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Research on price fluctuation and investment efficiency of newbuilding dry bulk carrier

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Research on Price Fluctuation and Investment Efficiency of Newbuilding Dry Bulk Carrier

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DECLARATION

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

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

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ABASTRACT

Titile of the research paper: Research on Price Fluctuation and Investment Efficiency of Newbuilding Dry Bulk Carrier

Degree: Master of science in International Transport and Logistics

Abstract: International trade markets are unavoidably subject to global crisis, shipping and shipbuilding industries are inevitably associated with uncertain cycles. For example, there have been more than twenty significant global crises in international trade markets in the last two hundred years. The shipping crisis resulting from international financial crisis in 2008, which has lasted for more than six years with no sign of the end in sight. The newbuilding ship prices is fluctuating along with the overall condition of the shipping market. The priority for the shipowners is to optimize the timing to invest to build the new ships.

As the main force of the world's maritime transport, the dry bulk vessels are responsible for the dry bulk cargo transportation worldwide and the dry bulk market is easily influenced and interfered by external factors. It is necessary to explore the main factors influencing the new ship price and to analyze the influencing mechanism between all the relevant factors so that it can give shipowners more efficient guidance to invest at the right time to build a new ship.

KEYWORDS: Newbuilding price, Dry bulk vessel, Asset Pricing Theory, Johansen Cointegration Test, VECM, Investment efficiency

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LIST OF ABBREVIATIONS

TC	**Time Charter**
VAR	**Vector Auto-regressive Model**
VECM	**Vector Error Correction Model**
PE ratio	**Price/Earnings Ratio**

1 Introduction

1.1 Backgrounds of the dissertation

Ship financing has always been permeated with the development of the shipping company's business. When investing in new ships, it usually needs large amount of money and relatively long payback time. In addition, the newbuilding price is fluctuating all the time along with the overall condition of the shipping market.

Noting the fact that international trade markets are unavoidably subject to global crisis, shipbuilding industries are inevitably associated with uncertain cycles. For example, there have been more than twenty significant global crises in international trade markets in the last two hundred years. The shipping crisis resulting from international financial crisis in 2008, which has lasted for more than six years with no sign of the end in sight, put all firms under the test of significant risks that undermine the productivity of each underlying business. Therefore, the priority is to optimize the timing to invest new ships.

The price of a new Capesize vessel at the peak of the market is more than 90 million U.S. Dollars. Under normal circumstances, the price of handy-size dry bulk carrier also require tens of millions of dollars. Moreover, the volatility of newbuilding prices in recent years have been relatively large. Therefore, it is necessary to explore the main factors related to a new ship price fluctuations and analyze the influencing mechanism between all the relevant factors so that it can give shipowners more efficient guidance to invest at the right time.

However, both domestic and foreign scholars focused much more on the research of freight rate analysis than shipping market research. In addition, in reality very few people can get direct investment gains from ordering new shipbuilding. The reason that most shipowners order new vessels is due to rigid demand such as for updating their fleet or for long-term transportation needs. Thus, most of the speculators tend to

purchase a secondhand vessel directly. It is because of this reason, there are more research focusing on the secondhand vessel transaction in shipping market. But research on the investment timing or investment efficiency for newbuilding ships is still in the state of beginning. As the main force of the world's maritime transportation, the dry bulk vessels are responsible for the dry bulk cargo transportation worldwide and the dry bulk market is easily influenced and interfered by external factors. Therefore, figuring out the law of price fluctuation of new dry bulk vessels and studying investment efficiency and timing is very necessary .

1.2 Literature review

Some domestic and foreign scholars have done quite a lot of research on the law of price fluctuation, ship investment decisions and investment efficiency by using different mathematical models. They have been researched from different perspectives such as figuring out the main factors affecting the price of the ship, the volatility of ship price, study on the financing methods and timing of investment etc.

(1) Research on factors affecting the new shipbuilding price

Cai Liming (2009)[1] focused on both the tanker market and bulk carrier market and used econometric theory and co-integration theory. He constructed predictive models to illustrate the volatility of the newbuilding ship price which were VECM and Auto Regressive and Moving Average (ARMA). He then used the historical data to detect the prediction results and compared the prediction performance of the two models based on the aims of econometric business cycle research. The conclusion shows that the result that one model predicted was not in all market segments better than another model. Different kind of ships in their respective market has its most appropriate newbuilding price forecasting models.

1 Cai Liming, (2009), Study on Price of Newbuilding Tanker & Bulk Carrier based on Econometric Theory, Shanghai Jiao Tong University master paper, http://www.cnki.net

Li Heng (2007)[2] mainly studied the dry bulk market and he analyzed both the ship trading market and the freight market and established model between the related markets. But unfortunately, one of the problem is that the author did not subdivide the markets into different segments of ships. In reality, different ship markets sometimes have quite different characteristics mainly due to the different dry bulk cargoes that they carried. And, in the process of ordering for new vessels, investors will assess the market very carefully at first and will not talk in generalities.

The model that Zhao Yan (2010)[3] used in her article is quite similar to the one that Cai used which are ARMA and VECM model, but the distinction is that Zhao discovered the relationship between the freight index as well as the volume of the shipping markets and the fluctuation of the newbuilding ship price. Then she analyzed the volatility of the freight rate both in short term and long term. Though the freight index to some extend reflects the supply and demand of the current market which also include the estimation of the brokers, it will be much reliable if the freight index along with the variables directly related to the ship building market all included in the model.

Yu Yupan (2012)[4] analyzes the characteristics of the newbuilding containerships market and the various factors affecting the newbuilding price of containerships which are secondhand price, time charter rates, order/fleet ratio, steel price and exchange rate. After that the co-integration theory is used to analyze quantitatively the co-integration relationships of newbuilding price and the related factors which shows that these factors have long-term stable relationship. Based on this the Vector Error Correction Model (VECM) is set up which precisely reflects the dynamic relation between newbuilding price and the related factors and comes to the conclusion that

2 Li Heng, (2007), Research on the Regularity Analysis and Development of the Shipping Market, Dalian Maritime University master paper, http://www.cnki.net
3 Zhao Yan, (2010), Research on the influence of freight rate fluctuation on the shipbuilding market, Dalian Maritime University master paper, http://www.cnki.net
4 Yu Panyu, (2012), Study on fluctuation of the price and investment timing of newbuilding containerships, Dalian Maritime University master paper, http://www.cnki.net

different degree the factors have on the price of newbuilding vessels. Regarding to the study of investment timing, Yu uses the Moving Average method based on P/E Ratio to discover the timing to invest in newbuilding containerships.

By taking an asset pricing approach,Beenstock (1985) observes that secondhand prices are flexible whereas newbuilding prices are relatively sticky. He follows this by implying that newbuilding prices adjust to secondhand prices over time. This position however is open to criticism since the shipbuilding industry is supply- and cost driven, whereas secondhand vessels are market driven.

Beenstock and Vergottis (1989)[5] distinguish between newbuilding and secondhand markets and adopt an asset pricing modeling approach. At the time of their yard contracting, ships will typically sell at prices that can differ from those of identical existing new ships by a larger or smaller amount. The main reason for this difference in price, they claim, stems from the fact that a new ship is immediately available to trade, while a contracted newbuilding only becomes available after the construction period has lapsed. Because new contracting is for forward delivery, the market for these ships should resemble a forward market. Prices arranged should reflect market expectations, at the time of contracting, regarding the value of new ships at the time of delivery. This conclusion is partly true today, since in some countries, it is national policy such as subsidies or aggressive pricing to capture market share, that is reflected in newbuilding prices rather than market expectations.

H. E. Haralambides et al. (2005)[6] in their article deal with the factors determining the prices of ships; new or old. And Theoretical Error Correction model is presented and estimated for both new and secondhand ship prices. Its forecasting performance is

5 Beenstock, M. and Vergottis, An Econometric Model of the World Shipping Market for Dry Cargo, Freight and Shipping. Applied Economics, 1989(a): 339-356.

6 H. E. Haralambides, S. D. Tsolakis and C. Cridland, Shipping Economics, Research in Transportation Economics, Volume 12, 65–105, 2005

finally compared with that of theoretical Auto-regressive (AR) model for all ship types under investigation. Newbuilding prices and timecharter rates have the greatest effect of all variables on the determination of secondhand ship prices, in most cases both in the short and long run. The cost of capital is only significant for bulk carrier owners. The Orderbook (as a percentage of the fleet) has a negative effect on the price of secondhand vessels only in the long run and only in large and Panamax tankers.

For newbuilding prices, shipbuilding costs are found to have the most significant effect for all ship types. Timecharter rates have an effect only on a few ship segments. This is in line with theory that newbuilding prices are cost driven, rather than market driven, as secondhand ship prices are. It is also found that actual exchange rates do not affect shipbuilding prices, but cost variations, due to exchange rate fluctuations, do. Orderbook is found significant only for tankers, indicating that shipyards' expansion policy is aimed at high value ships like tankers rather than bulk carriers. Finally, newbuilding prices for some ship types may be driven, to a certain extent, by asset pricing and speculation.

Ship price is the most important index in the shipbuilding industry. In Li shengjiang's (2007) article[7] talking about the price index of ships, the ARMA model is introduced to get more accurate price anticipation under fully considering the development tendency of time sequence.

(2) Research on investment efficiency and ship investment and financing

In Wang and Yang's (2010) article[8], the investment efficiency means the the efficiency of capital formation and usually expressed by the ratio of incremental capital-output (ICOR). In order to judge whether the macro-economy investment is efficient or not, from the view of whether investment could make the correct response

7 Li Shengjiang, Applying ARMA models to forecast the price index of ships, Shipping Engineering, Vol.29 No.6, 2007

8 Wang Jianqiang and Yang Jianjun, (2010), Research on Evaluation of Efficiency of Enterprise Investment Based on DEA Model, *Science Research Management, Vol.31, 2010*

to the change of the capital cost, is to examine whether the change of the total investment is in the same direction with the total output and in the reverse direction with the change of the capital cost.

Shao Ruiqing's (2005)[9] proposed the hierarchy of the factors of the international shipping investment environment and also the risks and mainly discovered the decision on the comprehensive issue of international shipping financing, international shipping investment decision under inflation of currency etc. He used supply and demand theory, decision theory, the time value theory, risk value theory, options theory, analytic hierarchy theory, fuzzy mathematics theory and combined qualitative analysis and quantitative analysis, macroeconomic analysis and microscopic analysis.

Yu introduces the concept of price-earnings ratio in stock market and introduced it into the research of investment timing for new containerships. Yu supposed the price of newbuilding ships as the stock price and time charter rate as annual return per share. He then uses the moving average method to see whether the price of new containership is overvalued or undervalued and provide a more robust basis to discover the best timing to invest new containerships.

Wang Zhipeng (2005)[10] studies the timing to invest vessels. He analyzes the volume of order book, delivery and demolishing and used time series model to analyze the price index of 5-year-old secondhand dry bulk vessels to find out the regularity of the volatility of price such as long-term changes, seasonal changes and cyclicity, etc. Finally, by comparing the cyclical changes in the shipping market as a whole, he summed up the best time to ship investment and ship financing.

9 Shao Ruiqing, (2005), Decision Making of International Shipping Investment, Shanghai Tong Ji University, PhD thesis, http://www.cnki.net

10 Wang Zhipeng, (2005), Research on Ship Investment Opportunity, Dalian Maritime University master paper, http://www.cnki.net

In Zhang Xu's (2004) thesis[11], he firstly analyzes the characters of ship investment and the four types of risks faced by the investment projects and combined with the establishment of evaluation index system and set up a new evaluation model by using the DHGF method. The purpose of the thesis is to give full consideration to the basis of the various influence factors and made decision between numbers of investment programs.

Amir H.Alizadeh, Nikos K.Nomikos (2007)[12] investigate for the first time, the performance of trading strategies based on the combination of technical trading rules and fundamental analysis in the sale and purchase market for bulk carrier. Using a sample of price and charter rates over the period January 1976 to September 2004, they establish the existence of a long-run co-integrating relationship between price and earnings and use this relationship as an indicator of investment or divestment timing decisions in the dry bulk shipping sector. In order to discount the possibility of data snooping biases and to evaluate the robustness of our trading models, they also perform tests using the stationary bootstrap approach. The results indicate that trading strategies based on earnings and price ratios significantly out-perform buy and hold strategies in the second-hand market for ships, especially in the market for larger vessels, due to higher volatility in these markets.

Based on the researches of domestic and foreign scholar, Yang Linda's (2009) article[13] further studied the compound options of ship investment by replacing the traditional evaluating method which is called discounted cash flow (DCF) with the real option analyses (ROA). This article mainly studies the following two kinds of compound options. One was produced by the gradual characteristic of ship investment. This article established the sequence compound option model and proved the value of the options through the case analysis. The other one was the combination compound

11 Zhang Xu, (2004), Research on ship investment decision based on comprehensive evaluation, Dalian Maritime University master paper, http://www.cnki.net

12 Amir H.Alizadeh .Nikos K.Nomikos.lnvestment timing and trading strategies in the sale and purchase market for ships. Transportation Research Part B, 2007(5): 126-143.

13 Yang Linda, (2009), Research of Ship investment decisions based on compound real option theory, Dalian Maritime University master paper, http://www.cnki.net

option which was produced by the characteristic of multiple options of ship investment． This article also analyzed the value of options through the cases， and drew the conclusion that the ship investment project faced with multiple options has a greater value because of the compound options．

(3) Conclusion of literature review

Summarizing the above literature, it can be said that traditional econometric method about newbuilding ship prices is quite comprehensive. Both Chinese and foreign scholars have studied the investment timing for new ships, standing on different point of view by using different methods such as qualitative or quantitative methods. Some of them study the new shipbuilding market with second-hand market as well as the hulk market and other endogenous variables. Some scholars analyze the new shipbuilding market with shipping related markets such as the freight market or freight index. The others may analyze the ship market with exogenous variables such as the shipping volume and trade volume and try to quantitatively find out the organic link with the freight ship market. But factors such as exchange rate (especially won against the dollar) has large impact on the cost price of shipbuilding, it can be considered in the following research.

However, we know that the econometric models that used most are time series model and the simultaneous equation model. These models must be based on the assumption that it is stationary, but most economic time series (including newbuilding and second-hand ship prices) are not stationary, so the results are sometimes unsatisfactory. Finally, researches on the newbuilding dry bulk market itself and various related variables on the price of newbuilding dry bulk carrier are not abundant, and the same to the articles about new shipbuilding investment and decision-making model. Therefore, the study about the law of price fluctuations of newbuilding dry bulk carrier and investment efficiency and timing model is worth to be discussed.

1.3 The frame work and content of the dissertation

The first step is to introduce the dry bulk ships and its development condition in the last few years and analyze the characteristics of the newbuilding dry bulk market as well as the fluctuation mechanism. Then I analyze the main factors that may influence the newbuilding price of dry bulk carriers in detail and also the present situation and try to estimate the future development of the newbuilding ship market and it is also the basis of the quantitative research on the newbuilding dry bulk ships. Through relevant principle of asset pricing and also supply-demand principle, I determine several factors, the secondhand ship price, timecharter rate, shipbuilding cost, orderbook to fleet size ratio, as the main factors influencing the newbuilding price of dry bulk ships and use econometric method to analyze their correlationship. After finding that there is long-term co-integration relationship between them, I set up the vector error correction model, further reflecting the dynamic relationship and changing rules between price and the main influence factors of new dry bulk ships for Capesize and Panamax.

Finally, on the basis of analyzing the newbuilding ship price, I analyze the co-integration relationship between the newbuilding price with one-year time charter rate by using the concept of the P/E ratio in the stock market. And I use it as kind of investment efficiency model. And its applicability is verified for the shipping company to make decision for the investment. I select the Clarkson database as the source.

2 Overview of the world newbuilding ship market

2.1 Basic characteristics and fluctuating mechanism of newbuilding ship market

2.1.1 Basic characteristics of newbuilding market

The main characteristics of investing new ships is that it needs large amount of money and it has relatively longer payback time. The newbuilding ship market is both labor-intensive and capital-intensive and it also has other distinguishing features such as fluctuation. The newbuilding ship market shows significantly volatility and it shows unstable state in long-term. In short-term, shipping related variables such as newbuilding ship prices, deliveries, orderbook and demolising amount of shipyards show great changes. For example, Figure 2.1 shows the trend of the newbuilding dry bulk price and Figure 2.2 shows the trend of the dry bulk ship orders that shipyards have, it can be found that the newbuilding ship market is quitet volatile.

