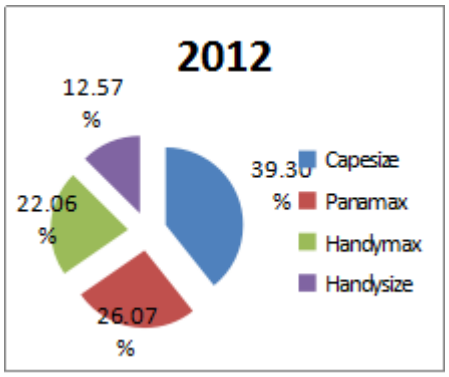
Chart 3-10: different ship size different capacities in recent years

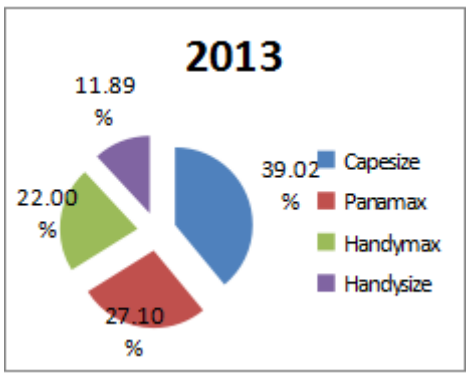












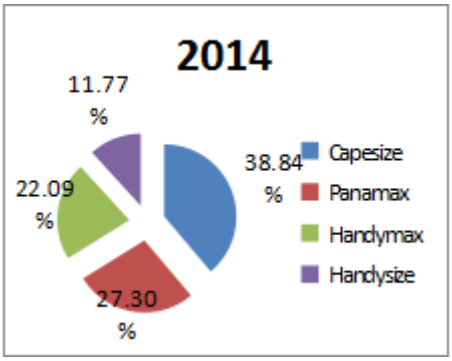


Chart 3-11: the percentage of each ship in recent year

From the chart 3-10 and chart 3-11 can know that the total capacity of Handesize accounted for less and less of the total global dry bulk carrier capacity. At the same time, on the contrary, the percentage of the total Capesie occupy the global dry bulk carrier capacity is an upward tendency and the percentage is always the biggest. Consult the shipping data in Drewry, which show in chart 4 and chart 5, under the pressure of fuel price fluctuations, more shipping companies choose the lower unit transportation cost of large dry bulk ship type to adapt to the market.

Under the double pressures of shrinking transportation market and the fluctuation of fuel price, large vessels show advantage properties of cost reduction in fuel consumption and many other factors. The four mainstream ship type which appeared in recent year selected in this paper, a standard ship were analyzed, and the ship data from the Baltic exchange market report.

Table 3-3: fuel consumption of each ship size

Ship Size	DWT	Speed (Kn)	Fuel Consumption (ton/day)	Fuel Consumption (/dwt)
Capesize	172000	14.5/15	56	0.000326
Panamax	74000	14	32/38	0.000473
Handymax	45496	14	29.5	0.000648
Handysize	28000	14	22	0.000786

From the table 3-3, obviously, Capesize ship on each tonnage of fuel consumption is better than the other three kinds of ship type, less 31.1% than Panamax, smaller 49.7% than Handymax, and less 58.5% than Handysize, respectively. Under the condition of fluctuation of fuel price, using a kind of index on the state of the ship shows that large-scale ship has a good obviously bear ability to fuel price. It reflect that compared with smaller ship size, the required fuel consumption of per ton is small when sailing.

It can be seen from the above cost calculation, under the same condition, for the larger ship form, the fuel costs in the total cost accounted for the proportion of the smaller. On the one hand, it may prove the large vessels have advantages on saving fuel. On the other hand, in the face of volatility of fuel price, because fuel price accounted for a small proportion in total operation cost, when the fuel price increase, the influence degree on large-scale ships is less than the impact on smaller ships. Therefore, the analysis can draw the conclusion that, in theory, the larger the ships, the less fuel consumption accounted for in the total cost, namely, the better the fuel economy.

