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Newbuilding ship price analysis for bulk carrier and its short-term forecast

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Newbuilding Ship Price Analysis for Bulk Carrier and Its Short-term Forecast

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DRECLARATION

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

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

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Supervised by

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ABSTRACT

Title of the thesis: **Newbuilding Ship Price Analysis for Bulk Carrier and ItsShort-term Forecast**

Degree: **Master of Science in International Transport and Logistics**

The relationship of supply and demand in shipping market is deteriorating. The bulk carrier market, due to less amount of dismantling, excess capacity has been significantly affected the development of the ship market.In order to help ship owners to better analyze the market dynamics and risk management, it is necessary to identify the main factors that affect the new ship prices in recent years.

This paper aims to make an analysis on ships market by market theory. Through the in-depth analysis of shipping market and ships market, an econometric model is made. Then the six classic assumptions of OLS are applied on the model. Results show Fleetsize, Orderbook, Libor, Japan Steel Ship Plate Commodity Price and Secondhand Prices have positive relations with Newbuilding Ship Price. 6 months Timecharter rate does not affect newbuilding ship price.

In the last part, ARIMA model is used in forecast of newbuilding ship price. The results show ARIMA model is viableandreliable in short-term forecast of newbuilding ship price.

KEYWORDS: Newbuilding Ship price, Bulk Carrier, Panamax, ARIMA model, Short-term Forecast,Econometric model.

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1. Introduction

1.1. Research Background

According to IMF, they predict that by 2014 the world economy will grow 3.7% and by 2015 it is expected to grow 3.9%.[1] After experiencing the downside in 2013, the world economic growth is now in recovery, but the risk is growing at the same time. In recent years, with lower investment costs and the sharp decline in ship prices, investors and owners of investment enthusiast for new ships increased significantly. This year in October, the market continues to remain active, new contracts totaled at 162 vessels, 1,012 dwt, cost $ 7.4 billion. From January to October, the total turnover is around 1,566 vessels, 10,094 dwt, an increase of 30 .6 % in vessels, 125.0% in weights. In the stimulation of new orders in November, price compared with the beginning of year bulk carriers raised 6.3%, oil tankers 1.1%, and container ships 7.8%. Similarly, in the second-hand ship market, bulk carrier vessels also showed active posture, most of the trading prices of the ship are showing up more than 10% increase.

Superficially both the world economy and the shipping market crisis seems to be on the down side, but in fact, the risk of world economic is still very great, new risks are also worth of the attention. In some of the wealthy countries, inflation rate is very low which will lead to harm to the economy, particularly in the European area. In emerging and developing economies, the financial markets and the volatility of capital flows still have concerns. On the other hand, the shipping market supply and demand relationship is deteriorating. Excess capacity has been significantly affected the development of the ship market.

So the timing is very important to invest in the shipping company especially for an investor. For new ship builders, shipping companies and investors entering the market, the market must first have a clear understanding. From maturity of the market, life cycle, market capacity, development law and competition must have a correct judgment to achieve strategizing and winning of the market. Variables associated with the ship building market, supply, demand, and prices showing a significant cyclical

[1]IMF (2014)

fluctuation, the price volatility caused new building prices continue to collapse, disrupting ship production, so that the ship builders and ship owners face serious financial problems or even bankruptcy. To take advantage of new vessels determinants of supply and demand conditions and prices of new vessels for ship owners and ship builders not only important , but also of great significance for the investment and management decision-making banks and utilities managers.

1.2. Research Purpose

The main purpose of this paper is to identify the main factors that affect the new ship prices in order to help the ship owner to better understand the market dynamics and risk management. In order to achieve the objective, the first thing of this research is to give an introduction of the newbuilding ships market in many different perspectives. Then, an abundant overview of the former literatures is given. On the basis of the former literature, I'll set an econometrics model based on at least 10 years monthly data which is related to price of newbuilding ships.

After qualitative and quantitative analysis of newbuilding ship's price, this paper will forecast the ship's price in next year. The purpose is to provide a guide for the investors which intend to make investment in newbuilding ships market. Because time-series forecasting method only make a forecast by using the information contained in data itself. So if external environment changes, the historical data cannot reflect the future trend in the future. Therefore, it is necessary to update the forecast result frequently.

1.3. Literature Review

Beenstock (1985) using the asset pricing model to discover the price of second-hand vessels has big flexibility. The price of building new ship stickiness strong. This means that the new ships prices over time to adjust the price of used boats. However, this concept points vulnerable to criticism because new build ships prices are driven by cost, while second-hand ship prices are market-driven.