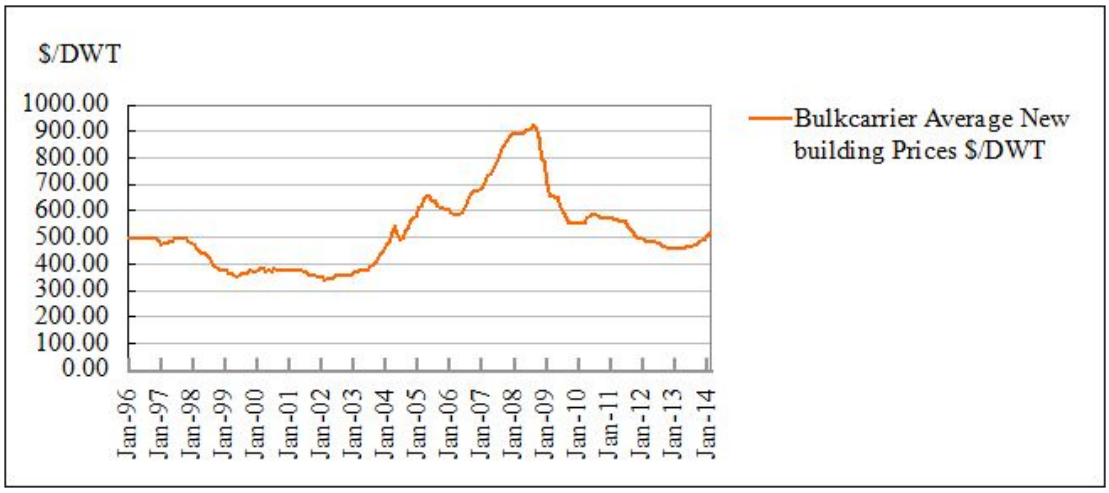

Fig 2.1 Trend of Bulkcarrier Average Newbuilding Prices

Source: Clarksons Shipping Intelligence Network

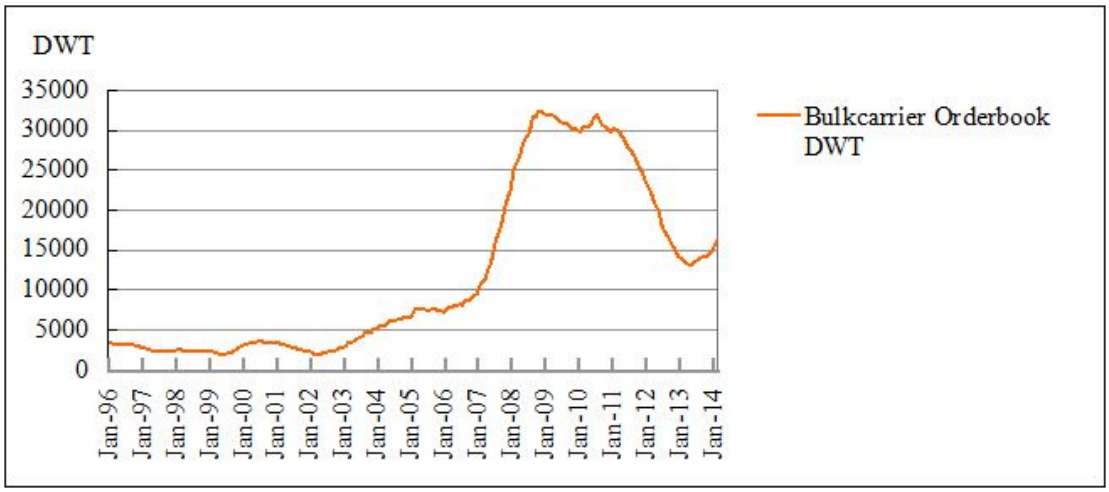

Fig 2.2 Trend of Bulkcarrier Orderbook

Source: Clarksons Shipping Intelligence Network

In addition, with the deepening of the process of global economic integration, the degree of interdependence in economy is increasing between different nations. For example, a ship flying Panamian flag may be built in South Korea while its equipment and components uesd on ships may come from other countries. The crews and investors may come from different countries and also the same to the insurance companies.[14]

Nowadays, there is more and more demand for energy-saving vessels and the proportion of various types of energy-saving equipment of the cost of whole ship is also increasing. Due to the huge work of ship construction and long designing and production cycle, it will take about two or three years from the ship's tender inquiry to signing a letter of intent and the final completion of delivery of the ship. But with the advances in technology, shipbuilding cycle has been greatly shortened compared with the old days. Large scale of production and modern shipbuilding technology enables the delivery of new ships much faster than before.

2.1.2 Fluctuation mechanism of newbuilding market

14 Wang Chuanxu, The international shipping market and policy, *Beijing: people's traffic press, 1999.99 110.*

When we talk about the fluctuations mechanism in world shipbuilding market, it is to discuss the relationship between the causes of the changes and fluctuations in the ship market and its influencing factors. There are many factors that lead to the volatility of the shipbuilding market which are summarized in the following paragraph.

a) World Economy and International Trade

As the major means of transportation, ships play an important part in the international trade and the development of international trade lead to the increasing demand of ships. When the world economy is in depression, the number of demolishing and idle ships will increase. As the global financial crisis caused huge losses to both the world shipping market and shipbuilding market. Thus, fluctuations in the world economy will certainly have an impact on the newbuilding ship market.

b) Freight structure

The development in science and technology, especially the industrial production in developing countries have caused significant changes to the structure of world trade. Before the 1960s , the products being transported are mainly primary products. With the deepening of the industrialization processing in different countries, the proportion of industrial products (including high value-added products) nowadays is more than 70% in the national trade which leads to the changes in demand of different kinds of ships. Changes in the structure will affect the maritime freight volume and then affect the demand for new ships. The increase in the amount of certain kinds of goods will stimulate the demand of corresponding types of new ships, on the contrary it will cause the decline to the demand of such ship types.

c) International finance and exchange rate

Changes in exchange rates and interest rates as well as the enthusiasm and expectation financial communities have on the shipbuilding industry will have an impact on the ship market. When the ratio of foreign currency to the currency of shipbuilding

countries rises that is to say if that currency is appreciation, there will be a beneficial impact on the shipbuilding country who exports new ships. Conversely, there will be disadvantage to the shipbuilding country. But changes in the exchange rate can only affect the interests of related shipbuilders and shipowners not really have impact on the whole ship market in long-term. Both changes in exchange rates and interest rates will eventually be reflected in the floating ship price. From a macro perspective, changes in exchange rates and financial markets will not only alter the share of new ship orders but also cause risks to the shipping industry but in short term not having long-term impact on the whole newbuilding ship market .

d) War and international political situation

Intense conflicts in the world wars and inter-regional districts will cause losses and opportunities to the shipping industry. In the late 1960s, the Suez Canal was closed because of war in Egypt for eight years and ships were forced to turn to the route of Cape of good hope and it led to significantly increasing demand of ships. Thus, the world shipbuilding industry received a large number of new ship orders and the new ship price rose to the highest level ever at that time. And talking about the political situation, it does exert a tremendous influence. Taking an example of sanction of one country to another, the importing country will have difficulty when importing marine equiment.

e) International conventions

The changes in the international maritime conventions as well as the formulation and implementation of new regulations will have imact on newbuilding market. Some conventions may have impact on the production cycle, the output of newbuilding ships per year per ship company as well as the price of each ship. But the impact of conventions may not have so much influence on the newbuilding ship market and some of the convetions are not mandatory.

f) Support policies

For the development and protection of the national industry, many countries have developed policies to protect shipping and shipbuilding industry, such as providing the subsidies and low-interest loans to the domestic shipowners who order new ships. For the world shipbuilding market, such support policies especially the subsidies will lead to the unreasonable rising to the ship price and hindering the formation of fair competition in the shipbuilding market.

g. Subjective factors

Decision makers in corporations can also predict the outcome of future ship market to adjust their plans and derive greater benefits. If the corporations response overheating, this would cause a depression in shipping market which would not happen at first. In addition, different people will get different infomation from the shipping market and have various perspectives and psychic reaction. Therefore, the new shipbuilding market will be affected by human subjective.

In summary, the fluctuation in newbuilding ship market will be affected by both objective factors and subjective factors and it is these factors influencing each other which lead to the volatility in newbuilding ship market.

2.2 History and Current Situation of new dry bulk shipping market

2.2.1 Characteristics of Panamax and Capesize

a. Features of Panamax dry bulk vessels

Panamax is kind of large vessels which specially designed to pass the Panama Canal and these vessels are severely restricted by the breadth and draft of the Panama Canal lock chambe. The vessels are built to match the exact limit of the Panama Canal in order to carry goods as much as possible under the premise of the waterway . Many dry bulk cargo such as coal , grain are mainly transported by Panamax vessels. Panama ship is usually about 65000t, 75000t and 82000t.

b. Features of Capesize dry bulk vessels

The deadweight of Capesize is 100,000 tons or more and usually has 9 hatches. The main cargo being carried is iron ore and other bulk cargo and its operating routes are relatively simplex. The deadweight of typical Capesize vessels is around 160,000 to 200,000t. Many shipowners gradually ordered mini Capesize after year 2007, which is about 14 meters draft and about 100000t to 120000 DWT in order to improve economic benefit of the ships after the expansion of the Panama canal which can pass larger vessels but the maximum darft is only 15 meters.

2.2.2 Trend of newbuilding Panamax dry bulk market

Figure 2.3 shows the contractss and deliveries of the newbuilding dry bulk vessels and and demolition numbers of old ships. Panamax ship has a very long history and is limited by the scale of the Panama Canal. It is the largest bulk fleet size so that the changes of size of the fleet has symbolic significance.

From 1996 to 2006, as the traditional ship size in the shipping market, the contracts of new Panamax dry bulkers remained quite balanced volatility. From year 1997 to 2001, the world trade remained a lower level due to the Asian financial crisis and the 911 terrorist attacks and starting from 2002, the world economy started to recover and new orders for Panamax ships began to rise slowly. Until 2006, shipyards prefered to build tankers rather than bulk carriers because it was more attractive to build tankers such as VLCC due to the high freight at that time.

In 2007, it can be described as the year of world bulk carriers. With the development of infrastructure construction in China as well as the soaring of the freight rate of major bulk cargo, the contracts for large dry bulk vessels increased significantly especially in 2007,2008 and 2010. Due to the lower barriers to entry the market, a large number of speculative Panamax ship orders instantly disrupted the freight

market in the following three years thus making the market supply and demand seriously out of balance.

It can be found that from 2009 the deliveries of new Panamax vessels increased rapidly but the shipowners did not have sufficient funds on hand and led to the delay in deliveries and then causing the backlog of orders. In 2012, the Panamax bulk carrier deliveries reached the highest point .

It is not difficult to figure out that the contracts had fallen sharply from 2011, but due to the amount of orders on hand was still high enough to make deliveries in 2013 and 2014 continuously remain at not low level. The good news is that starting from 2010, the demolition of the old Panamax bulk carrier was also rising. Only a small amount of ships were demolished because of operating and cash flow problems and most of the demolition were largely due to that Panamax bulk carriers in late 80s early 90 had to face mandatory scrapping. Because of the huge base of Panamax carriers, it led to a significant increase in the amount of demolition. From the perspective of the ship companies, updating their fleet and eliminating high energy consumption and high cost old ships will play a positive role in Panamax carriers and even the whole dry bulk market.

After being experienced peak time in 2008, the Panamax ship price is currently at relatively low price. China is one of the world's leading shipbuilding countries mainly bulk carrier as well as other low value-added vessels. Extreme downturn in the market made more than 3,000 shipyards in China in 2008 close and decreased to about 300 shipyards. A large number of small and even medium shipyards have closed. As the price of raw materials and labors continue to rise up, the profit margins of shipyards are further compressed.

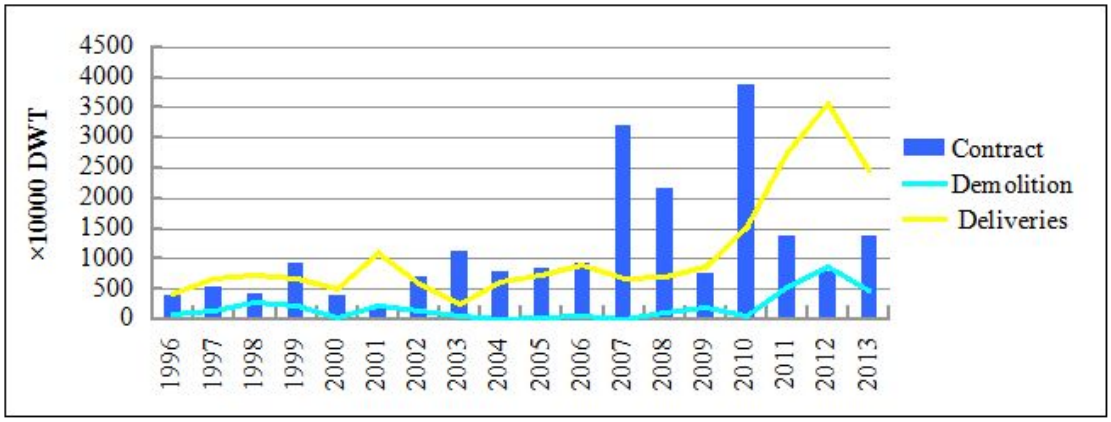

Fig 2.3 Contracts, demolition and deliveries of Panamax bulkcarries

Source: Clarksons Shipping Intelligence Network

2.2.3 Trend of newbuilding Capesize dry bulk market

The trend of the shipbuilding market of the Capesize are basically the same to the Panamax ships. First of all, the occurrence of Capesize vessels is later than Panamax, so the fleet size is smaller than the Panamax vessels. And because of the huge size, the loading cargoes and routes are more simplex and less flexible than traditional Panamax. Therefore, Capesize vessels are more sensible to the cargo volume compared to the Panamax and so the shipyards will not blindly build excessive Capesize vessels. By the following figure, after the orders blowout in 2007, Capesize orders start to shrink rapidly because the downturn in the world's bulk cargo trading. Meanwhile the China's housing construction becomes rationable than before and leads to the main types of Capesize cargo such as iron ore decreased, which has a direct impact on the amount of Capesize orders. We can see from Figure 2.4 , deliveries of Capesize vessels appeared to fall, but excess capacity still need some time to absorb. In terms of ship demolition,the growth speed of ship demolition in 2012 much slowed down than that in 2011, the market panic leading to ship demolition has significantly been reduced and become rational.

Fluctuation in ship price is quite similar in both Capesize and Panamax. Nowadays one 180k Dwt Capesize sharply decreased from the peak in 2008 about $97 million and now the average price of 180k Dwt Capesize dry bulk vessel is around $56

million. Due to the overcapacity of the Capesize and the weak growth of dry bulk cargo volume, shipowners started to lose enthusiasm to order Capesize vessels. On the contrary, some of the ore shippers are ready to build their own ore transportation fleet. With the widening of the Panama Canal, mini Capesize are now increasingly sought after by shipowners. In addition, the weight of mini Capesize is increasing in dry bulk market in Southeast Asia. That is because countries like India, Indonesia and other countries whose port infrastructure is relatively underdeveloped prefer these kind of ships in order to make up its shortcomings.

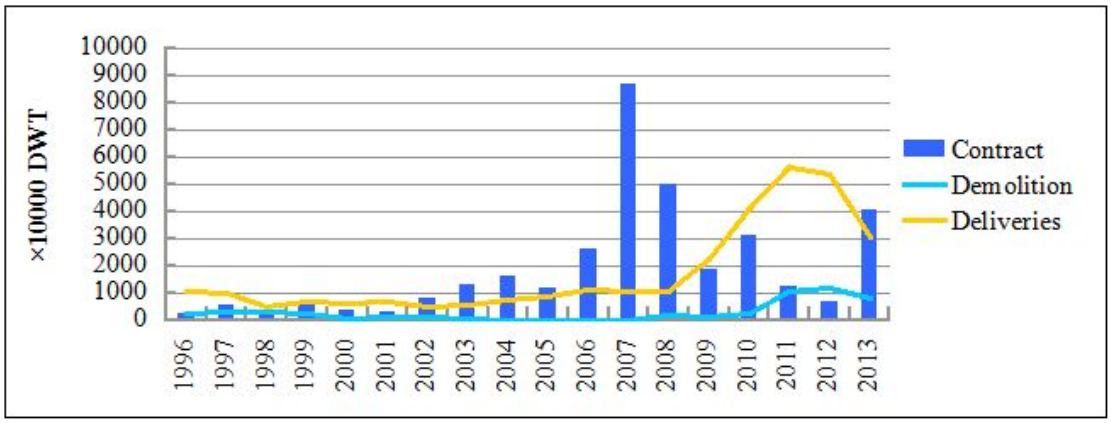

Fig 2.4 Contracts, demolition and deliveries of Capesize bulkcarries

Source: Clarksons Shipping Intelligence Network

3 Newbuilding ship price introduction and influencing factors analysis

3.1 Introduction of ship price

Ship price is the overall cost of both ship construction as well as the cost happened during the process of sale, the quantity of money performed by the total cost is the ship price. People usually have quite different understanding of the ship price and I'll select some common ones which are cost price, bid price, opening price, counter-offer price, market price,etc.

Cost Price is the internal pricing methods of the shipyard. The price includes two parts that are fixed costs and variable costs. The cost price can be represented as

$$P_c = C_f + C_v - S + T$$

C_f is fixed cost and C_v is variable costs. S here refers to the subsidies given by the government to the shipyards and T for a variety of taxes.

The bid price is the competitive price and shipyards are willing to build new vessels at this price after the shipowners have issued the invitation. After the comprehensive evaluation, shipowner will judge its quality, credibility, delivery time as well as the price to select the best shipyard. The bidding price may not be the lowest price. The bid price wil be viewed as the closing cost by the time when the contract is certified.

Market price is the actual transaction price of certain kind of ships that happens in a period of time in the world shipbuilding market. The actual transaction price is generally subjected to a competitive price which is paid by cash.

$$P_{\max} \geq P_m \geq P\min$$

The newbuilding price being mentioned in this article is the market prices.

3.2 Influencing factors of newbuilding ship price

3.2.1 Main microscopic influencing factors

a. Shipyard production conditions

When talking about the manufacturing condition of shipyards, we usually consider factors such as its facilities, personnel, management level, and geographical location.

Different quality of personnel management will affect the workers' attitudes and also have different impact on the use of shipyard facilities such as its depreciation expense, maintenance cost and operating costs. These costs will be allocated to shipbuilding costs. Management level will influence the use of raw materials and fuel consumption, degree of labor utilization and the utilization of facilities which will matter the depreciation of production equipment, product quality and whether the funds are used reasonable.

Due to the location of the different shipyards, the impact on the hull will be different such as air humidity. For different shipyards, completion cycle are quite different such as welding, rust and other spending in the whole construction process. These all have increased shipbuilding costs at different levels.

b. Quality and lead time

Impact of world economy and the shipping market can be regarded as the dynamic changes to ship price. Within a certain period of time, there are static differences in ship price that is due to different quality and production cycle of different shipyards around the world, which is based on principle of high quality and urgent work deserve high price. Shipbuilders are relatively engaged in a good market. So the shipowner will be asked to increase the proportion of down payment.

Direct impact of the construction period on the cost is mainly reflected in the following aspects. First, for materials and equipments, even if the purchase cost remains the same, both that funding being used and increasing loan interest rates wil raise the cost. Secondly, costs of slipway, wharf, equipment and other special charges and water, electricity and gas costs will increase as the extention of the work cycle.

c. Selection of marine equipment manufacturers

Equipment cost usually accounts for about 45% of the construction cost of the ship and even higher. If the device is manufactured by domestic equipment manufacturers, such as Japan and South Korea usually do then costs generated by foreign exchange

can be saved. If the two parties are fixed partnerships, prices can generally slightly lower than the normal level and about 5% to 6% below the normal level. Therefore, under certain technical conditions, the selection of equipment vendors is crucial to the construction costs and the ship price.

d. Navigation zone and classification

Different navigation areas and classifications require different rules and norms. According to the standard which required to meet different rules, the ship design and difficulty level of construction as well as the time and materials required for shipbuilding are not the same which will affect the shipbuilding costs, thereby affecting the ship price. The gap between ship price in the specified classification societies and trade areas is very large.

e. Terms of payment and delivery

As we all know, the construction of ships all needs long period of time and high costs. Usually it needs long time for shipowners to pay all of the money. So all these make the way of payment quite important. Terms of payment generally refers to the trading currency, time of payment and proportion of the payment each time after being negotiated between shipowner and shipyard. When the ship is buillding in the shipyard, shipowners will first pay a portion of the money to the shipyard , then the rest of the money will be paid in the following time before the delivery of the ship. Shipyards will borrow money from the banks in order to build new vessels. As the deposit rates are much lower than loan rates, the shipyard will be have additional costs in these years. Table 3.1 shows several methods for the payment of newbuilding ships.