4. Correlation analysis

4.1 Methodology

4.1.1 Research method

Kavussanos (1996) creates a single variable and multi-variable analysis of the seasonal model study of dry bulk freight index, the characteristics of seasonal fluctuation in the international dry bulk shipping market. Shi(2014) uses correlation analysis to analyze the characteristic of dry bulk freight rate and uses the ARCH model to research the sustainability of the dry bulk freight rate index fluctuation. Zhang(2012) uses the balance between supply and demand model to reflect the international dry bulk shipping market balance of supply and demand situation scientifically. Zhang(2011) uses correlation analysis to analyze the relationship between the two ship type, Capesize and Panamx, and some factors of shipping industry, such as cost, cargo type, transportation routes, capacity and freight rate.

Through the past research methods, that can be seen the correlation analysis is the main methods to analyze the influence degree. This thesis will use regression model to figure out the correlation analysis.

4.1.2 The definition of model

In statistical modeling, regression analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables (or 'predictors'). More specifically, regression analysis helps one understand how the typical value of the dependent variable (or 'criterion variable') changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables – that is, the average value of the dependent variable when the independent variables are fixed. Less commonly, the focus is on a

quantile, or other location parameter of the conditional distribution of the dependent variable given the independent variables. In all cases, the estimation target is a function of the independent variables called the regression function. In regression analysis, it is also of interest to characterize the variation of the dependent variable around the regression function which can be described by a probability distribution. A related but distinct approach is Necessary Condition Analysis (NCA), which estimates the maximum (rather than average) value of the dependent variable for a given value of the independent variable (ceiling line rather than central line) in order to identify what value of the independent variable is necessary but not sufficient for a given value of the dependent variable.

Regression analysis is widely used for prediction and forecasting, where its use has substantial overlap with the field of machine learning. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. However this can lead to illusions or false relationships, so caution is advisable

4.1.3 The theory of model

Regression models involve the following variables:

The unknown parameters, denoted as β, which may represent a scalar or a vector.

The independent variables: X.

The dependent variable: Y.

In various fields of application, different terminologies are used in place of dependent and independent variables.

A regression model relates Y to a function of X and β.

$$Y \approx f(X, \beta)$$

The approximation is usually formalized as $E(Y \mid X) = f(X, \beta)$. To carry out regression analysis, the form of the function f must be specified. Sometimes the form of this function is based on knowledge about the relationship between Y and X that does not rely on the data. If no such knowledge is available, a flexible or convenient form for f is chosen.

Assume now that the vector of unknown parameters β is of length k. In order to perform a regression analysis the user must provide information about the dependent variable Y:

If N data points of the form (Y, X) are observed, where $N < k$, most classical approaches to regression analysis cannot be performed: since the system of equations defining the regression model is underdetermined, there are not enough data to recover β.

If exactly $N = k$ data points are observed, and the function f is linear, the equations $Y = f(X, \beta)$ can be solved exactly rather than approximately. This reduces to solving a set of N equations with N unknowns (the elements of β), which has a unique solution as long as the X are linearly independent. If f is nonlinear, a solution may not exist, or many solutions may exist.

The most common situation is where $N > k$ data points are observed. In this case, there is enough information in the data to estimate a unique value for β that best fits the data in some sense, and the regression model when applied to the data can be viewed as an overdetermined system in β.

In the last case, the regression analysis provides the tools for:

1. Finding a solution for unknown parameters β that will, for example, minimize the distance between the measured and predicted values of the dependent variable Y (also known as method of least squares).

2. Under certain statistical assumptions, the regression analysis uses the surplus of information to provide statistical information about the unknown parameters β and predicted values of the dependent variable Y.

4.2 Data research

The data research from the internet and a shipping company. (From January in 2013 to April in 2016)