Beenstock and Vergottis (1989) asset pricing model using a new method to distinguish shipbuilding market and second-hand ship market. When signing the contract, the price of new and existing ship prices may keep the same differences in more or less. They believe that the main reason for this difference lies in the fact that existing ships can be made immediately after contract period expires. After agreement when signing the contract price should be reflected by market expectations, considering the value of the time of delivery of new vessels. However, this view is not entirely correct, because today in many cases new ship prices in some countries is reflected in national policies (such as subsidies or bowel control market share pricing) rather than market expectations.

Wang Tengfei(1999) according to regular changes in freight shipping market with the new shipbuilding market, the use of economic models ARMA freight shipping market , new shipbuilding orders and market price of the time-series analysis, and were in bulk carriers, container ships and tankers markets empirical analysis results show that the freight shipping market fluctuations newbuilding prices for long-term and short-term effects are more significant, it should accurately grasp the laws of the market, identify financing opportunities.

Kavussanos and Alizadeh(2002) verify the efficient market hypothesis in conjunction with rational expectations of dry bulk ship prices. The data are collected from January 1976-December 1997. Their research includes orthogonally and unpredictability of excess returns on investment and vector Autoregressive model was applied. The result shows that newbuilding and second-hand vessels price are not determined efficiently in the sense of market. According to their research, the Failure of the Efficient Market Hypothesis is explained by time varying risk. The results show an important implication on second-hand markets and newbuilding markets.

Wang Zhipeng (2004) based on supply and demand theory, market supply and demand elements of the ship, taking into account the capacity of ships, new ship completions, orderings, newbuilding prices, used boat prices and ship dismantling price, quantitative analysis of the secondary boat prices, summed up the ship price volatility patterns and trends, recalling the historical volatility of the shipping market , providing a reference for ship investments.

Alizadeh and Nomikos(2007) pointed out that the traditional approach to build a ship pricing model is based mainly on general and partial equilibrium relationship between the variables to consider, such as shipbuilding orders is mainly based on the amount of newbuilding deliveries, dismantling ratio charter rates, bulk carriers prices, etc., and for ship market, " efficient market hypothesis."

Cai Liming, Lu Chunxia(2008) based on 1984-2004 time series data on the Panamanian bulk carrier ship 's klaxon provided through the establishment of ARIMA (p, d, q) model, data from 2005-2008 Panamanian ship prices were used to simulate to predict , and the average mean absolute error (MAE), root mean square error (RMSE) and the mean relative error (MPE) to analyze and run the model.

Lun and Quaddus(2009) pointed out that the ship market is dominated by four markets, namely freight market, second-hand ship market, new shipbuilding market and scrapped ship market. These four markets closely related to each other. This article analyzes the associated variable vessel prices, fleet number, time charter rates and the amount of the world's seaborne trade, and empirical analysis of the interaction of bulk carrier newbuilding market, second-hand ship market and the role of ship recycling market factors.

Lei Dai, Hao Hu, Feier Chen and Jianing Zheng(2014) study on the volatility mechanism between the newbuilding ships markets and second-hand ships market. The volatility transmission effect of the two markets is identified by using bivariate GARCH model. Their result shows that volatility was spread from newbuilding to secondhand market in capesize, panamax, and handymax sectors and in handysize sector volatility transferred from secondhand to newbuilding market. Another interesting result was found in the dry bulk market that lagged variances and could affect the current variance in a counterpart market, regardless of the volatility transmission.

1.4. Existing Problem

So farmany researcheshave researched on this area, but still lack of an overall model to describe the price of newbuilding ships. Resent researches on this area show that they do not test Classical Linear Regression Assumption for their multiple linear regression model. This two issues will cause the assessed co-efficient to be invalid and not efficient. Usually the weight of co-efficient will be over-valued or under-valued.

On the other hand, in order to verify the model of newbuilding ship price, a large quantity of time series data is needed. If not, co-efficient of econometric model will also be biased. And sometimes it leads to important factors which affect ship price to be ignored.

Existing forecast method can only provide a reference to investors for a short period. In time-series forecast, dependent variables of forecast model are independent variable itself. If the system is disturbed by external factors, the forecast will be inaccurate which can be seen happened in 2008. Therefore, it is necessary to update forecast results frequently.