Table 3.1 Terms of payment of newbuilding ships

Terms of payment (%)	Contract	Start working	Slipway	Launching	Delivery
20+20+20+20+20	20	20	20	20	20

25+25+25+25	25	25	25	-	25
10+10+10+30+40	10	10	10	30	40
40+30+10+10+10	40	30	10	10	10

Source: Clarksons Shipping Intelligence Network

Both terms of payment and deadline have great impact on the ship price. The more money shipyards get from shipowners in advance, the shorter the delivery time and better compensate for the additional costs caused by purchasing materials and loan interests thus generating higher income. From the shipowners side, they will generally take the action such as delay in ship delivery or reducing the proportion of down payment to reduce their financing risk . However, such an approach does really harm to the interests of the shipyards, and even endanger the shipyard capital chain .

At present, the domestic large shipbuilding shipyards have decided to increase the down payment to deal with the risk of cancellation and largely reducing the risk of abandonment by some shipowners. For some private shipyards, the down payment now received is around 5% of total costs and still face the abandon risky. Many small shipyards now has suffered the malicious withdrawals of the shipowner.

3.2.2 Macro factors of newbuilding ship price (Market factors)

Here emphasis will be put on macroeconomic factors because of the variables being taken into consideration are presented in time series, and therefore all indicators are changed by average price or volume and reflect the overall condition of the entire market. It is also an important basis to conduct modeling assumptions. It should start from the most basic asset pricing theory to select the main macroeconomic factors of newbuilding dry bulk prices, by comparing the correlation with the price volatility of the newbuilding ships and then determine the main factors to the price of newbuilding dry bulk carriers.

And asset pricing usually includes the following three main pricing methods.

a. Market approach is also known as the current market pricing method or market price comparison method which compares the difference and similarities between the assets being assessed and similar assets that have been transacted recently. By adjusting the market price of similar assets, the price of the assets is then determined.
b. Cost approach refers to the method which determine the price of assets being evaluated by reducing all loss value.
c. Income approach refers to the methods which estimate the future expected earnings of the assets being evaluated and convert it into present value in order to determine the value of the assets being evaluated.

The market approach refers to that selected data which are directly derived from the market and meanwhile estimate the value of the impending asset business. So the application of market approach is closely related to the establishment of the market economic system and the marketization degree of the assets. The restriction of the market approach is timeliness while the data of the cost approach is not limited by time. And income approach is to assess the value of assets by estimating the expected future earnings.

Therefore, the above three methods being taken into consideration is fundamental to choose the factors that may affect newbuilding ship market. Regarding to the market approach, I choose the 5-year-old secondhand ship price as the reference market price of newbuilding ships. For the cost approach, I decide to choose the average price of Japanese ship plate who can be represented as the shipbuilding cost as well as the exchange rate of the shipbuilding countries currency to the US dollars as the variables. Regarding to the income approach, I choose the one-year time charter rates. Finally, filter out some of the above variables and some other important factors as the main factors affecting newbuilding prices.

All the data will be selected from the Clarkson shipping database website and the historical data is from 1996 to 2013. The following paragraph will focus on the influencing mechanism for these factors affecting the price of new ships.

a) Second-hand ship price Price

Figure 3.1, 3.2 show the comparison between historical trends of five year old ship price with newbuilding prices. It can be said that the secondhand ships are substitutes of the newbuilding ships. The up-going price of second-hand ships will indirectly lead to the growth of the demand of newbuilding ships, thereby increase the shipbuilding price. And shipowners seem to be easier to transfer to order a new ship rather than purchase a secondhand ship, so the new shipbuilding demand is more elastic and second-hand vessels become close substitutes of new ones.

By the following graph it can be found that in the booming market when 2006 to 2008, the second-hand ship price is largely affected by market influence, so when the market freight level is very high, second-hand vessel prices tend to be much higher than the price of a new vessel. This is because the second-hand vessels can be immediately put into use especially for five year old second-hand ships whose performance has reached a very good condition. We can say that growth in freight rates will lead to the increase in demand for vessels and also have an impact on the value of second-hand ship immediately. Shipowners who do not have sufficient money but want to update their fleets will choose to order new vessels and thereby driving up the price of new vessels.

At the start of March 2014, the price of a secondhand five year old Capesize reached $48m and in the last half year and the secondhand price for a five year old Panamax rose from $22m to $27m. It seems that the newbuilding ship price would increase according to the secondhand price.

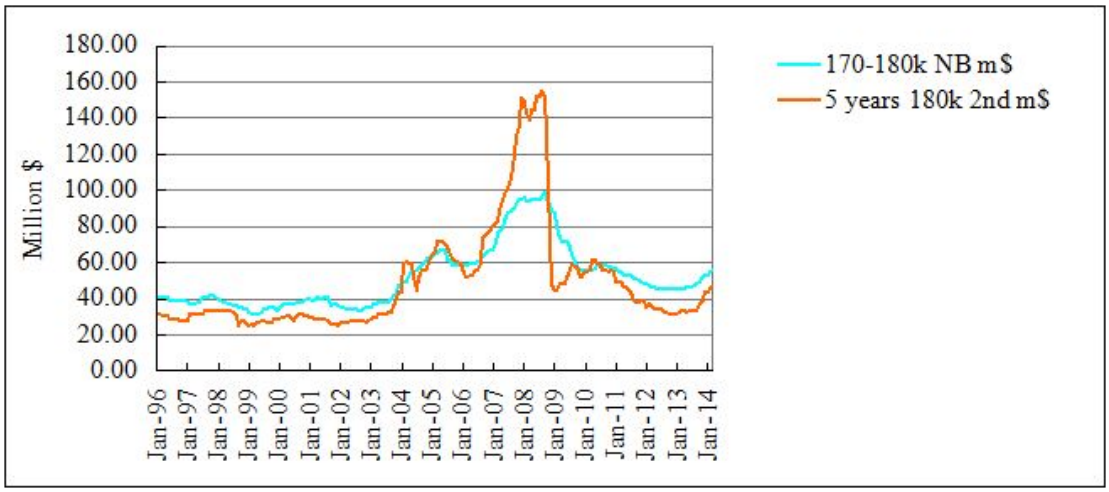

Fig 3.1 Comparison of price of 5-year-old and newbulding Capesize dry bulk carrier

Source: Clarksons Shipping Intelligence Network

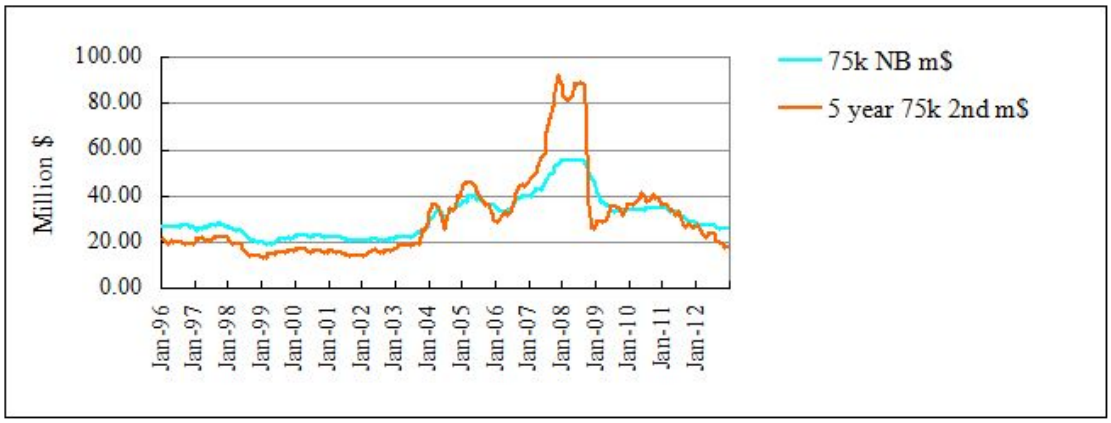

Fig 3.2 Comparison of price of 5-year-old and newbulding Panamax dry bulk carrier

Source: Clarksons Shipping Intelligence Network

b) Time charter rates

Figure 3.3, 3.4 show the comparison of the newbuilding price and one-year time charter rate of bulk carrier. The fluctuation of newbuilding price to some extent reflect the earnings of the ship. Such income is expressed in dollars per Day because time charter rates express the expectations of shipowners and charterers to the future condition of the industry. The higher the time charter rate, the stronger the profitability of the ship and also the greater desire for shipowners to invest in new ships, meanwhile there will be a positive impact on the newbuilding ship price. Thus

time charter rates determines the demand and supply of the shipping industry, because the shipowner desire to build the vessels which generate the largest profit. Thus, the type of ship the shipyard will build is largely depended on the demands of the shipping industry.

For those large shipyards their preference is based on the level of average time charter rate. In short, the time charter rate is the consensus value of both the shipowners and charterers in the near future, which reflects the expectations of both parties on the future of the market. More crucially, the time charter earnings has excluded the interference of voyage variable costs and better reflect the owners' net income but current charter rate can only reflect the gross profit. Sometimes current charter rates simply reflect the market at some point but not a guide for future prospects. Due to the volatility and unpredictability of the current charter rate, it is not really the driving force of the new shipbuilding order while the performance of time charter rate is more stable and easier to understand .

Fig 3.3 Comparison of newbuilding price and time charter rate of Capesize

Source: Clarksons Shipping Intelligence Network

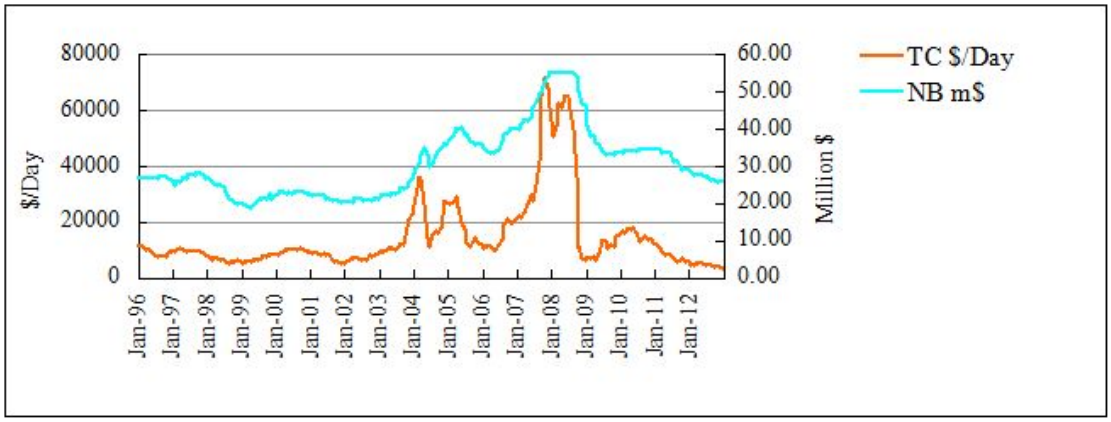

Fig 3.4 Comparison of newbuilding price and time charter rate of Panamax

Source: Clarksons Shipping Intelligence Network

c) Ratio of Orderbook/fleet (Based on the steady growth of demand of iron ore, coal and other bulk cargo)

Figure 3.5, 3.6 show the comparison between the ratio of bulk carrier orderbook to fleet size and newbuilding price. An important factor of the price of new bulk carriers is supply and demand. According to Clarkson statistics the global trading of iron ore and coal from year 2000 to 2013 is showing steady growth. (see Figure 3.7). However, the supply of dry bulk vessels is not stable by contrast. Since 2007, both the ratio of new shipbuilding Capesize and Panamax orderbook to the fleet size shoot up which lead to the excess construction and caused negative impact on the dry bulk transport. When this ratio is too large, excess capacity would arise and it is the time for shipowners to consider if it is appropriate time to build new ships, thus influencing the newbuilding prices. Actually different ship types may have different impact and it is difficult to judge from a single line and I'll verify it quantitively later. The ratio of new shipbuilding orders to fleet size can be said showing weak negative correlation to newbuilding ship price.

From the 2014 Spring report of Clarkson, Capesize fleet growth is projected to slow to 4% in 2014 from the 5% growth of 2013. In 2014, the Panamax fleet is projected to expand by 6% followed by a further 3% in 2015. Supply side pressures in the

Panamax sector have been significant in recent years and are expected to continue to exert pressure in coming years.

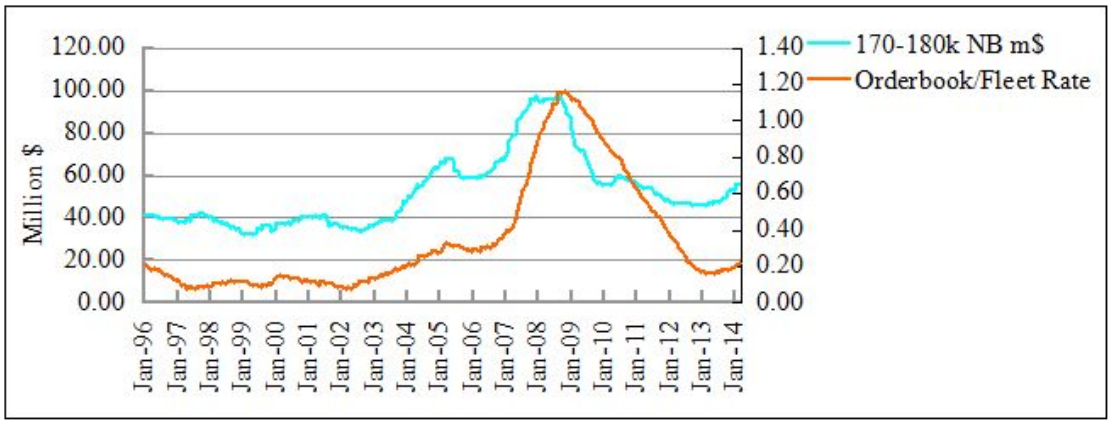

Fig 3.5 Comparison of newbuilding price and Orderbook/Fleet rate of Capesize

Source: Clarksons Shipping Intelligence Network

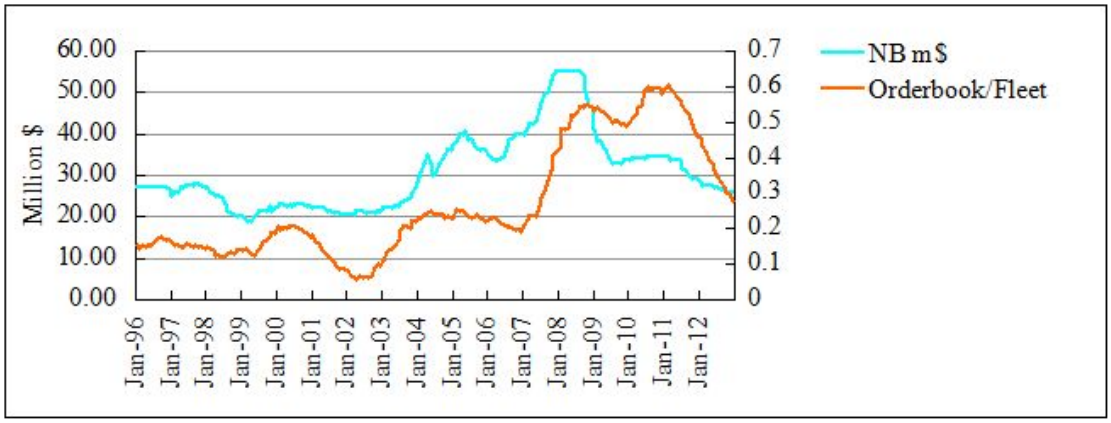

Fig 3.6 Comparison of newbuilding price and Orderbook/Fleet rate of Panamax

Source: Clarksons Shipping Intelligence Network

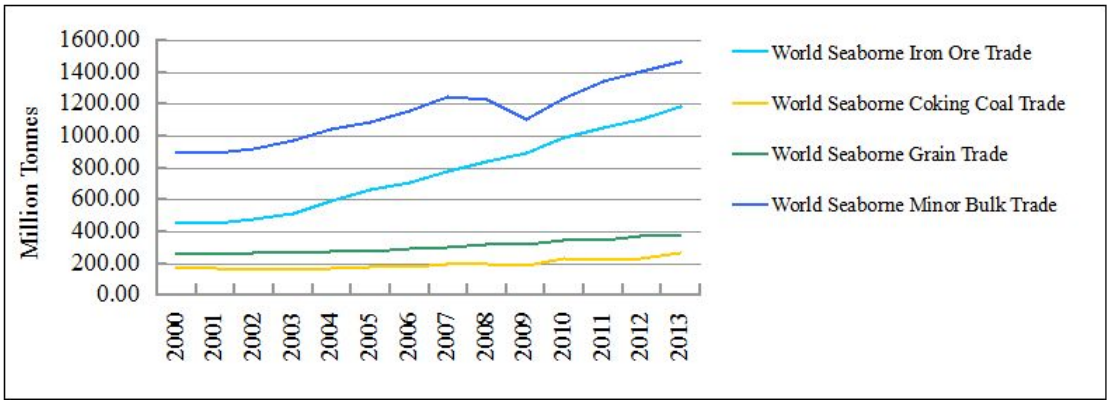

Fig 3.7 Trend of world demand of bulk commodities

Source: Clarksons Shipping Intelligence Network

d) Steel price

Figure 3.8, 3.9 show the comparison of the trend of Japanese shipbuilding steel price and the price of new bulk carriers. The intense competition between the shipyards make the costs of ship construction becoming a major factor in the price of newbuilding ships. It can be considered that under the same conditions, the higher the cost of ship construction, the higher the price of the new ship Since the estimated cost of the new ship is a very complex task, which involves not only some of the technical parameters in ship design, construction, but also the national shipbuilding operations, financial, political and other factor. In addition, the shipbuilding costs include equipment costs, time costs, material costs and management costs. In this article, I'll use Japan steel price as a new shipbuilding costs index. This is because steel is the main material in ship construction, and steel prices are a major component of the cost of materials. Fluctuations of steel price is a liable indicator for the volatility of shipbuilding costs. Japan has great power in shipbuilding for the steel they used is of reliable quality and excellent technology. Therefore, the choice of this indicator is representative .