Table 4-1: the data of fuel price and BDI

Date	Fuel Price	BDI	$(x-\bar{x})\times(y-\bar{y})$	$(x-\bar{x})^2$	$(y-\bar{y})^2$
1	112.47	698.00	-7606.99	842.75	68664.01
2	112.14	700.00	-7463.12	823.69	67619.85
3	111.31	706.00	-7080.07	776.74	64535.40
4	111.40	712.00	-6935.17	781.77	61522.94
5	111.94	734.00	-6442.11	812.25	51093.26
6	111.76	743.00	-6146.54	802.03	47105.57
7	111.89	751.00	-5947.15	809.41	43696.96
8	110.64	760.00	-5441.06	739.84	40015.27
9	111.88	762.00	-5632.22	808.84	39219.12
10	110.30	765.00	-5238.74	721.46	38039.89
11	110.61	781.00	-4864.48	738.21	32054.67
12	111.10	820.00	-3873.47	765.08	19610.69
13	111.89	837.00	-3500.45	809.41	15138.39
14	111.71	838.00	-3450.03	799.20	14893.32
...	...	...	...	...	...
806	41.79	398.00	23408.84	1734.72	315886.91
807	40.47	398.00	24150.73	1846.41	315886.91
808	40.44	401.00	24038.59	1848.99	312523.68
809	39.14	406.00	24543.84	1962.48	306958.30
810	39.26	409.00	24344.82	1951.86	303643.07
811	39.60	414.00	23938.27	1921.94	298157.69

812	38.67	429.00	23774.53	2004.35	282001.55
Sum	67753.21	779551.00	5757609.23	662600.54	137253045.82
Average	83.44	960.04	7090.65	816.01	169030.84
Symbol	$\bar{x}$	$\bar{y}$	σ_{xy}	σ_x^2	σ_y^2

4.3 Calculation of correlation between BDI and fuel price

4.3.1 Building a model

Simple linear regression model can be expressed as:

$$y_i = b_o + b_1 x_i + u_i$$

In the formula, b_0 , b_1 are the unknown parameters; u_i is the remaining residual item or can be called random disturbance term. Adopt the random disturbance term u_i , so that including all the other factors affecting the change of the dependent variable y_i .

4.3.2 Evaluation parameters

If use simple linear regression model to analyze and forecast, need to assess the two unknown parameters b_0 and b_1 . Build a unary linear regression equation:

$$y_i = b_o + b_1 x_i$$

A good measure should satisfy the demand of consistency, unbiasedness and validity.

Method of estimation of parameters in linear regression model usual is divided into two type, one is ordinary least square, the another is maximum likelihood estimate method.

The meaning of least square method is make:

$$\sum_{i=1}^{n} u_i^{\,2} = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 = \sum_{i=1}^{n} (y_i - b_0 - b_1 x_i)^2$$

Achieve the minimum.

In the above equation, y_i is the actual value, but $\hat{y}_i$ is the theoretical value or called estimated value.

According to the extreme value theory of mathematical analysis, if want to work out the minimum of $\sum_{i=1}^{n} u_i^{\,2}$, just need solve the partial derivatives of b_0 and b_1 in the last equation, and then, make them equal to zero.

Get the two formulas of b_0 and b_1 :

$$b_1 = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2}$$

$$b_0 = \bar{y} - b_1 \bar{x}$$

In this thesis, nothing but exist a relationship between the fuel price and BDI, then can find the regression equation between the two elements. Therefore, if the paper find the linear regression equation between fuel price and BDI, that not only can prove that there is a correlation between both, but also can realize the correlation coefficient through the result. So, next step is data calculation.

According to the data in the table 4-1, combined with previous formula, can work out:

$$b_1 = \frac{575760923}{66260054} = 8.69$$

$$b_0 = \bar{y} - b_1 \bar{x} = 960.04 - 83.44 * 8.69 = 234.99$$

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.603747435
R Square	0.364510965
Adjusted R Square	0.36372641
Standard Deviation	328.1500817
Observed Value	812

Variance Analysis					
	df	SS	MS	F	Significance F
Regression Analysis	1	50030240.15	50030240.15	464.6089313	8.40515E-82
Residual	810	87222805.66	107682.4761		
Total	811	137253045.8			

	Coefficients	SE	t Stat	P-value	Lower 95%	Upper 95%
Intercept	234.9943689	35.55388042	6.609528023	6.98782E-11	165.2057645	304.7829734
X Variable 1	8.689412242	0.403131398	21.55478906	8.40515E-82	7.898106839	9.480717645

In this thesis, the R Square is:

$$R^2 = 1 - \frac{\sum (y - \hat{y})^2}{\sum (y - \bar{y})^2} = 0.36$$

the correlation coefficient is :