1.5. Research content and methodology

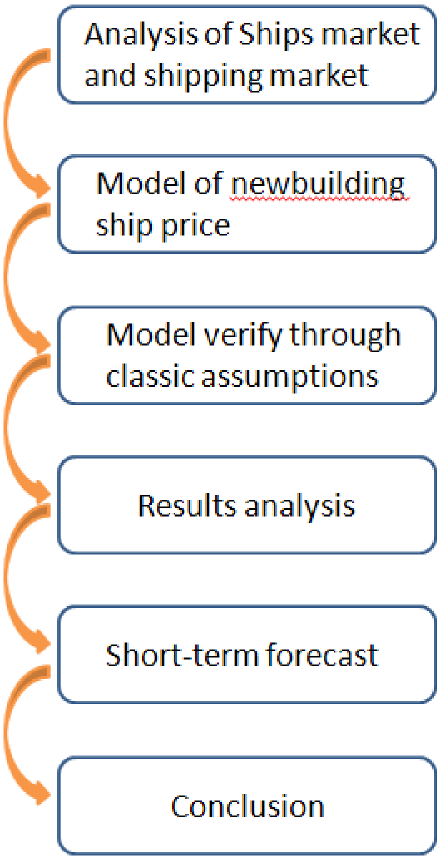
Firstly, the literaturesof domestic and foreign scholars in the new shipbuilding market made significant contributions to the field which were reviewed and pointed out their short comings, but also learned important research results in order to find the impact of new ship building prices from the most important variables.

Secondly, I'll introduce the ship building market overview. From the macro perspective on the world ship building market overview, which mainly include the new ship building market. The basic characteristics of its fluctuation mechanism, then the status of the new ship building market has been a rough analysis, and gives a brief outlook for the coming period ship building market changes, then introduced the main factors about the impact of the new ship building prices. Finally, financing and risk issues new ship building market made a cursory description.

The third part is the econometric analysis and modeling strategies. In this section, I will describe the analysis of new ship building marketwhich is used in economic theory and methods, which with a certain universality, can also be used to study the market and the demolition market in the used boats and other shipping related markets. The core idea is through a variety of tests, such as the stationary test, co integration test, etc., error correction model in line with the classical linear regression model assumptions, using OLS method to estimate the model and the model parameters for significance test and analysis. Then we propose a bulk new ship building prices economic model, and bulk new ship building price regression. The main purpose of this chapter is to identify the main factors that affect the new ship building prices in recent year, and many scholars doing research supplement before.

Finally this paper will use the ARIMA model to predict new ship building price trends.How the paper proceeding is showed in fig 1.1.

Figure 1.1 flowchart of the paper



2. Shipping Market and Shipbuilding Market

2.1. Basic features of the newbuilding ship market

In order to have an overview of the shipbuilding market, the following characteristics will be introduced first.

a) Irreplaceability

Shipping is an integral part of the international trade and it is one of the most important means of transportation. Shipping has advantages such as its large freight volume and low transportation cost. It also cannot be replaced by any other ways of transport.

b) Volatility

As we all know, the newbuilding ship market is of great volatility and it’s always in an unstable state. The newbuilding ship price as well as some shipping-related variables such as time charter rate may change a lot in relatively short period.

c) International collaborative

Withfurther deepening of global economic integration, the interdependence of national economies is increasing gradually. Different countries will be involved in the whole process of ship construction such as investors, insurance company and registration countries etc. For example, a ship with Cyprus flag may be built in South Korea while a variety of equipment and components on ships may come from many different countries. The crew may come from the Philippines and the investors may come from New York and insurance companies in Berlin.

d) High price

Construction and operation of a ship nowadays needadvanced science and technology. Shipbuilding industry has combined computer application technology, robotics, energy saving technology and heavy industry production capacity. Moreover, the satellite navigation and other new technologies like unmanned engine roommake the ship becoming more than a giant electromechanical and technology-intensive product. Capital and labor-intensive features of the ship make the price so expensive even to several hundred million dollars or higher.

e) Long construction period

Due to the complicated design and huge construction and production cycle, the entire process usually takes two to four years from first inquiry to delivery of the ship.

f) Early order

Being different from other industrial products, each single ship needs to be ordered by advance and also be designed individually and constructed in relatively small quantity.

g) Highly sensitive to environmental change

The newbuilding ship market is subject by many factors such as the world economic turmoil, political and military events and other exogenous variables.

2.2. Current Bulk carriers market

Among the international maritime fleet, the bulk fleet is the second largest vessel type following the tanker fleet. In 2014, the global dry bulk fleet size is 723 million DWT and its year-on-year growth is 5.72%.[2] Before 2008, the bulk carrier freight market, the amount of the dismantlingships was relatively lower. A large number of aging vessels was in operation in the market. From the ships' age structure, by the end of 2008, there were more than29 percent of capacity was ships of more than 20 years old which was about 396 million dwt fleet. In 2008 the ship market entered the further adjustment period and shipping market began showing depressed.