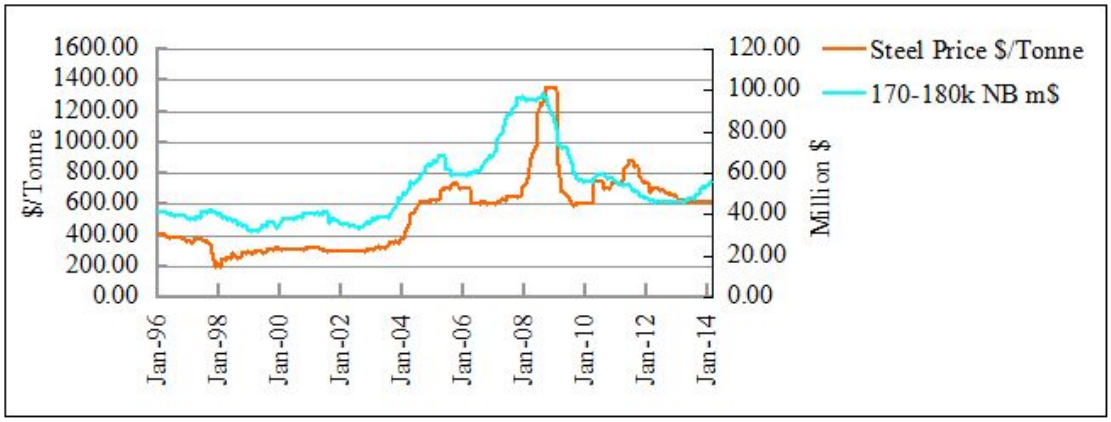

Fig 3.8 Comparison of newbuilding price and steel price of Capesize

Source: Clarksons Shipping Intelligence Network

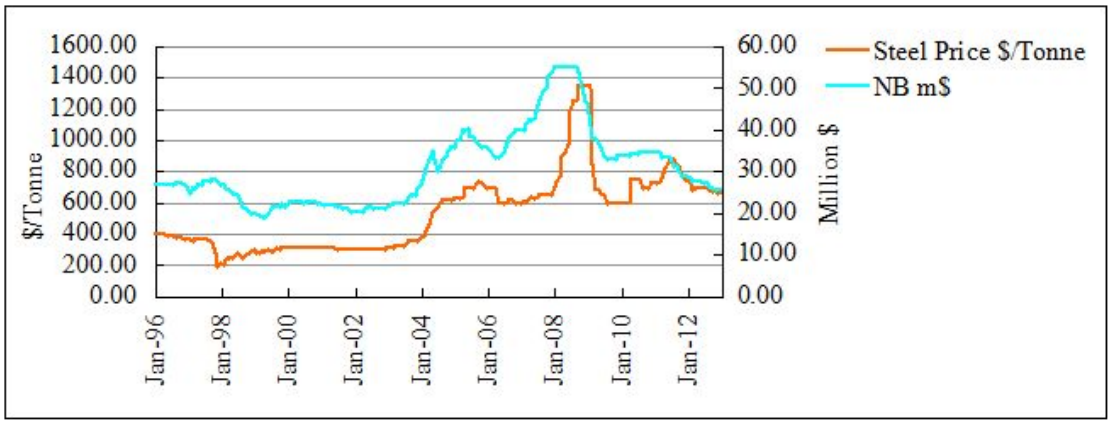

Fig 3.9 Comparison of newbuilding price and steel price of Panamax

Source: Clarksons Shipping Intelligence Network

e) Exchange rate

Figure 3.10 shows the comparison of won-dollar exchange rate with the Capesize newbuilding prices. Changes in exchange rates will have some impact on newbuilding prices. It can be said that when the the ratio of USD to RMB exchange rate is appreciating, it is beneficial to shipbuilding countries. Thus, ship building countries will offer a more competitive price by taking advantage of the exchange rate. This is because the cost of ship construction is calculated by the national currency, but trading of ships is deal with dollars. So if the currency of shipbuilding country is dereciated to US dollars, there will be negative impact on ship price which will increase the enthusiasm of the shipowners to build new ships. But the exchange rate is

kind of exogenous variables belonging to those factors of newbuilding price. Therefore, it does not directly affect the ship price. And Policy adjustment and speculation and other factors will influence the exchange rate. Therefore, it is not representative to compare it with the shipbuilding price.

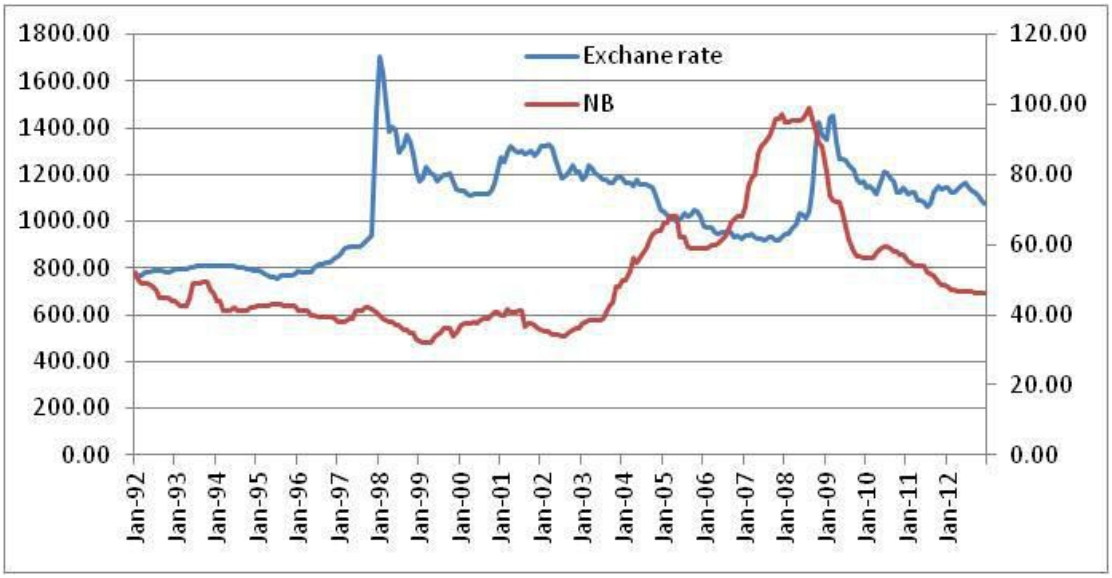

Fig 3.10 Comparison of newbuilding price and exchange rate

Source: Clarksons Shipping Intelligence Network

4 Quantitative analysis of newbuilding dry bulk vessels based on VECM model

4.1 Model strategy

This article will use the co-integration theory in economics to quantitively analyze the dynamic relations between newbuilding dry bulk vessel prices (Capesize and Panamax) and its main influencing factors such as second-hand ship prices, one-year time charter rates, shipbuilding costs and ratio of orderbook/fleet which can help ship companies better understand and master the changes of the price of new dry bulk vessels.

4.2 Introduction of related theory

4.2.1 Long-term equilibrium

According to some economic theory, it indicates that long-run equilibrium relationship does exist among some economic variables, this equilibrium relationship means that economic system do not have internal mechanism that destroy the balance. If variables deviate from its long-run equilibrium point in a period of time because of disturbance, the equilibrium mechanism will adjust in the next period to make it back to the equilibrium state.[15]

Classical regression model is built on the basis that variables are all stable but for non-stable variables classical regression model can not be used because there would be spurious regression and many other issues. Since many economic variables are non-stable and this leads to the limitation to the classical regression analysis. However, if there is long and stable relationship between all the variables, that is co-integration relationships between them then the classic regression model can be used. Assuming that the long-term equilibrium relationship between X and Y can be expressed as:

$$Y_t = \alpha_0 + \alpha_1 X_t + \mu_t \qquad (4\text{-}1)$$

15 Li Enyuan, Econometrics, *Harbin industrial university press, 2007.141 151*

μ_t is the random perturbation terms. The equilibrium relationship means that when there is a given value of X, then the value of Y can be identified as the corresponding equilibrium value $\alpha_0+\alpha_1 X$. At the end of period t-1, there will be three different situations of Y. The first is that Y equals to its equilibrium value. The other two are Y being smaller or larger than equilibrium value that is $Y_{t-1} = \alpha_0 + \alpha_1 X$.

When it is in period t, assuming that there is a change in X which can be write as ΔX_t and if both variables X and Y still meet the long-term equilibrium relationship at period t and t-1, the corresponding change in the amount of Y is given by the formula:

$$\Delta Y_t = \alpha_1 \Delta X_t + v_t \tag{4-2}$$

Here $v_t=\mu_t-\mu_{t-1}$. But usually this is not the case. For example, if the second case that I mentioned before occurs, that is when at the end of period t-1, the value of Y is less than its equilibrium value, theen the change in Y is often larger than the changes in Y in the first situation. Conversely, if Y is largerr than its equilibrium value, then changes in Y tend to be smaller than changes in Y under the first scenario.

So we can see that if $Y_t = \alpha_0 + \alpha_1 X_t + \mu_t$ indicates that there is long-term stable "balanced relationship" between X and Y, it can be said that Y only deviates from its equilibrium point temporarily. Thus, an important assumption is that random disturbance term μ_t must be stationary sequence.

Obviously, if there is random trend in μ_t (increase or decrease), it will result in the deviations of Y from its equilibrium point being accumulated and can not be eliminated. In $Y_t = \alpha_0 + \alpha_1 X_t + \mu_t$, random disturbance term is also known as non-equilibrium error,which is a linear combination of variable X and Y:

$$\mu_t = Y_t - \alpha_0 - \alpha_1 X_t \tag{4-3}$$

Therefore, if the long-term equilibrium relationship of the X and the Y in $Y_t = \alpha_0 + \alpha_1 X_t + \mu_t$ seem to be correct, the non-equilibrium error in (4.3) should be expressed in stationary time series and has zero expectation. In conclusion, even for the non-stationary time series, their linear combinations are likely to be stable.

4.2.2 Co-integration

In macroeconomics there is a universal phenomenon that is many economic indicators are following random walk process. Therefore, the impact of sudden economic shocks will not disappear in the few years and is permanent, for example such as consumption amount and disposable income of a family which are subject to random walk. So in the long run, households will consume their disposable income in accordance with certain proportion. So, we can say that consumption and disposable income are linked. That is, the two random variables follow the random walk process that is to say they are non-stationary, but the linear combination of them is stationary. We can call this relationship co-integration. In general, if two or more variable are non-stationary but their combination series is present to be stationary, then we can say that these variable series have co-integration relationship.[16]

The concept of co-integration is first proposed by Engle and Granger in 1978. Before this, in order to avoid spurious regression, people often only use stationary time series to run regression model, or first turn the non-stationary time series into stationary time series and then run regression model.

Once there is co-integration theory, it is possible to have a long-term stable relationship between several time series that are in same order and show integration, and once they are co-integration relationship, we can build multivariate regression models. And then we can find out the exact relationship between the variables through the regression model and predict the value of the variables.

4.2.3 Expression and test method of cointegration

Co-integration as I mentioned before means the linear combination of two or more non-stationary variables occurs to be stationary. We can say there is co-integration relationship between these variables. In order to give a precise definition of

16 Gao Tiemei, Econometric analysis and modeling application by EViews. Beijing: Tsinghua university press, 2006:274-301.

co-integration, we need to give the concept of integration. If time series have been run through difference method for d times before it becomes stationary series, then we call this time series d-order uniformity integration and can be write as I(d). A precise definition of co-integration will be given in the following paragraph.

Let the components contained in the random vector are d-ordered integration and denote as $X_t \sim I(d)$. If there is a nonzero vector βmaking the random vector $Y_t = \beta X_t \sim I(d-b)$， $b>0$，then we call random vector X_t with d- and b-order co-integration and denote as $X_t \sim CI(d,b)$. The vector β is called co-integration vector. In particular, y_t and x_t are random variables and $y_t, x_t \sim I(1)$ .When $y_t = k_0 + k_1 x_t \sim I(0)$, we say y_t and x_t are co-integration and (k0,k1) are co-integration coefficients.

Currently, there are two commonly used co-integration approach which are EG and Johansen test method. EG two-step method is based on unary variables and more suited to test the co-integration relationship between two variables. The Johansen Cointegration test is applied in multivariate. In this paper I have assumed several variables may be related to the newbuilding ship prices, so I will choose Johansen Cointegration test. Johansen Cointegration test is a method of testing the regression coefficient which based on vector autoregression (VAR) model.

The core of Johansen Cointegration test is to analyze the rank of matrix. If the rank of matrix r is smaller than k, then it can be decomposed into several parts. β is called co-integration vector matrix and α is called adjustment parameter matrix while r is rank of matrix which shows the number of co-integration and the maximum number of the co-integration relationship is k-1.

Eviews will be selected to solve the problem of Johansen Cointegration test. In the output, Eviews will automatically display the number of co-integration relations between the multivariate variants as well as the expression of co-integration equation . The prerequisite of the Johsansen test is that the original sequence is not stationary, but through same-order difference method, it should demonstrate stationarity. So, if the original sequence exhibits the same order and uniformity integration, it can use Johansen Cointegration test. Then I will use ADF unit root test to test both the integration and stationarity of thetime series. ADF unit root test method is the improvement of DF test method and it is also built on the basis of the original DF which can guarantee the random disturbance term is white noise.

Integretion refers to that if time sequence becomes a stable one through difference method for one time, then we say that the original sequence is one-order integrated which can be noted as I(1). Generally, if the time series becomes stable after d times difference, we call the original sequence d-order integrated sequence which can be denoted as I(d). The premise of co-integration test is that the original sequence is not stable, that is, not passing the ADF test, but after making the original sequence with the first difference, it can all pass the ADF test and meanwhile show the same order and integration.

The main observation of the ADF inspection output is to check the result under the 1 %, 5 %, 10 % significance level. If ADF test value which is t value is greater than the significant value typically 5%, that means it does not pass the test and there is unit root which means not stationary. And at this moment, using first-order difference to see whether the unit root is stationary after difference. The P value in the results is the probability of accepting the null hypothesis .

4.3 Construction of the vector error correction model

4.3.1 Vector autoregression model and vector error correction model

As mentioned before, non-stable time series should be translated into a stationary sequence through differential approach before establishing classical regression model. However, this would cause a problem that using differential approach to estimate will lead to the ignorance of important information about the level of variables, then the model can only express the short-term relationship between the X and Y but not reveal the long-term inter-relationships. From the point of long-term equilibrium, the change of Y in period t depends not only on the change of X itself, but also on the state of the X and Y at the end of period t-1, particularly the balance degree of X and Y in period t-1. In addition, using differential approach tend to have some unsatisfactory regression equation. So, simple differential approach can not always solve the problems encountered with the non-stationary time series and so the error correction model (VECM) has come into use.[17]

Before discussing the VECM model, I have to mention vector autoregression (VAR model). Vector autoregression (VAR) is usually used in time series forecasting and analysis of dynamic effects of random disturbance to variables system. The mathematical form of VAR (p) model is:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t \qquad (4\text{-}4)$$

Here y_t is an endogenous variable of K-dimension and x_t is a d-dimension exogenous variable. And $A_1, \cdots, A_P$ and B are the matrix of coefficients that need to be estimated. And ε_t is the perturbation vector and they can be related to each other in the same stage but not related to the hysteresis value of them and also not related to the variables in the right direction of the equation .

Vector autoregression model (VAR) is based on the statistical nature of the data. It pretend that each endogenous variable in the system as lagged values of all

17 Fan Huanhuan, Li Yanyi, Cheng Shengke, Eviews statistical analysis and application, China Machine Press, 2011.7

endogenous variables to construct the model and promote the univariate and autoregressive model to the VAR consisting of multivariate time series variables. VAR model is well suited to describe the generation process of data of small and medium scale time series variables. In such model, all variables are assumed to be endogenous and allow dynamic changes between the variables. If co-integration exists between a number of variables, VAR is not the most appropriate model. In this case, one specific parameterize method which can effectively support the co-integration structure is introduced and vector error correction model (VECM) is now used. VEC model can be considered a VAR model with co-integration constraints and always be used in non-stationary time series modeling which has co-integration relations.

4.3.2 The structure of the vector error correction model

For yt (1，1), the autoregressive distributed lag model is

$$y_t = \alpha + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 y_{t-1} + \varepsilon_t$$

Minus y_{t-1} at both sides of the model and plus $\pm \beta_0 x_{t-1}$ at the right side of the model,

$$\begin{aligned}
&\Delta y_t = \alpha + \beta_0 \Delta x_t + (\beta_0 + \beta_1) x_{t-1} + (\beta_2 - 1) y_{t-1} + \varepsilon_t \\
&= \beta_0 \Delta x_t + (\beta_2 - 1)[y_{t-1} - \frac{\alpha + \beta_0}{(1-\beta_2)} - \frac{\beta_1}{(1-\beta_2)} x_{t-1}] + \varepsilon_t \\
&= \beta_0 \Delta x_t + \gamma(y_{t-1} - \alpha_0 - \alpha_1 x_{t-1}) + \varepsilon_t
\end{aligned}$$

And， $\gamma = \beta_2 - 1$， $\alpha_0 = (\alpha + \beta_0)/(1-\beta_2)$， $\alpha_1 = \beta_1/(1-\beta_2)$。

Denote $$ecm_{t-1} = y_{t-1} - \alpha_0 - \alpha_1 x_{t-1} \qquad (4\text{-}5)$$

Then $$\Delta y_t = \beta_0 \Delta x_t + \gamma ecm_{t-1} + \varepsilon_t \qquad (4\text{-}6)$$

If $y_t \sim I(1)$，$x_t \sim I(1)$，then in the left side of Formula 4-9 $\Delta y_t \sim I(0)$ and right side $\Delta x_t \sim I(0)$， so only when y_t and x_t are co-integrated, that is to say when there is long term equilibrium relationship between y_t and x_t, the ecm~I(0) in Formula 4-5, the stability on both ends will be the same in Formula 4-6.