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2}\sqrt{\sum (y - \bar{y})^2}} = 0.604$$

4.4 Result analysis

Using correlation analysis to analyze the relationship is a common method in research. Using regression model to prove the close degree of some elements is also a common method. Through the data and calculation, there is a correlation between BDI and fuel price. The correlation coefficient is 0.608 and the R Square is 0.36. Although the index show the relationship between fuel price and BDI are not very strong, it still can prove fuel price have an impact on BDI or the two elements have correlativity. By the way, the linear regression model also can forecast the figure, but in this thesis, the study just needs to prove the correlation relationship between fuel price and BDI.

4.5 Correlation between fuel price and trade volume

Use the same method to figure out the degree of correlation between the fuel price and the trade volume of three dry bulk cargoes. The results are as follows.

4.5.1 Iron ore

Table 4-2: fuel price and trade volume of iron ore from 2006 to 2014

	Million tons								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Iron ore	716	780	842	899	992	1053	1112	1270	1350
	Dollar/ Barrel								
Fuel price	66.11	72.66	98.82	62.67	80.34	110.03	111.73	108.68	99.98

The volume of iron ore transported is in the table 4-2, meanwhile, the data of fuel price is also in the table 4-2. The data is from 2006 to 2014. It was found in Drewey.

Table 4-3: the calculation between fuel price and trade volume of iron ore

Regression Statistics	
Multiple R	0.704781
R Square	0.496716
Adjusted R Square	0.424819
Standard Deviation	164.2035
Observed Value	9

From the table 4-3 can see that the correlation coefficient is about 0.705. This correlation coefficient can prove there is a positive correlation between the fuel price and the trade volume of iron ore. Moreover, the 0.705 can show the correlation is strong. As a consequence, the research show that between the fuel price and the trade volume of iron ore has a strong positive correlation, put another way, the fuel price influences the trade volume of iron ore.

4.5.2 Bulk grain

Table 4-4: fuel price and trade volume of bulk grain from 2006 to 2014

	Million tons								
	2006	2007	2008	2009	2010	2011	2012	2013	2014
Bulk grain	292	306	319	321	343	345	367	376	389
	Dollar/ Barrel								
Fuel price	66.11	72.66	98.82	62.67	80.34	110.03	111.73	108.68	99.98

Put the data of bulk grain and fuel price in table 4-4. The data is also from the Drewry, and the time nodes are from 2006 to 2014.

Table 4-5: the calculation between fuel price and trade volume of bulk grain

Regression Statistics	
Multiple R	0.746753
R Square	0.55764
Adjusted R Square	0.494446
Standard Deviation	23.47663
Observed Value	9

The table 4-5 shows that the correlation coefficient of between the two factors is about 0.747. The figure explains between the fuel price and the trade volume of bulk grain exist a positive correlation relationship. The figure is so big (the max is 1) that it can attest the correlation is very strong. Therefore, the fuel price impacts the trade volume of bulk grain as well.

4.5.3 Coal

Table 4-6: fuel price and trade volume of coal from 2009 to 2014

	Million tons					
	2009	2010	2011	2012	2013	2014
Coal	321	343	345	367	376	389
	Dollar/ Barrel					
Fuel price	62.67	80.34	110.03	111.73	108.68	99.98

The same with the previous two dry bulk cargoes, the data in table 4-6 also find from Drewry. But the different point is the time nodes are from 2009 to 2014.

Table 4-7: the calculation between fuel price and trade volume of coal

Regression Statistics	
Multiple R	0.661803
R Square	0.437983
Adjusted R Square	0.297478
Standard Deviation	16.66209
Observed Value	6

The correlation coefficient can be seen from the table 4-7 is the 0.662. Although it is smaller than the correlation coefficients in the table 4-3 and table 4-5, the number also can prove there is a positive correlation relationship between the fuel price and the trade volume of coal, likewise, the correlation is still strong. Thus can know, the fuel price influences the trade volume of coal.

Therefore, the data research shows that there is a positive correlation between the fuel price and the trade volume of dry bulk cargo. At the same time, the result of research also proves the correlation is strong.