When y_t and x_t are co-integrated, the co-integration regression equation is:

$$y_t = \alpha_0 + \alpha_1 x_t + \varepsilon_t \qquad (4\text{-}7)$$

It reflects the long term equilibrium relationship between y_t and x_t. So the ecm_{t-1} in formula 4-5 is "unbalanced error" in previous stage, and we call γecm_{t-1} in formula 4-6 error correction term and $\gamma=\beta_2-1$ is correction factor. Usually β_2 is smaller than 1, then γ is smaller than 0; when ecm_{t-1} is larger than 0 that means there is positive error, γecm_{t-1} is smaller than 0, and when ecm_{t-1} is smaller than 0 that means there is negative error, γecm_{t-1} is larger than 0. The two of them are in opposite direction so we can say that the error correction is a reverse adjustment mechanism (feedback);

In conclusion, error correction model has the following specific meanings:

(1) Balanced deviation adjustment mechanism

(2) Co-integration and long-term equilibrium relationship

(3) Long-term and short-term change models of economic variables

Model in long-term trend $$y_t = \alpha_0 + \alpha_1 x_t + \varepsilon_t \quad (4\text{-}8)$$

Model in short-term fluctuation: $$\Delta y_t = \beta_0 \Delta x_t + \gamma ecm_{t-1} + \varepsilon_t \quad (4\text{-}9)$$

There are two steps in using Eviews to estimate VECM models. In the first step, use Johansen test to estimate co-integration relationship. In the second step, use the estimated co-integration to construct the error correction term, and estimates the first-order VAR which including error correction term as the regressor. Therefore, the output of the VECM estimation consists of two parts. The first part is the result obtained from the Johansen procedure. The second part of the output is the first-order difference VAR.

4.4 VECM for new dry bulk ships (Capesize and panamax bulk carriers)

4.4.1 Cointegration test of Capesize vessels and Establishment of the VAR and VECM

I select five variables which are newbuilding ship price, one-year time charter rates, 5-year-old secondhand ship price, the Japanese ship plate price, and the ratio of the orderbook to total fleet size and study the interrelation between the five variables. The

construction of the Vector error correction model (VECM) can be divided into mainly four steps.

First, determine the lag interval of the vector autoregression model (VAR), build VR model and test its stability. Second step is the co-integration test for the VAR model and estimate the impact of various factors on the new ship price according to the co-integration equation expression. The premise of the test is that the original sequence must be unstaionary and both in the same order and integration. Next step is to build the VECM which is on the basis of the VAR model. In other words, that is to build quantitative expression between all the variables. Finally, use the VECM to do short-term prediction and statistics analysis. In the following paragraph I'll use Eviews to build VEC model for new Capesize dry bulk vessels first. (Note: In order to reduce fluctuations in the data, the sequence of all the variables are all taken natural logarithm.)

(1) Estimate the lag interval of the model

First try to determine the lag interval of the model according to the AIC (Akaike information criterion) and SC (Schwarz information criterion) criterion.The following is the calculation method of AIC and SC.

$$AIC = -2l/T + 2n/T \qquad (4\text{-}10)$$

$$SC = -2l/T + n\ln T/T \qquad (4\text{-}11)$$

And n=k(d+pk) which is the total numbers of the parameters being estimate. K is the number of the endogenous variables while d is number of exogenous variables. T is the length of the sample and p is the lag order number. When choosing the lag interval. It is believed that the smallest the recommended value (starred by E-views) of both AIC and SC the most parsimonious the result will be. If AIC and SC are not recommended as the same lag interval, it is better to choose the starred AIC value cause AIC value is used to evaluate the performance of the model.

Table 4.1 is the optimized lag interval selected by the software. The asterisk mark is the recommended indexes of the system. According to the information below, I choose three as the lag order number of the vector auto-regression model and it will be adjusted in the later paragraph.

Table 4.1 Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-9.297450	NA	7.88e-07	0.136166	0.215859	0.168383
1	1559.005	3046.988	3.26e-13	-14.56195	-14.08379*	-14.36865
2	1619.321	114.3130	2.33e-13	-14.89829	-14.02167	-14.54391*
3	1651.374	59.22148*	2.18e-13*	-14.96547*	-13.69038	-14.44999
4	1668.650	31.09685	2.35e-13	-14.89190	-13.21835	-14.21535
5	1686.253	30.84720	2.53e-13	-14.82146	-12.74944	-13.98382
6	1696.839	18.04703	2.92e-13	-14.68418	-12.21370	-13.68546
7	1712.663	26.22214	3.20e-13	-14.59679	-11.72784	-13.43698
8	1730.225	28.26677	3.47e-13	-14.52595	-11.25854	-13.20506

(3) Construction of VAR model

On the basis of all the variables mentioned before, we can build VAR model which in the form of $y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + u_t$. Then using the unit circle and unit root to test the stability of VAR model and the results are shown in Figure 4.1 that the inverse roots of AR characteristics polynomial are within the unit circle and indicating that the estimated VAR model meets the standard of stability. Next step is to test if there is same order integration between different time series in order to determine whether it can be carried out by the co-integration test.

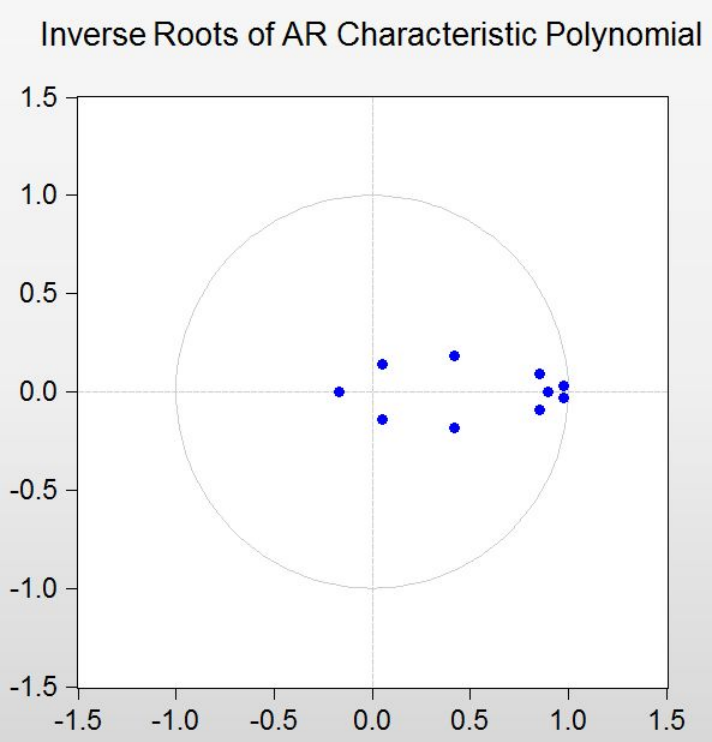

Fig 4.1 Inverse Roots of AR Characteristic Polynomial

(4) ADF stationarity and integration test

After the VAR model is proved to be stable, next step is to test that the time series is in the same order. The ADF unit root test will be used and the results are shown in Table 4.2.

Table 4.2 ADF Stationarity and integration test

	Original	1% Level	5% Level	1st	1%	5%
NB Price	-1.767375	-3.461030	-2.874932	-3.949291	-3.46103	-2.8749
2nd Price	-1.898768	-3.460596	-2.874741	-9.313389	-3.46059	-2.8747
1 year TC	-2.338880	-3.461783	-2.875262	-4.154205	-3.46178	-2.8752
Order/Fleet	-1.409981	-3.460884	-2.874868	-4.106670	-3.46088	-2.8748
Steel Price	-1.349967	-3.460596	-2.874741	-10.96022	-3.46059	-2.8747

In Table 4.2, the first column is the value of the original sequence and 1 st Difference refers to the original time sequence after first order difference. 1% Level, 5% Level refers to the critical value when the confidence interval is 1% and 5% in ADF test. From the table, we can find that all the five variables of the original sequence accept the assumption under 5% confidence level. So the five variables of the original

sequence are not smooth. All the five variables after first order difference refused the assumption that under 1% confidence level which means they are smooth and the five variables are all first-ordered and integrated. Thus it can be seen that the original sequence is unstationary but they are in the same order and integrated, then it can comply with the the co-integration test.

(4) Cointegration test

The model involves more than two time sequence, so I choose Johansen Cointegration test method. It is based on the number of co-integration relationship and executes from zero until it rejects the null hypothesis. In Table 4.3, "None" means the null hypothesis that there is zero co-integration relationship. "At Most 1" means there is one co-integration relationship at most. From the output, we can compare the statistics with the critical value under 5% confidence level. According to both the trace and the maximum eigenvalue test, there is at most one co-integration relationship in these five endogenous variables.

Table 4.3 Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.149248	77.86520	69.81889	0.0099
At most 1	0.082161	43.43706	47.85613	0.1223
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.149248	34.42814	33.87687	0.0430
At most 1	0.082161	18.26130	27.58434	0.4735
1 Cointegrating Equation(s): Log likelihood 1692.828				
Normalized cointegrating coefficients (standard error in parentheses)				
NB	SE	TC	OF	ST

1.000000	-0.353455	-0.083097	-0.000903	-0.247524
	(0.08040)	(0.04132)	(0.02485)	(0.04641)
Adjustment coefficients (standard error in parentheses)				
D(NB)	-0.139555			
	(0.03436)			
D(SE)	0.203470			
	(0.09365)			
D(TC)	0.483626			
	(0.23822)			
D(OF)	0.095976			
	(0.07642)			
D(ST)	-0.131934			
	(0.08289)			

According to the Johansen Cointegration Test, we can get the co-integration equation:

LNNB=0.3535LNSE+0.0831LN7TC+0.0009LN(O/F)+0.2475LNST+μ_t

We can see that in the newbuilding ship market, the impact of the second hand ship price on the newbuilding ship price is most significant.When the logarithm value of the secondhand price increase by one, the logarithm value of newbuilding price will increase 0.35. The time charter rate and the steel price have relative smaller impact which are 0.08 and 0.25. The ratio of orderbook to fleet size has very limited influence on the fluctuation of newbuilding ship price.

(5) Construction of Vector Error Correction Model

After building the VAR model and the co-integration test, it is time to build VEC model that is to say to build VAR model with co-integration constraints. And it can be expressed as:

$$\Delta Y_t = \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \alpha ECM_{t-1} + \varepsilon_t \qquad (4\text{-}12)$$

Error correction term reflects the long-term equilibrium relationship between variables (the co-integration relationship between the variables), that is to say the deviation for the long-term equilibrium can be revised through a series of short-term adjustment. And the coefficient vector reflects the adjustment speed of the deviation to the long-term equilibrium state. The coefficient of the lag difference delta of each variable reflects the influence to the delta of the variables'short-term fluctuations [22].

The following table is the results of vector error correction model. From the error correction term ECM, we can see that the correction coefficient of the newbuilding ship price is -0.215402. That is to say when the new shipping prices increase and ECM is positive, the correction coefficient is negative which will make the newbuilding ship prices to adjust downward. And when the newbuilding ship prices fal and the ECM is negative, but the correction coefficient is negative which will make the newbuilding ship price to adjust upward. So, the correction coefficient has made the newbuilding ship price adjust from short-term volatility to long-term equilibrium.

At last, from the overall statistics of the VEC model, we can see that the AIC and SC are -14.81 and -13.00. Both of them are small enough which means the degree of fitting of the model is really good. The matrix expression and overall statistics of the VECM is:

LNNB=0.3535LNSE+0.0831LNTC+0.0009LNO/F+0.2475LNST+0.2154

Log likelihood = 1692.82

Akaike information criterion = -14.81； Schwarz criterion = -13.00

Table 4.4 Vector Error Correction Estimates

Vector Error Correction Estimates
Sample (adjusted): 1996M06 2014M02
Included observations: 213 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1				
NB(-1)	1.000000				
SE(-1)	-0.353455				
	(0.08040)				
	[-4.39637]				
TC(-1)	-0.083097				
	(0.04132)				
	[-2.01129]				
OF(-1)	-0.000903				
	(0.02485)				
	[-0.03634]				
ST(-1)	-0.247524				
	(0.04641)				
	[-5.33348]				
C	-0.215402				
R-squared	0.393149	0.408382	0.251912	0.376182	0.325010
Adj. R-squared	0.326427	0.343335	0.169661	0.307595	0.250796
Sum sq. resids	0.091798	0.682132	4.413705	0.454221	0.534394
S.E. equation	0.021923	0.059761	0.152014	0.048766	0.052895
F-statistic	5.892362	6.278255	3.062738	5.484717	4.379388
Log likelihood	523.0832	309.4834	110.6216	352.7905	335.4789
Akaike AIC	-4.705007	-2.699374	-0.832128	-3.106014	-2.943463
Schwarz SC	-4.357831	-2.352199	-0.484952	-2.758838	-2.596288
Mean dependent	0.001580	0.002246	0.001534	0.000892	0.002119
S.D. dependent	0.026712	0.073747	0.166824	0.058605	0.061110

Determinant resid covariance (dof	1.48E-13
Determinant resid covariance	8.60E-14
Log likelihood	1692.828
Akaike information criterion	-14.81528
Schwarz criterion	-13.00050

(6) Forecast by VECM

Now use both the VAR model and the error correction term of VEC model to find out the final estimate. By using the recursion formula, iterative approach can be used to forecast the Capesize newbuilding ship price based on the existing newbulding ship price. Figure 4.2 is the fitting effect of both the actual price and forecast value of newbuilding ship price on static forecast. We can see that the fitting effect is good. And short-term prediction can be used for further iterations to acquire dynamic prediction. Figure 4.3 shows the deviation of the predicted values and actual value of the model under static forecast. It can be seen from the graph that the residuals are mostly distributed within the range of 5%. The residual error is small, so it can satisfy the requirement of forecast.

Figure 4.4 is the co-integration relationship graph based on VECM model. Zero represents the long-term stable equilibrium relationship between variables. The figure shows that from 1996 to 2003, the price of newbuilding Capesize fluctuated near equilibrium value which means that market price was relatively stable. But in 2004 and 2008, the market had two strong fluctuations and gradually came back to the equilibrium price. This also complied with the historical performance of the newbuilding capesize bulk carrier market.

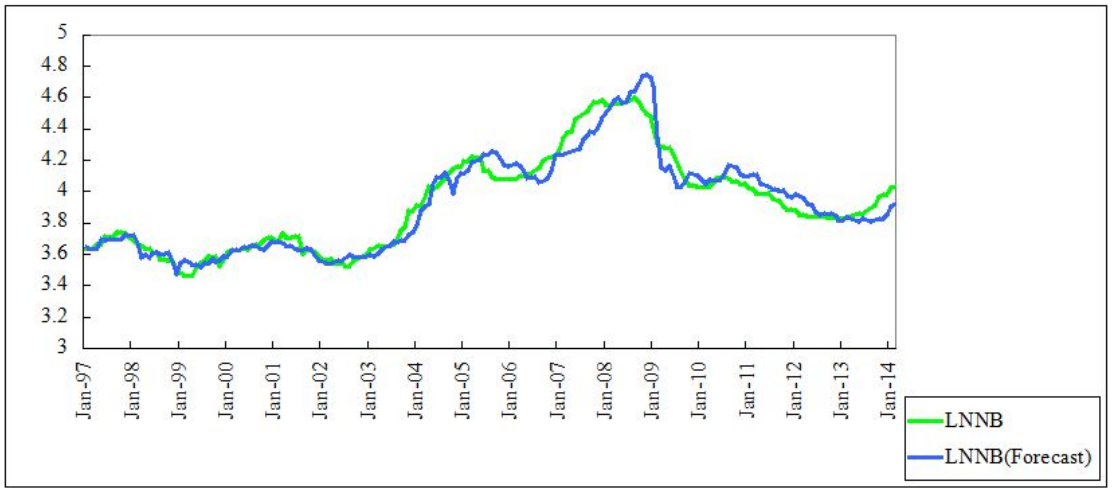

Fig 4.2 Fitting curve of Capesize

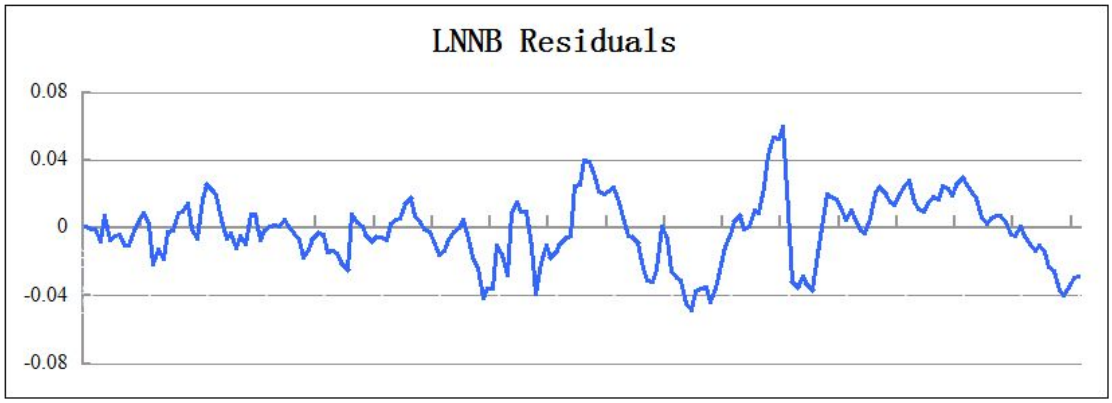

Fig 4.3 LNNB residuals of Capesize

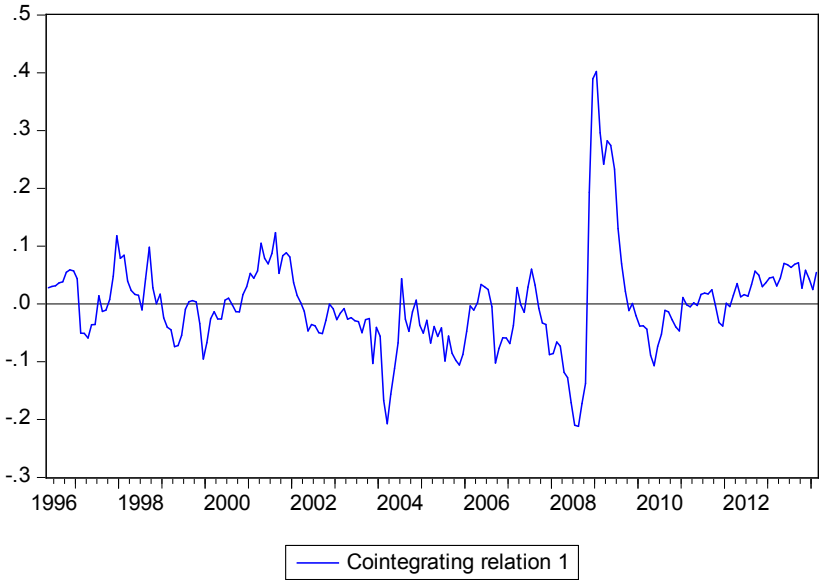

Fig 4 .4 Capesize cointegrating relation graph based on VEC model

4.4.2 Cointegration test of Panamax vessels and Establishment of the VAR and VECM

The methods and steps used for Panamax vessels are exactly the same to the Capesize, so I'll not explain the principles in detail.

(1) Estimate the lag interval of the model

According to the AIC and SC, I decide to choose three as the lag interval of the model. Table 4.5 is the optimized lag interval selected by the software.

Table 4.5 Lag Order Selection

Lag	LogL	LR	FPE	AIC	SC	HQ

0	14.29863	NA	6.26e-07	-0.094884	-0.011259	-0.061028
1	1451.895	2787.176	3.44e-13	-14.50913	-14.00738	-14.30600
2	1526.392	140.6323	2.08e-13	-15.01420	-14.09432*	-14.64179*
3	1557.306	56.78064	1.96e-13*	-15.07455*	-13.73654	-14.53286
4	1572.155	26.51582	2.18e-13	-14.97097	-13.21483	-14.26000
5	1601.349	50.64300*	2.09e-13	-15.01376	-12.83950	-14.13352
6	1621.077	33.21527	2.22e-13	-14.95997	-12.36758	-13.91044
7	1636.510	25.19744	2.47e-13	-14.86235	-11.85184	-13.64355
8	1648.359	18.74033	2.85e-13	-14.72815	-11.29951	-13.34007

(2) Construction of VAR model

In Figure 4.5, we can see that the inverse roots of AR characteristics polynomial are within the unit circle and so the estimated VAR model meets the standard of stability.

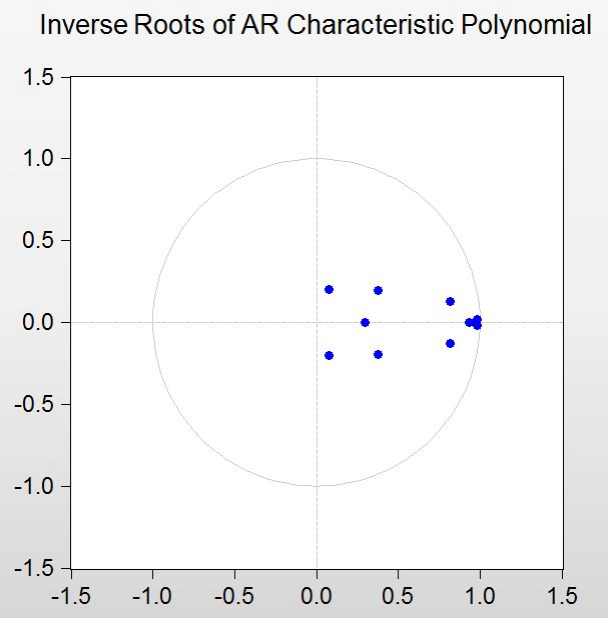

Fig 4.5 Inverse Roots of AR Characteristic Polynomial

(3) ADF stationarity and integration test

Table 4.6 ADF Stationarity and integration test

	Original	1% Level	5% Level	1st	1% Level	5% Level
NB Price	-1.134969	-3.462737	-2.875680	-8.79347	-3.46273	-2.8756
2nd Price	-1.767458	-3.462737	-2.875680	-9.50649	-3.46273	-2.8756
1 year TC	-2.558149	-3.462737	-2.875680	-8.745984	-3.46273	-2.8756
Order/Fleet	-2.120481	-3.463235	-2.875898	-3.216313	-3.46323	-2.8758
Steel Price	-1.264088	-3.462737	-2.875680	-10.58895	-3.46273	-2.8756

From Table 4.6, we can find that all the five variables of the original sequence accept the assumption under 5% confidence level. So the five variables of the original sequence are not smooth. But only four of them after first order difference refused the assumption that under 1% confidence level. The ratio of orderbook to fleet size does not meet the standard that I need so it should not be included in the model.

(4) Cointegration test

Table 4.7 Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.177412	60.36295	47.85613	0.0022
At most 1	0.076616	21.69368	29.79707	0.3159
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.177412	38.66928	27.58434	0.0013
	0.076616	15.78268	21.13162	0.2378
1 Cointegrating Equation(s): Log likelihood 1265.813				
Normalized cointegrating coefficients (standard error in parentheses)				

NB	SE	TC	ST
1.000000	-0.495713	-0.092340	-0.018246
	(0.06015)	(0.03380)	(0.04003)

According to the Johansen Cointegration Test, we can get the cointegration equation:

LNNB=0.4057LNSE+0.0923LNTC+0.0182LNST+μ_t

We can find that in the newbuilding Panamax market, the secondhand price is still the most significant factor. And the other two factors are relatively important which are time charter rate and the steel price. And all the factors has positive effect on the ship price.

(5) VEC Model

We can see from Table 4.8 that the AIC and SC are -11.85669 and -10.32881, both of them are small enough and have good fitting effect. And the correction term of VEC is -0.783493. So we can say that the correction coefficient has the function to move the newbuilding ship price from short-term fluctuation to long-term equilibrium state. Log likelihood = 1265.813 and the overall statistics can be summarized as:

LNNB=0.4057LNSE+0.0923LNTC+0.0182LNST+0.7835

Table 4.8 Vector Error Correction Estimates

Cointegrating Eq:	CointEq1
NB(-1)	1.000000
SE(-1)	-0.495713
	(0.06015)
	[-8.24117]
TC(-1)	-0.092340
	(0.03380)
	[-2.73203]
ST(-1)	-0.018246
	(0.04003)

	[-0.45576]			
C	-0.783493			
R-squared	0.464215	0.355755	0.305199	0.393951
Adj. R-squared	0.400286	0.278885	0.222296	0.321638
Sum sq. resids	0.089402	0.891629	3.399849	0.477897
S.E. equation	0.022538	0.071176	0.138987	0.052109
F-statistic	7.261416	4.628004	3.681423	5.447881
Log likelihood	481.6350	253.9444	121.4392	315.6863
Akaike AIC	-4.642778	-2.342873	-1.004437	-2.966528
Schwarz SC	-4.277415	-1.977510	-0.639074	-2.601165
Mean dependent	-0.000239	-0.000532	-0.004058	0.002688
S.D. dependent	0.029104	0.083817	0.157604	0.063267
Determinant resid covariance (dof adj.)		5.27E-11		
Determinant resid covariance		3.29E-11		
Log likelihood		1265.813		
Akaike information criterion		-11.85669		
Schwarz criterion		-10.32881		

(6) Forecast by VECM

Figure 4.6 is the fitting effect graph of the newbuilding panamax price for actual one and the forecast one based on the static forecast. And it shows a good result. And Figure 4.7 is the difference between the forecast and the actual price and most of them is within the range of 5% so it fits the requirements.

From figure 4.8 we can see that it is the same to the one in the Capesize market. There were two shock in 2004 and 2008 generally moved back to the equilibrium position which are coincided with the historic representation.

Fig 4.6 Fitting curve of Panamax

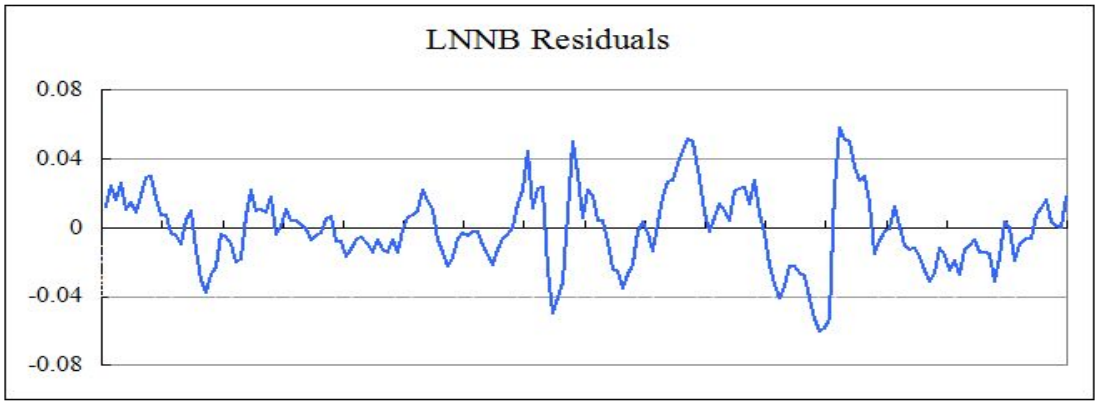

Fig 4.7 LNNB Residuals of Panamax

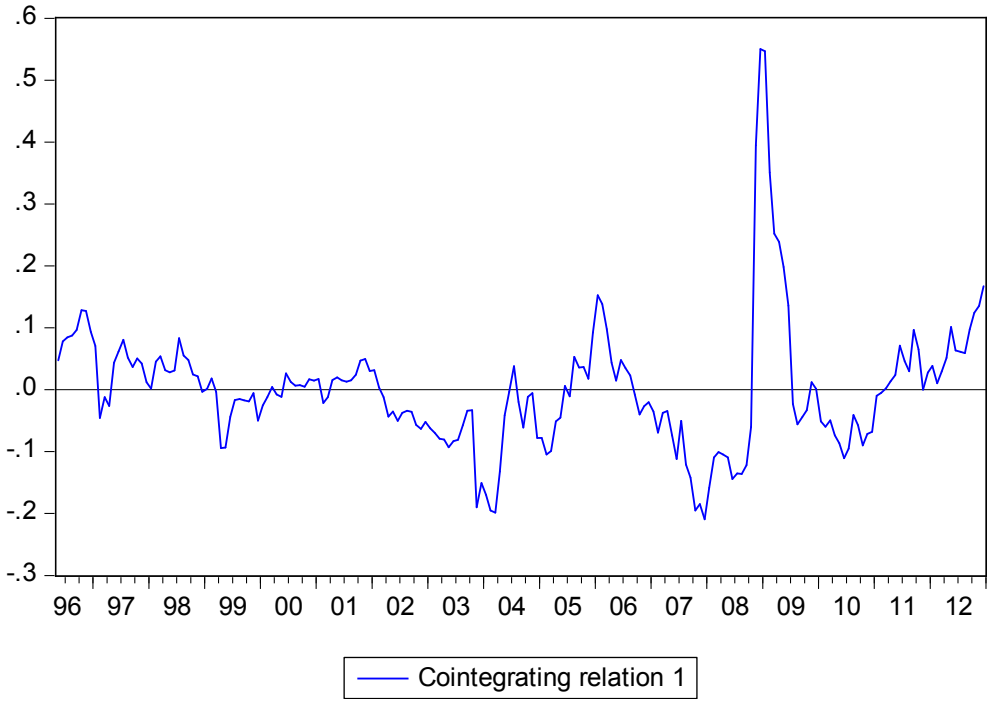

Fig 4.8 Panamax Cointegrating relation graph based on VEC model

4.5 The similarity and difference of the Panamax and Capesize newbuilding price fluctuation (Based on the results of the VECM)

(1) Similarity analysis

The secondhand price is the most important factor influencing the newbuilding price of both Panamax and Capesize. And the following two critical factors are the one-year time charter rate and the Japanese Plate price. And the less important one is the ratio of orderbook and the fleet size.

It is obvious that the secondhand price is most closely related to the newbuilding ship price which includes market information. It can be regarded as the weather vane of the newbuilding ship price. Speaking of the time charter rate, it is kind of return on the ship investment and also an important reference to an investment. But one of the disadvantage is that it does not take the vessel age into account so it may be a little different to the movements of the newbuilding ship price. And the marine steel plate which is used for ship building, the fluctuation of its price seems to be similar to the newbuilding price. But actually, it is a little bit hysteretic compared to the newbulding price. That is because in reality the procurement of the raw materials is a kind of strategic behavior of the enterprise. Shipbuilders are not always waiting for orders, for example when the steel prices fall they began to replenish stock. It is responding to the steel market price fluctuations. Therefore, it is not suitable to view the newbuilding ship price fluctuations the same as the steel price fluctuations. Besides, with the development of shipbuilding technology specification, the proportion of procurement cost to the total cost accounts larger and larger. Finally, the orderbook to the total fleet size is the representation of the whole market only and is kind of factor with low reference value, so the influence on the prices of newbuilding vessels is limited.

(2) Differences analysis

The ratio of new ship orders accounted for the fleet size has almost no effect to Panamax ship investment. Compared to Capesize bulk carrier, the Panamax construction history is longer than Capesize and the technology is also more mature. So within the scope of the worldwide, its stock is very large. It is also because of this vast basis of Panamax leading to new shipbuilding orders for total fleet is still small. Therefore, its fluctuation rule has a large gap compared with the price fluctuation os newbuilding price.

In addition, Panamax ship price is much more affected by secondhand ship price than Capesize. This is because the dead weight of Panamax bulk carriers is much smaller than Capesize so the cargoes are more diverse for Panamax and also routes are more flexible (without being limited by the Panama canal traffic). The mature construction technology and lower price are two attractions for people to build Panamax rather than Capesize. Its investment threshold is not high so it is favored by speculators. Therefore these ships are more likely to be affected by the market price fluctuations. And for Capesize vessels, the cargoes are generally only iron ore, coal or something more than 10 DWT bulk materials for one time. The shipowners and the cargo owners are relatively fixed and meanwhile the routes are single (focused on the main iron ore importer and exporter), together with large tonnage, building materials, so the ship price compared with Panamax will be constrained much more by shipbuilding cost and fleet supply, etc.

5 Investment efficiency model for newbuilding vessels

5.1 Related theory of investment efficiency model for newbuilding vessels

5.1.1 Ratio of price to earnings

The price to earning ratio or P/E ratio is the valuation ratio of a company's current share price compared to its per-share earnings. It usually refers to the ratio of stock price to earnings per share in four quarters. It is one of the indicators that usually being used to evaluate the rationality of the stock price. The comparison of the P/E ratio has quite important reference value in the same industry. P/E ratio can reflect the stock price is overvalued or underestimated. P/E in essence is a price, and the change process of P/E is the discovering process of market price.[18]

When analyzing the historic average P/E ratio of one stock, the investor will be likely to purchase the stock by a lower price if the P/E ratio is relatively lower. **If the P/E ratio is too high that means the stock price is overvalued**. In other words, by comparing price and earnings per share for a company, one can analyze the market's stock valuation of a company and its shares relative to the income the company is actually generating. Stocks with higher (or more certain) forecast earnings growth usually have a higher P/E, and those expected to have lower (or riskier) earnings growth usually have a lower P/E.

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5.1.2 Moving average theory

Moving average method is usually used to predict the future demand or supply capacity for a period of time for one company by a set of recent data. Moving average has the effect of smoothing and makes the fluctuation of the original sequence weakened. And the larger the average interval number N, the greater the smoothing influence on the sequence. Moving average method is appropriate for the products or sequences neither grow rapidly nor quick decline.

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18 Zhao Dewu, (2006), The research of investment expectation based on P/E ratio, Southwestern University of finance, master paper

5.2 Investment efficiency of newbuilding dry bulk carrier based on P/E ratio and moving average

5.2.1 Model theory overview

In this chapter, the investment efficiency model of the newbuilding dry bulk carrier is derived from the P/E ratio theory in stock market. I compare the stock price with the newbuilding ship price of a particular type and the annual earnings per share with the one-year time charter rate of the particular type of. So, it can be interpreted as the p/e ratio in shipping industry

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The statistical time range of both earnings per share and one-year time charter rate is the same all about 12 months. More importantly, the time charter rate represents the benefit obtained after the ship being put into the charter market. It does not include the voyage cost which can effectively avoid the disturbance of variable costs such as fuel costs. In addition, time charter rate can reflect the future profitability for a long time to ship and can better reflect the information of market trends such as the profitability better than the spot rate.

When establishing this investment efficiency model, considering that in real practice it will typically take two or three months or even longer time from issuing tender, bidding, consultation about the specific parameters and signing a letter of intent. The investment climate will be different from the environment of keel laying, so I will not built the investment timing model but the investment efficiency model.

5.2.2 Cointegration test between the newbuilding ship price and time charter rate

The basis of the investment efficiency model is to prove that there is co-integration relationship between newbuilding ship price and time charter rate. The reason is that the P/E ratio in stock market can roughly evaluate the actual value of the stock peice and tell people whether it is overvalued or undervalued. If the majority of investors achieve the agreement that the price is overvalued or undervalued, then after several

transactions, the price will be back to the normal level. So, it is necessary to prove that there is co-integration relationship between these two sequence then the P/E ratio in newbuilding ship market will achieve pratical significance. For example, if we judge that the ship price is obviously overvalued, then according to the inherent co-integration mechanism the ship price will gradually back to the equilibrium position.

Here the Johansen method is being used to test the relationship between the newbuilding ship price and the time charter rate for both Capesize and Panamax. According to the ADF test in VECM before, we know that the time series are not stationary but is the first-ordered integrated, so it meets the requirements of the Johansen Cointegration test. According to the Johansen Cointegration test I finally decide to choose three as the lag interval of the Capesize model and four as the lag interval of Panamax. Table 5.1 is the result of Johansen Cointegration test between the newbuilding price and the time charter rate of both Capesize and Panamax.

Table 5 1 Result of Johansen test between newbuilding ship price and time charter rate

		Hypothesized No. of CE(s)	Statistics	0.05 Critical Value
Capasize	Trace	None*	23.41808	15.49471
		At most 1	2.568925	3.841466
	Maximum Eigenvalue	None*	20.84916	14.26460
		At most 1	2.568925	3.841466
Panamax	Trace	None*	18.57277	15.49471
		At most 1	2.041077	3.841466
	Maximum Eigenvalue	None*	16.53169	14.26460
		At most 1	2.041077	3.841466

Compare the result with the 5% critical value, we can find that both the Capesize and Panamax all pass the Johansen Cointegration test and there exists only one

cointegrated relation between the sequence newbuilding ship price with the one-year time charter rate.

5.2.3 Model Overview

According to the discussion above, the next step is to establish the investment efficiency model for the newbuilding ships based on the theory of P/E ratio. After proving there exists only one co-integration relationship between the numerator and denominator in the P/E ratio, it can be said that the the P/E ratio will fluctuate near the long-term equilibrium value in actual situation. Therefore the newbuilding price is selected as the numerator of the ship's p/e ratio and one-year time charter rate as the denominator, the following new shipbuilding price-earnings ratio model is then set up. (Note: in order to reduce data fluctuation, taking natural logarithms for all sequence.)

$$Log(P/E) = LnNB - LnTC \tag{5-2}$$

Meanwhile, construct both long-term and short-term moving average sequence and compare the correlation between them to figure out whether it is overvalued or undervalued. Cause the moving average model can modify and smooth the original sequence, in a certain period of time, if the value of short-term sequence is larger than the value of long-term sequence, then it means that the newbuilding ship price at this present is overvalued. And the price will gradually go back to the normal level after a period of time by the adjustment of the market itself. And it is not good time if someone wants to invest the newbuilding ship speculatively now. When the value of short-term sequence is smaller than long-term squence, it means the ship price is undervalued at this present.