5. Suggestions for shipping company handle the fluctuation of fuel price

5.1 Economic speed

Economic speed is the speed with minimum cost in the fixed transportation distance, namely the minimum fuel consumption per mile, and includes absolute economic speed and relative economic speed. Absolute economic speed refers to the speed with least oil consumption without considering shipment cost in the same mile. It has serious limitations. The economic speed we said in shipping production is the relative economic speed that considers the shipment cost. The choice of economic speed is mainly influenced by oil price and rental levels of shipment. When corresponding cost change of the saved oil quantity in each day is equal to increased rental cost change caused by declined speed, which reaches to the critical point of economic speed. In order to facilitate comparison, whole voyage divides the saved oil cost in the shipment with reduced the speed in each mile and the shipment cost caused by the declined speed in each mile, finally calculate that reduced speed, full speed, oil cost saving and shipment loss has nothing to do with the actual distance, and only are related to oil price and daily rental level. The details are as follows:

The oil cost saving calculation formula in different shipment speed in each mile:

BS= 【full speed daily oil consumption/（full time*24）-reduced speed daily oil consumption/（reduced speed*24）】x oil price

The shipment loss calculation formula in different speeds in each mile:

TL= [1/（full speed*24）-1/（full speed*24）]*daily rental level

In principle, as long as BS > TL, it is more cost-effective to use reduced speed, and vice versa, it is more cost-effective to use high speed. In addition, it also uses the difference between BS and TL to measure the oil saving effect, it is more cost-effective when the different is bigger than 0 and turns bigger.

In the case of oil price fluctuations, the shipping company reduces speed considering the situation, which is a way to save cost. If the future oil price becomes stable, then how to choose the most economic speed?

Under the assumption that oil price has been fixed, how to choose the most economic speed in shipment is determined by the change of market rental level, the speed is proportional to market rent level. The level is higher, the fastest speed is most economic.

Taking the typical food transportation from South America to China, the general oil price was over $600 in Singapore in the second quarter of 2014, ship owners all chose the reduced speed. Currently, the price in Singapore is only $270, calculating the transportation fee of $24/per ton in 2015 from South America to China, if the reduced speed is used, the rental level is $7100 per day; if the full speed is used, the rental level is $7275 per day, the effect of full time is better than the reduced speed. If the oil price continues to fall, there will be more and more ship owners who will choose full speed. In that case, the shipment time will be shortened to 95 days from 106.7 days and 11.7 days is saved, which means the single voyage capacity increases about 11%.

If transportation capacity supply increases, it will inhibit the rise in rents in turn. Once the rental level is lower than the one of economic speed critical point, ship owners will choose the reduced speed again. Shipping enterprises shall deeply analyze various factors, carefully study and research, pay close attention to the trend of oil prices and rent levels, choose the real economic speed and improve the their level of profitability.

5.2 Energy-saving technology

Different from the economic speed, the suggestion of shipping companies on fuel price, energy-saving technology is a suggestion of shipping companies on technical innovation.

(1) Due to international fuel price increases quickly, the cost rises constantly. Especially, the EU announced mandatory regulations on the use of low sulfur fuel oil in 2015, it may cause the growth of fuel cost. Shipping company can reduce fuel costs by reducing fuel consumption, thus can use cheap price of high viscosity oil 380 CST, 380 CST fuel oil is at 50 ℃ of kinematic viscosity is greater than or equal to 380, fuel prices haven't changed much in the overall price movements. Secondly, can mix in fuel additives in the normal use in order to increase the combustion value, through reasonable calculate to determine the appropriate adjustment ratio of crude oil.

(2) The purpose of hull modification is through the ship's linear optimization, power propulsion and ship accessories improve optimization to implement technical oil-saving. Firstly, in the process of ship's linear optimization, including the transformation of the ship tail shape. Linear optimization techniques to the ball tail hull design as an example, based on the main principle for fluid mechanics principle, through the tail on the ball tail and stern wave calculation, estimate the length of the hull waterline, in order to have the effect of wave pressure wave, the wake influence rectifier thus increasing efficiency of ship propulsion, budget the host power saving more than 8% according to the experiment. Secondly, in the operation of the fuel to optimize the routes to realize economic speed of the ship. Thirdly, the improvement of ship accessories products such as the application of drag reduction and energy saving bulbous bow in reducing the wave-making resistance and free rotation booster impeller improvement after oar, booster impeller can be increased by 6% - 9% of the driving force of the ship.