Considering the time charter being used is one-year and in reality the update frequency is one month, so when using Excel to construct the moving average model, for short period the cycle will be set for one month and the long period for 12 months and then the next step is to compare the long-term and short-term situation of the time charter rate and the newbuilding price.

5.3 Investment efficiency model for newbuilding dry bulk carrier and empirical analysis

The data is from January 1996 to February 2014 for the Capesize ships. Comparing the long-term and short term time series of Capesize and Panamax, two moving average simulated trend can be acquired. Due to the data from Clarkson, the data for Panamax is from Jan 2002 to Feb 2014. From Fig 5.1 and Fig 5.2, green line represents the trend of the newbuilding ship price and blue one refers to the short-term P/E ratio and the red one is the long-term one. According to the theory of the model of P/E ratio, if the blue line (short-term) is higher than the red line (long-term), it indicates that the newbuilding ship price is overvalued. So the price may be in an downward trend during this period, vise versa. And the larger the P/E value, the worse the ship market is and it also indicates the investing value is declining at this time.

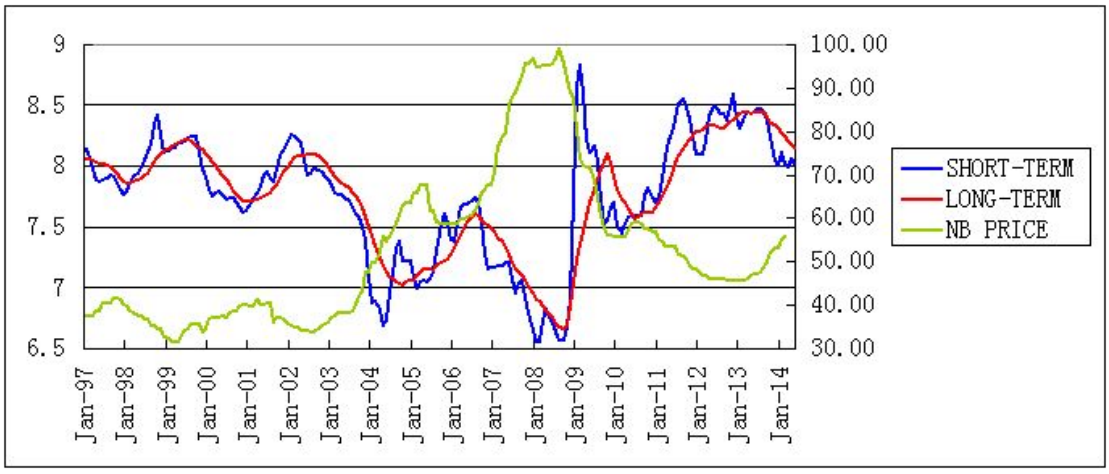

Fig 5.1 Capesize P/E ratio comparison

Source: Clarksons Shipping Intelligence Network

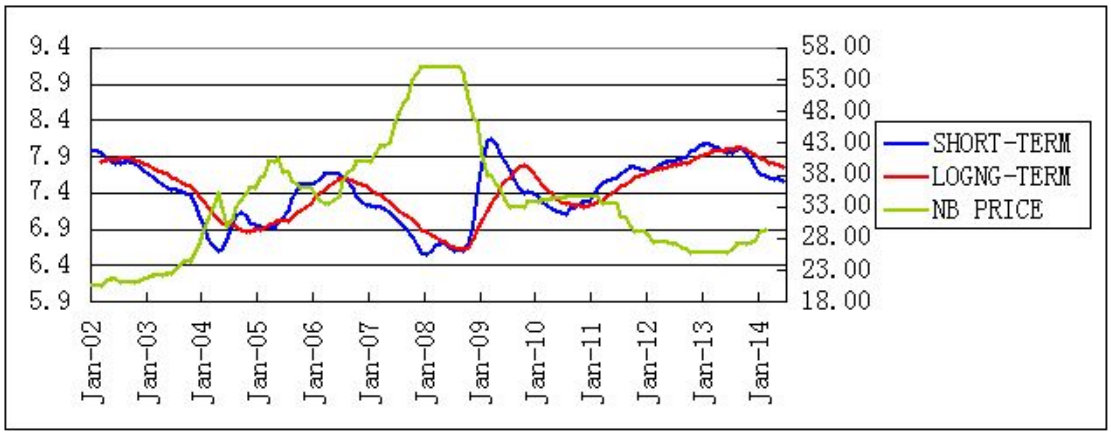

Fig 5.2 Panamax P/E ratio comparison

Source: Clarksons Shipping Intelligence Network

Then verify the validity of the model by combining the actual situation. From 2002 to 2004, the shipping market was in the recovery and from 2000 to 2002, both Panamax and Capesize dry bulk ship prices remained at low price and nearly to the bottom. Panamax ship price was only about $20 million at that time and after 2004 this type of ship prices rise month by month, once more than $33 million. As you can see, just from the appreiciation of the ship itself, in 2002, it is fortunate and wise to build new panamax bulk carriers. Besides the ship appreciation, thanks to the stock market, economic development and rapid growth of the trade after 2004 and especially China's economic growth lead to great demand for bulk commodities. Shipping market reached the peak and freight rose sharply.[19] Though the price of steel plate for shipbuilding was high because of the soaring of the iron ore price at that time, the shipowners still got huge profit after the dry bulk ships being put into use due to the high freight rate and large cargo volume in 2002.

From late 2005 to 2006, we can see that short-term is larger than the long-term value, it indicates that the ship price was overvalued at that time and it was not the right time to build new ships and according to the dry bulkers fleet summarized by Clarkson in 2006, the supply and demand is almost balanced in late 2004. But in 2005 and 2006,

19 Zhu Mo, Zhu Renyi, International shipping trade. Shanghai: Shanghai jiaotong university press. 2011.139-148.

the contradiction of excess capacity appeared and excess capacity was up to more than 300 ton and freight also has dropped. But in the meantime, by speculative factors to world economic growth and overly optimistic estimates of emerging markets in China, shipping market was in an unprecedented peak period. Although the price of new shipbuilding reached the peak, in order to compete for profit, many shipowners still choose to order ship. The move instantly aggravated the excess capacity situation of shipping market and also continuous weakness after the financial crisis.

From 2009 to 2010 in Fig 5.1 and Fig 5. 2, the absolute value of the ship's p/e ratio for both short-term or long-term are at relatively historical high price. This is mainly because of the very low ship operating earnings and pessimistic expectations of the shipowners. According to Clarkson statistics in 2011, world newbuilding vessel deliveries reached the peak to more than 160 million tons a year. Considering that many owners have delayed the ship delivery time, excess capacity will continue for a period of time, at the same time, the newbuilding ship prices were low. We can find that in 2011 and 2012 the blue line was almost above the red line and it is really not good time to build new ships. But the demolition quantity was still high at that time, it can be said that newbuilding market has reached the bottom and the cost of the ship was near break-even point for shipyards.

In 2013, average earnings in all bulk carrier sectors remained relatively weak as a result of continued oversupply.However, average earnings in 2013 were marginally higher than in 2012, led by notable improvements in Capesize spot earnings in the second half of the year. In Q4 2013, Capesize earnings exceeded $40,000/day for two short-lived periods, supported by strong Chinese iron ore import growth.And it seems that from the beginning of the year 2014, for both Panamax and Capesize vessel, the value of long-term curve is larger than that of short-term value which indicates that it is the right time to build new ships.

According to Greek shipping analyst Nikos Roussanoglou the latest report, though since the end of March 2014, the bulk carrier market fell again, but many of the shipowners, analysts and experts agree that year 2014 would be a breakthrough after five years slump. And he said, along with the increase of market demand, the pressure of the new ship orders will be reduced.[20] From the point of the market so far, these predictions will be realizing. However, due to great changes in recent months, whether the future market can really achieve the expected value remains to be seen.

According to second-hand ship broker George Iliopoulos, from the first quarter of 2014, the bulk carrier market does not reach the expected high rebound, but many market participants still believe the market will rebound in 2014. Currently the optimistic signs of second-hand ship market also confirmed this trend. As I said before, second-hand price is the most significant factor that may affect the newbuilding ship price. As a result, the performance of the newbuilding bulkers mrket in the future is expected to follow secondhand ship market performance.

20 Bulk carrier market is in the direction of sustainable development, http://www.chinairn.com/news/20140507/

6 Conclusion

Due to the research level and the time limitation, this paper still exists some deficiencies which need to be improved and need more in-depth research including the following aspects.

In this paper, only the fluctuation of Capesize and Panamax bulk carriers is studied while for this market there are other two important ship size which are handy-max and handy-size ships are not discussed.

For the investment efficiency model of the newbuilding ship investment, the data being used is lasting for 20 years to verify the model. But it still lacks a very specific example of shipping enterprise thus may affect the validity of the model in the current market environment.

The estimation of shipbuilding cost is a very complex work, the current main shipbuilding countries around the world do not have a unified method or standard to estimate the cost of shipbuilding. So this article uses the prices of the major materials in the process of shipbuilding that is steel plate to represent the shipbuilding cost. However, with the development of shipbuilding technology such as fuel-efficiency, environmental protection which is meant to improve the economy of ship operating as well as deal with all kinds of international maritime conventions, the changes in the steel price may not completely reflect the real cost of shipbuilding as accurate as it used to be.

In conclusion, the new price will be affected by multiple factors. The price influence factors are quite complex and still need a lot of research on price fluctuation. At the same time, the new bulk ships carry the main strategic cargoes around the world. For the newbuilding ship, especially newbuilding dry bulk carrier, the study of price fluctuation and the investment efficiency is of great significance to the world shipping industry and trade around the world.

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Appendices

Appendix 1 Raw data of Capasize

Date	NB m$	5 years	Timecharter rate	Orderbook/Fleet	Steel Price
Jan-96	41.00	32.08	14125	0.21	402.27
Feb-96	41.00	31.50	13450	0.19	402.74
Mar-96	41.00	30.92	13700	0.18	404.81
Apr-96	41.00	30.92	13875	0.19	399.82
May-96	40.00	29.75	13150	0.18	388.39
Jun-96	40.00	29.75	12975	0.18	387.62
Jul-96	39.50	29.17	11662	0.17	384.59
Aug-96	39.50	29.17	11400	0.15	381.59
Sep-96	39.50	28.00	11725	0.15	381.17
Oct-96	39.50	28.00	11012	0.14	380.18
Nov-96	39.50	28.00	11760	0.13	372.98
Dec-96	39.00	28.00	12500	0.12	364.18
Jan-97	38.00	32.08	13800	0.12	364.50
Feb-97	38.00	32.08	14600	0.10	351.97
Mar-97	38.00	32.08	14250	0.10	369.42
Apr-97	39.00	32.08	14362	0.08	369.66
May-97	39.00	32.08	14290	0.08	371.12
Jun-97	41.00	32.08	14375	0.08	370.50
Jul-97	41.00	33.83	15462	0.08	365.22
Aug-97	41.00	33.83	15750	0.08	360.33
Sep-97	42.00	34.42	17688	0.08	341.63
Oct-97	42.00	34.42	17600	0.09	281.50
Nov-97	41.50	34.42	16375	0.09	194.86

Dec-97	40.50	34.42	14872	0.09	215.99
Jan-98	40.00	34.42	14400	0.10	201.71
Feb-98	39.00	33.83	13438	0.11	238.08
Mar-98	38.50	33.83	12688	0.10	246.72
Apr-98	38.00	33.83	11500	0.11	248.76
May-98	38.00	33.83	11050	0.11	254.82
Jun-98	37.00	32.67	9875	0.11	284.55
Jul-98	37.00	31.50	7800	0.11	259.36
Aug-98	35.50	25.67	8000	0.12	251.71
Sep-98	35.50	28.00	10412	0.12	265.39
Oct-98	35.00	28.00	10600	0.12	280.94
Nov-98	35.00	26.83	9938	0.11	291.06
Dec-98	33.00	25.67	9600	0.12	297.90
Jan-99	32.50	26.50	9000	0.12	286.06
Feb-99	32.00	26.00	8750	0.11	285.23
Mar-99	32.00	27.25	8875	0.11	294.61
Apr-99	32.00	27.25	8500	0.10	295.11
May-99	33.50	28.50	8862	0.10	302.38
Jun-99	34.50	28.00	8775	0.09	290.75
Jul-99	35.00	27.50	9380	0.09	296.48
Aug-99	36.00	27.50	11875	0.10	310.00
Sep-99	36.00	27.50	12438	0.10	307.50
Oct-99	36.00	29.25	13750	0.10	312.50
Nov-99	34.00	29.25	14400	0.11	315.00
Dec-99	35.00	29.25	14990	0.14	315.00
Jan-00	37.00	30.50	14938	0.14	310.00
Feb-00	37.50	30.50	15338	0.15	310.00
Mar-00	37.50	31.00	16320	0.15	310.00
Apr-00	37.50	31.00	16350	0.15	310.00
May-00	38.00	29.75	16000	0.14	310.00
Jun-00	37.50	28.50	16550	0.14	310.00
Jul-00	38.50	30.75	17375	0.14	310.00
Aug-00	39.00	32.00	18938	0.13	310.00
Sep-00	39.00	32.00	19000	0.13	310.00
Oct-00	40.00	31.50	18938	0.12	312.50
Nov-00	40.50	31.50	18288	0.12	315.00
Dec-00	40.50	30.25	17050	0.12	315.00
Jan-01	40.00	30.25	16188	0.12	315.00
Feb-01	40.00	29.75	15062	0.12	315.00
Mar-01	41.50	29.25	14220	0.11	315.00

Apr-01	40.50	29.25	14300	0.10	315.00
May-01	40.50	29.75	15300	0.11	312.50
Jun-01	41.00	29.75	15400	0.11	303.00
Jul-01	41.00	28.50	12562	0.11	300.00
Aug-01	36.50	26.25	11150	0.11	300.00
Sep-01	37.50	26.25	10688	0.11	300.00
Oct-01	37.50	26.25	9750	0.09	300.00
Nov-01	37.00	26.00	9500	0.09	300.00
Dec-01	36.00	27.00	9500	0.09	300.00
Jan-02	35.50	27.50	9500	0.09	300.00
Feb-02	35.25	27.50	10000	0.08	300.00
Mar-02	35.25	27.50	12200	0.08	300.00
Apr-02	34.50	28.00	12875	0.08	300.00
May-02	34.50	28.00	11550	0.10	300.00
Jun-02	34.50	28.00	11812	0.10	300.00
Jul-02	34.00	28.00	11750	0.12	300.00
Aug-02	34.00	28.00	11940	0.11	300.00
Sep-02	35.00	28.00	12962	0.12	300.00
Oct-02	35.50	27.00	13438	0.12	300.00
Nov-02	36.00	28.00	14350	0.13	303.00
Dec-02	36.25	29.00	15438	0.13	310.00
Jan-03	37.50	30.50	15670	0.13	309.00
Feb-03	38.00	30.50	16125	0.14	315.00
Mar-03	38.50	32.00	16688	0.15	327.50
Apr-03	38.50	32.00	17312	0.16	320.00
May-03	38.50	32.00	18750	0.17	320.00
Jun-03	38.50	32.00	19062	0.16	320.00
Jul-03	39.00	33.00	20188	0.18	343.75
Aug-03	40.50	33.00	23325	0.19	352.50
Sep-03	42.50	35.50	27000	0.18	356.25
Oct-03	43.50	40.50	46000	0.19	360.00
Nov-03	48.00	44.00	47500	0.20	355.00
Dec-03	48.00	44.00	49438	0.20	376.67
Jan-04	50.00	60.00	56625	0.22	385.00
Feb-04	50.00	61.00	67031	0.21	425.00
Mar-04	52.50	60.00	55188	0.21	467.50
Apr-04	56.00	60.50	47300	0.23	540.00
May-04	55.00	53.00	43000	0.25	553.33
Jun-04	56.00	45.00	30000	0.25	573.33
Jul-04	57.50	52.00	40700	0.26	600.00

Aug-04	59.00	56.50	43750	0.27	613.75
Sep-04	61.00	56.50	42500	0.27	620.00
Oct-04	63.00	57.00	47500	0.28	620.00
Nov-04	64.00	63.00	57375	0.28	620.00
Dec-04	64.00	64.50	58700	0.28	625.00
Jan-05	66.00	66.50	53750	0.29	630.00
Feb-05	66.00	72.00	58125	0.32	630.00
Mar-05	68.00	72.00	56500	0.33	640.00
Apr-05	68.00	72.00	56700	0.32	695.00
May-05	68.00	70.50	51625	0.32	700.00
Jun-05	62.00	69.25	36312	0.32	700.00
Jul-05	62.00	64.50	31100	0.31	700.00
Aug-05	59.50	62.50	28938	0.31	727.50
Sep-05	59.00	61.00	34050	0.30	735.00
Oct-05	59.00	61.00	38125	0.29	731.25
Nov-05	59.00	60.50	34688	0.29	705.00
Dec-05	59.00	57.00	29550	0.29	700.00
Jan-06	59.00	53.00	25500	0.29	700.00
Feb-06	59.00	53.00	28000	0.29	700.00
Mar-06	60.00	54.00	26300	0.29	700.00
Apr-06	60.00	54.00	26625	0.30	600.00
May-06	60.50	56.00	25488	0.31	600.00
Jun-06	61.00	56.50	28750	0.32	600.00
Jul-06	62.00	60.00	35938	0.31	605.00
Aug-06	63.50	74.00	50000	0.33	616.00
Sep-06	66.00	76.00	50000	0.32	620.00
Oct-06	67.00	76.50	51000	0.35	600.00
Nov-06	68.00	79.00	51562	0.36	600.00
Dec-06	68.00	81.00	50950	0.37	600.00
Jan-07	71.00	82.50	53625	0.40	602.50
Feb-07	76.50	83.50	54125	0.40	610.00
Mar-07	79.00	93.00	60400	0.42	628.00
Apr-07	80.00	95.00	72750	0.47	640.00
May-07	86.00	100.00	83125	0.51	630.00
Jun-07	88.00	101.00	68800	0.58	642.00
Jul-07	89.00	106.50	82000	0.63	650.00
Aug-07	91.00	120.00	93100	0.65	650.00
Sep-07	93.00	130.00	110000	0.72	650.00
Oct-07	96.00	136.00	134250	0.77	650.00
Nov-07	96.00	152.00	137200	0.83	656.00