(3) First of all, in the propulsion ship power, the improvement of the propeller can improve the ship driving force in maximum level. The working efficiency of the

propeller is closely related to the diameter size, in addition, determine the reasonable propeller blade area can enhance the utilization rate of cavitation allowance, reduce the friction loss, and indirectly, improve the efficiency of ship driving, reduce fuel use. Secondly, adjust the fuel injection timing devices, when the travel resistance is small, it can reduce fuel injection quantity and save fuel usage. Thirdly, the engine of the ship is the largest power system of energy consumption, ship company can optimize the host in three aspects, duce the loss of energy conversion, reducing thrust power and the development of new energy. New type electronic smart host is through hydraulic mechanical system to realize the drive function, because the electronic smart host can achieve more accurate measurements, represented by common rail fuel injection technology, research and development of new host raised fuel utilization rate, reduce the pollution of the environment at the same time to save the shipping cost.

6. Conclusion and expectation

Overall, the sharp fluctuations in oil price will have a series of effects on the operation of the dry bulk market. The decline in cost support will directly lower the transportation fee to the balanced state of demand and supply, but it has little impact on rental level. Moreover, when discussing ships separately, the advantage for the dry bulk enterprises is limited. The decline in oil price has the most obvious impact on transportation capacity of dry bulk cargo, especially when the current price continues to fall, the oil price nearly reached the price equilibrium point of economic speed of Panamax ships and Handymax ships. As the rental level rises in the future and the price remains below the price equilibrium point, the economic speed will be canceled largely, and hidden shipping capability will be released, which will have a significant impact on the supply and demand layout of markets.

In terms of the shipping demand, low price will have positive effects on some cost-sensitive routes. For the commodity importers led by China, the proportion of

transportation cost in cargo cost is relatively low, along with weak demand, the advantage of falling oil price is unclear. In the recent year, although the crude oil price has fallen sharply, it did not improve the situation where supply exceeded demand. in the dry bulk market. In the bargaining process, dry bulk ships are in weak positions, and cannot enjoy the advantage brought by the declined oil price.On the contrary, the ships have to face the condition of excessive capacity caused by the release of hidden transportation capability. Oil as one of the major costs of ship's fuel and shipping enterprises, the increasing oil prices will continuously reflect the transportation fee, which enables the trade cost of owners to rise sharply. Facing different difficulties, shipping enterprises continue to strengthen their management, introduce a variety of measures, strive to reduce cost and improve effect, increase revenue and reduce expenditure, make themselves more competitive.

In this thesis, the research shows that fuel price has certain influence on transportation cost of dry bulk cargo market and the volume of dry bulk cargo transported of dry bulk cargo market. According to the understanding of the market and data display, fuel price in operating costs account for a large part of it. From this we can conclude that if oil prices fluctuate, the overall operating costs will also face changes and have impact on overall profit of the shipping company. In the same way, through the data shown above, it can be seen that although fuel price has different influences of volume of dry bulk cargo transported, it is not going to be too serious. Based on the calculation,it can be concluded that BDI (the Baltic Dry Index) and fuel prices share certain relevance. In another word, there is a certain impact from fuel price on the dry bulk volume,as fuel prices not only has a great influence on the operating costs, it also has a certain influence on dry bulk transportation quantity. At the same time, there is also a correlation relationship between fuel price and the BDI, it suggests that fuel price for dry bulk market does have a certain impact.

The research shows that fuel price has a certain impact on dry bulk cargo market, but the level of influence is not particularly high. Therefore, in the future study, other topics can be selected regarding fuel price and dry bulk cargo market. For example, what other factors can affect the dry bulk cargo market? Is it the supply and demand

of dry bulk cargo market, or the type change of the vessel, or the government support? Similarly, does fuel price also have an impact on the other markets or some of the aspects of the shipping industry? Study of shipping is beneficial to the shipping market and the shipping enterprises and is worth continuous effort.

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