Dec-07	97.00	150.00	135000	0.86	710.00
Jan-08	95.00	143.50	94875	0.93	735.00
Feb-08	95.00	139.50	109000	0.96	770.00
Mar-08	95.50	145.00	111250	0.99	900.00
Apr-08	95.50	145.00	116500	1.02	927.50
May-08	95.50	153.00	130200	1.06	980.00
Jun-08	96.00	153.00	135312	1.09	1200.00
Jul-08	97.00	155.00	132000	1.08	1250.00
Aug-08	99.00	153.00	112600	1.16	1250.00
Sep-08	96.00	134.00	84000	1.16	1350.00
Oct-08	92.50	75.00	20100	1.16	1350.00
Nov-08	89.00	48.00	12500	1.15	1350.00
Dec-08	88.00	45.00	13250	1.13	1350.00
Jan-09	81.00	45.00	17850	1.12	1350.00
Feb-09	74.00	48.50	24000	1.12	862.50
Mar-09	72.50	48.50	20000	1.10	685.00
Apr-09	72.00	48.50	20562	1.08	680.00
May-09	72.00	52.00	25100	1.06	662.00
Jun-09	69.00	56.00	37562	1.04	650.00
Jul-09	65.00	59.00	34485	1.02	602.00
Aug-09	61.00	58.00	31375	1.00	597.50
Sep-09	58.00	58.00	24750	0.97	600.00
Oct-09	56.50	52.50	26550	0.94	600.00
Nov-09	56.50	52.50	34875	0.91	600.00
Dec-09	56.00	55.00	29875	0.90	600.00
Jan-10	56.00	55.00	29600	0.87	600.00
Feb-10	56.00	56.50	27125	0.86	600.00
Mar-10	56.00	62.00	28500	0.84	600.00
Apr-10	57.50	62.00	27900	0.81	750.00
May-10	59.00	60.00	30500	0.81	750.00
Jun-10	59.50	59.00	28500	0.80	750.00
Jul-10	59.50	56.00	22400	0.79	750.00
Aug-10	59.00	56.00	24750	0.74	700.00
Sep-10	58.00	55.00	26000	0.71	700.00
Oct-10	58.00	56.50	26000	0.69	700.00
Nov-10	57.25	55.50	23750	0.65	730.00
Dec-10	57.00	50.00	19200	0.64	730.00
Jan-11	55.50	50.00	15938	0.62	730.00
Feb-11	55.00	50.00	14125	0.59	740.00
Mar-11	54.00	47.00	13500	0.58	760.00

Apr-11	54.00	47.00	11252	0.56	830.00
May-11	54.00	45.00	10188	0.53	860.00
Jun-11	54.00	44.00	10500	0.51	880.00
Jul-11	52.00	40.00	11370	0.50	880.00
Aug-11	51.50	39.00	11881	0.48	840.00
Sep-11	51.00	39.00	14850	0.47	840.00
Oct-11	49.50	40.00	15375	0.43	780.00
Nov-11	48.50	40.00	14000	0.41	750.00
Dec-11	48.50	36.00	15300	0.39	750.00
Jan-12	48.00	38.00	11250	0.37	730.00
Feb-12	47.00	36.50	10000	0.35	680.00
Mar-12	47.00	35.00	9000	0.33	700.00
Apr-12	46.50	35.00	10375	0.30	700.00
May-12	46.50	35.00	9750	0.28	700.00
Jun-12	46.50	35.00	10300	0.25	690.00
Jul-12	46.50	33.00	11031	0.23	690.00
Aug-12	46.50	33.00	8175	0.21	685.00
Sep-12	46.00	32.50	9000	0.21	670.00
Oct-12	46.00	32.50	11500	0.19	670.00
Nov-12	46.00	32.50	10800	0.18	660.00
Dec-12	46.00	32.50	9688	0.17	660.00
Jan-13	46.00	33.00	9812	0.17	630.00
Feb-13	46.00	34.00	10000	0.16	630.00
Mar-13	46.50	34.00	9650	0.16	630.00
Apr-13	47.00	33.00	9844	0.16	620.00
May-13	47.50	34.00	9850	0.17	620.00
Jun-13	47.50	34.00	10500	0.17	620.00
Jul-13	48.00	34.00	11250	0.17	620.00
Aug-13	49.00	34.00	14300	0.18	620.00
Sep-13	50.00	38.00	17438	0.18	620.00
Oct-13	52.50	40.00	16250	0.18	620.00
Nov-13	53.50	44.00	15400	0.19	610.00
Dec-13	53.50	44.00	19625	0.20	610.00
Jan-14	55.50	46.00	16838	0.21	610.00
Feb-14	56.00	48.00	18231.5	0.22	610.00

Appendix 2 Raw data of Panamax

Date	NB m$	2nd m$	1 year TC	O/F	Steel Price
Jan-96	27.00	21.50	11600	0.154698545	402.27
Feb-96	27.00	20.00	11162	0.145293054	402.74

Mar-96	27.00	19.50	10370	0.151410864	404.81
Apr-96	27.00	21.00	10000	0.151114357	399.82
May-96	27.00	20.00	9400	0.154247794	388.39
Jun-96	27.00	20.00	8375	0.154820819	387.62
Jul-96	27.00	20.00	7875	0.162431759	384.59
Aug-96	27.25	20.00	7860	0.17346138	381.59
Sep-96	27.25	19.00	7600	0.175821254	381.17
Oct-96	27.25	19.00	7750	0.172782836	380.18
Nov-96	27.00	19.50	8950	0.169880912	372.98
Dec-96	26.50	19.50	9488	0.165882659	364.18
Jan-97	25.00	21.50	9650	0.161181578	364.50
Feb-97	26.00	21.50	10375	0.152743745	351.97
Mar-97	26.00	22.00	10875	0.154344835	369.42
Apr-97	27.00	21.00	10025	0.146660225	369.66
May-97	27.00	20.50	9350	0.148065657	371.12
Jun-97	27.50	20.50	9250	0.156469705	370.50
Jul-97	27.50	21.50	9312	0.15279504	365.22
Aug-97	27.50	22.00	9450	0.147886018	360.33
Sep-97	28.00	22.00	9812	0.15320223	341.63
Oct-97	28.00	22.00	9690	0.149292172	281.50
Nov-97	27.50	22.00	8938	0.148820567	194.86
Dec-97	27.00	22.00	8438	0.143471715	215.99
Jan-98	27.00	20.50	7650	0.146713625	201.71
Feb-98	26.00	19.50	6475	0.143276164	238.08
Mar-98	25.50	19.50	7000	0.140937761	246.72
Apr-98	25.00	19.00	6900	0.125182239	248.76
May-98	25.00	19.00	6660	0.123784247	254.82
Jun-98	24.50	17.00	6438	0.120745463	284.55
Jul-98	23.00	16.00	6000	0.126740687	259.36
Aug-98	21.50	14.50	5575	0.128730691	251.71
Sep-98	21.00	14.50	5800	0.13237955	265.39
Oct-98	20.50	14.00	6000	0.131346264	280.94
Nov-98	20.00	14.00	6212	0.140976372	291.06
Dec-98	20.00	14.00	5840	0.141426787	297.90
Jan-99	20.00	13.75	5062	0.140928864	286.06
Feb-99	19.50	13.50	5688	0.142092516	285.23
Mar-99	19.00	15.00	6188	0.137341766	294.61
Apr-99	19.00	15.00	6120	0.131188358	295.11
May-99	20.00	15.00	6438	0.125821318	302.38
Jun-99	21.00	15.50	6538	0.141070317	290.75

Jul-99	21.50	16.00	7000	0.145576804	296.48
Aug-99	21.50	16.00	7562	0.162098866	310.00
Sep-99	21.50	16.00	7750	0.168558805	307.50
Oct-99	22.50	16.75	8600	0.176857695	312.50
Nov-99	21.50	16.75	8475	0.184807582	315.00
Dec-99	22.00	16.75	8250	0.188686885	315.00
Jan-00	22.75	17.25	8588	0.204110118	310.00
Feb-00	23.00	17.00	9125	0.198256503	310.00
Mar-00	23.00	17.25	9700	0.202055587	310.00
Apr-00	22.75	17.00	9975	0.201106993	310.00
May-00	23.00	16.25	9850	0.205457316	310.00
Jun-00	22.50	16.00	9970	0.206249328	310.00
Jul-00	23.00	16.75	10188	0.205884478	310.00
Aug-00	23.00	16.75	10062	0.203163523	310.00
Sep-00	23.00	16.75	10500	0.198980003	310.00
Oct-00	23.00	16.50	10000	0.189666924	312.50
Nov-00	22.50	16.00	9788	0.185048204	315.00
Dec-00	22.50	16.00	9300	0.177317159	315.00
Jan-01	22.00	16.50	9000	0.180793994	315.00
Feb-01	22.00	16.25	8975	0.163622961	315.00
Mar-01	22.00	15.50	8950	0.157158927	315.00
Apr-01	22.00	15.50	8312	0.140526131	315.00
May-01	22.00	15.50	8975	0.13390196	312.50
Jun-01	21.50	15.00	8500	0.124265123	303.00
Jul-01	21.50	15.00	8125	0.114744513	300.00
Aug-01	21.00	14.50	6450	0.103426253	300.00
Sep-01	21.00	14.00	6188	0.096985886	300.00
Oct-01	21.00	14.00	5912	0.086336822	300.00
Nov-01	20.50	14.00	5440	0.088678304	300.00
Dec-01	20.50	14.00	5325	0.084975667	300.00
Jan-02	20.50	14.50	6100	0.081989274	300.00
Feb-02	20.50	14.75	6688	0.065336989	300.00
Mar-02	20.50	15.50	6990	0.064242396	300.00
Apr-02	21.25	16.25	7025	0.05792039	300.00
May-02	21.50	17.00	7080	0.065887266	300.00
Jun-02	21.50	16.75	6538	0.061568266	300.00
Jul-02	21.00	16.00	6525	0.061543734	300.00
Aug-02	21.00	16.00	6720	0.060517932	300.00
Sep-02	21.00	16.25	8312	0.069263701	300.00
Oct-02	21.00	16.50	8000	0.091616781	300.00

Nov-02	21.25	16.50	8150	0.098554762	303.00
Dec-02	21.50	17.00	9000	0.096432132	310.00
Jan-03	22.00	17.80	9550	0.112408087	309.00
Feb-03	22.25	18.50	9406	0.134385828	315.00
Mar-03	22.25	18.50	9906	0.137966435	327.50
Apr-03	22.25	18.75	10562	0.145701727	320.00
May-03	22.50	18.75	10800	0.15398032	320.00
Jun-03	22.50	18.75	10406	0.16939584	320.00
Jul-03	23.25	19.00	11375	0.195316552	343.75
Aug-03	24.00	19.25	11700	0.205704392	352.50
Sep-03	24.25	19.50	12156	0.204520444	356.25
Oct-03	24.50	25.00	18100	0.202149768	360.00
Nov-03	26.00	25.50	20812	0.218347046	355.00
Dec-03	27.00	28.00	22688	0.220319184	376.67
Jan-04	29.50	33.25	29300	0.2295205	385.00
Feb-04	31.00	36.00	35500	0.231167656	425.00
Mar-04	33.00	36.00	35875	0.239211808	467.50
Apr-04	35.00	35.50	26450	0.246201067	540.00
May-04	33.00	32.00	14125	0.24772472	553.33
Jun-04	30.00	26.00	11125	0.245769613	573.33
Jul-04	31.00	29.50	15550	0.240970403	600.00
Aug-04	33.00	35.00	16938	0.238152731	613.75
Sep-04	34.00	34.00	16188	0.237651094	620.00
Oct-04	35.00	35.00	18075	0.23020923	620.00
Nov-04	36.00	40.00	27000	0.233143604	620.00
Dec-04	36.00	40.00	27200	0.230807982	625.00
Jan-05	37.50	45.00	26625	0.23223713	630.00
Feb-05	38.00	45.50	27250	0.253894208	630.00
Mar-05	40.00	45.50	29312	0.247253357	640.00
Apr-05	40.00	46.00	25150	0.24922296	695.00
May-05	40.50	44.00	20000	0.242888869	700.00
Jun-05	38.50	42.15	17188	0.235324606	700.00
Jul-05	38.50	39.00	12350	0.232343005	700.00
Aug-05	37.00	38.00	11250	0.232572372	727.50
Sep-05	36.50	36.50	13350	0.23872591	735.00
Oct-05	36.00	36.50	14562	0.232375234	731.25
Nov-05	36.00	32.50	12562	0.226820439	705.00
Dec-05	36.00	29.50	11725	0.221118524	700.00
Jan-06	35.00	29.00	10875	0.22596662	700.00
Feb-06	34.00	29.50	11219	0.231298407	700.00

Mar-06	33.50	31.50	11450	0.231363885	700.00
Apr-06	33.50	33.00	10375	0.222987221	600.00
May-06	34.00	32.00	10344	0.217106983	600.00
Jun-06	34.50	33.00	12250	0.211904015	600.00
Jul-06	37.00	37.50	13938	0.206756171	605.00
Aug-06	38.50	41.00	19562	0.208291266	616.00
Sep-06	39.00	44.00	21100	0.202480854	620.00
Oct-06	40.00	45.00	20062	0.19663729	600.00
Nov-06	40.00	44.60	19625	0.198353135	600.00
Dec-06	40.00	45.50	20850	0.191515206	600.00
Jan-07	40.00	48.00	22062	0.21017154	602.50
Feb-07	41.50	48.50	21781	0.22355069	610.00
Mar-07	42.50	50.00	23600	0.232797158	628.00
Apr-07	42.50	53.00	26312	0.23437958	640.00
May-07	43.00	57.00	29625	0.235023034	630.00
Jun-07	46.00	58.00	27750	0.26203264	642.00
Jul-07	47.50	68.00	33194	0.289597267	650.00
Aug-07	49.50	74.00	41900	0.30760273	650.00
Sep-07	50.00	79.00	65125	0.334344028	650.00
Oct-07	53.00	85.00	71500	0.364184719	650.00
Nov-07	54.00	92.00	67800	0.405162144	656.00
Dec-07	55.00	88.50	61125	0.417975419	710.00
Jan-08	55.00	83.00	50875	0.427473585	735.00
Feb-08	55.00	81.50	54800	0.476728429	770.00
Mar-08	55.00	82.00	62375	0.478366948	900.00
Apr-08	55.00	83.00	61250	0.482637531	927.50
May-08	55.00	88.00	64800	0.515657314	980.00
Jun-08	55.00	88.00	65188	0.519153061	1200.00
Jul-08	55.00	89.00	60750	0.529141723	1250.00
Aug-08	55.00	88.00	53200	0.541278018	1250.00
Sep-08	54.00	80.00	36625	0.540763925	1350.00
Oct-08	50.00	36.00	11600	0.545664996	1350.00
Nov-08	47.00	26.00	7188	0.544476714	1350.00
Dec-08	46.50	26.00	6312	0.539124262	1350.00
Jan-09	41.00	29.00	7050	0.533489716	1350.00
Feb-09	38.00	29.00	7344	0.539952281	862.50
Mar-09	38.00	29.00	7750	0.534018319	685.00
Apr-09	36.50	29.50	6469	0.527531365	680.00
May-09	36.00	31.00	8955	0.520518683	662.00
Jun-09	34.00	35.50	13250	0.51292172	650.00

Jul-09	33.00	35.50	13060	0.500145413	602.00
Aug-09	33.00	35.50	10562	0.503974681	597.50
Sep-09	33.00	34.50	11688	0.503456937	600.00
Oct-09	33.00	32.00	11475	0.49266742	600.00
Nov-09	33.75	33.00	15031	0.495705178	600.00
Dec-09	33.75	36.00	15469	0.489353579	600.00
Jan-10	33.75	36.25	16725	0.496113119	600.00
Feb-10	34.00	36.25	15938	0.514162739	600.00
Mar-10	34.00	37.50	17250	0.522909886	600.00
Apr-10	34.25	39.50	17150	0.539614147	750.00
May-10	34.25	41.00	17938	0.546130462	750.00
Jun-10	34.25	40.25	16500	0.590628444	750.00
Jul-10	34.50	38.00	12950	0.598546711	750.00
Aug-10	34.50	38.50	14344	0.589922895	700.00
Sep-10	34.50	40.50	15156	0.595316739	700.00
Oct-10	34.50	39.50	14100	0.594703134	700.00
Nov-10	34.50	39.50	13750	0.595920972	730.00
Dec-10	34.50	36.00	12800	0.580908464	730.00
Jan-11	34.50	36.00	11750	0.592046901	730.00
Feb-11	34.50	36.00	10500	0.602276093	740.00
Mar-11	33.50	34.00	9438	0.595482452	760.00
Apr-11	33.50	34.00	8425	0.582445155	830.00
May-11	33.50	31.50	8250	0.572065767	860.00
Jun-11	33.50	33.00	8062	0.559777471	880.00
Jul-11	31.50	31.00	6925	0.544205956	880.00
Aug-11	31.25	27.50	6156	0.532731893	840.00
Sep-11	30.00	27.00	6300	0.522031499	840.00
Oct-11	29.00	28.00	7062	0.49388326	780.00
Nov-11	29.00	27.00	6125	0.476819107	750.00
Dec-11	29.00	26.50	6125	0.460908688	750.00
Jan-12	28.50	27.50	4938	0.453906219	730.00
Feb-12	27.50	25.00	4750	0.429239895	680.00
Mar-12	27.50	24.00	5025	0.416098213	700.00
Apr-12	27.50	22.00	5094	0.395068696	700.00
May-12	27.50	23.50	5031	0.384028147	700.00
Jun-12	27.25	23.50	4420	0.362053861	690.00
Jul-12	27.25	23.50	4562	0.344795048	690.00
Aug-12	26.50	21.00	4525	0.330676054	685.00
Sep-12	26.25	20.00	3875	0.314157911	670.00
Oct-12	25.75	19.00	3860	0.30362852	670.00

Nov-12	25.75	18.00	3780	0.296769924	660.00
Dec-12	25.75	18.00	3750	0.27877051	660.00