From year 1980 to 1989, the ship market was in recession. During this time, the orders were really small. From 1992 to 1997, the market gradually moved into a stable and ordinary state and the orderbook was recovering. However, the Asia economic crisis brought the market to the bottom in 1999. Between 2002 and 2008, the shipping market as well as the shipbuilding market was in a booming market and the orderbook began to increase sharply.According to Clarkson statistics, in June2008 the world's total orderbook of bulk carriers was 3584 ships. In 2009 and 2010, due to

[2]Data collect from Clarkson Sin database.

the influence of the financial crisis and the turn down of world economics, new ship orders began to decline slowly. By 2014 the total bulk carrier orders is about162 million dwt, nearly 50 % down compared to 2008, the market was more pessimistic.[3]

We can say that Asia is the world's manufacturing center for bulk carriers. As one of the world's first three majorbulk carrier shipbuilding countries, China has a longer history, so the technology is relatively mature. Bulk carrier is one of the most favorable choices for a country who would like to join the world shipbuilding market. Since the reform and opening up of China, the Chinese shipbuilding industry also has considerable developmentby the year of 2010 China has occupied half of the world's bulk carrier shipbuilding market. According to China's national conditions, it can be said that China has the comprehensive advantages in developing bulk carriers. On the one hand China itself is a large user of bulk carriers. China's huge demand for bulk cargo provided the impetus to the development of the bulk carriers market. On the other hand, the technology for the construction of bulk carriers is more mature nowadays and entry permission is not tough.

Talking about the ship type, the competition between Korean and Japanese shipyards once mainly focused on the high-value added ships. Other countries are difficult to compete with them. Additionally, some large and medium shipyards always have advantages on dry bulk carriers.In addition, some medium-sized shipyards in Japan have great advantages for bulk carriers. With high-efficiency, high-quality, low-cost high-volume construction, they created a large number of high-efficiency ships. Among them, the Capesize and Panamax vessels markets has the most intensecompetition between Japanese shipyards and Chinese on bulk carrier shipbuilding. Speaking of the current situation, for the Capesize market, both countries are so well-matched that neither could gain the upper hand. The demand of Japanese shipowners made the national orderbook maintained in a stable state. And for the Panamax bulk carrier, Japanese shipyards have more advantages. On one side, the ship types they can provide are abundant. On the other side, some specialized shipyards set this kind of ships as basic types or in other words key groups.Since 2006, due to the boom of bulk market, the shipbuilding market was also active.Shipyards

[3]Data collect from Clarkson sin database.

such as East Shipyard and DAEHAN shipyard began to undertake a large number of bulkers'orders. Old ships like Samsung heavy industries, Hyundai heavy industries andHanjin heavy industries were actively developing the 13-180000 DWT bulkers which indicated the Korean shipyards had more advantages in the field of bulk carrier construction. Also during this period, quite a number of Chinese shipyards with the newly increased capacity and the implementation of the expansion plan, also won a number of orders. WhileIndia, Vietnam andshipyards in other countriesundertake handymax andhandysize ships mainly. It can be concluded that Sino-Japanese competition pattern will continue for a period of time.

2.3. Overview of newbuilding ship prices and the main determinants

2.3.1 Overview of newbuilding prices

There are quite different understandings of the ship price, which can be summarized as following.

Cost Price: This is an internal valuation of shipyards, ship price includes the price of fixed costs (FC) and changeable cost price (CC) two parts. Fixed cost is the cost for primarily gaining shipyard production conditions in order to maintain production capacity in the ready state and so the cost incurred consequently. Changeable cost is so called relative to fixed costs in terms. In addition, some costs cannot be completely attributed to fixed costs or changeable costs. The expression for cost price:

$$CP = FC + CC - S + T \quad (2\text{-}1)$$

Where:

CP: Cost Price

FC: fixed costs

CC: changeable costs

T: Tax

S: shipbuilding subsidies

Cost-plus prices, whatshipyards expected transaction price under normal circumstances. When the market is in normal or better state, shipyards get 5% -10% margin, the highest you can get a 20% profit margin. Cost-plus price expression is:

$$PP = FC + CC - S + r + T \quad (2\text{-}2)$$

Where:

PP: cost-plus prices,

r: profit

Minimum price (Min Price): This is the lowest price at the shipyard can afford when ship market is extremely depressed. It’s lower than the cost price.

Bidding Price: This is a price after the owner tenders the bid of the new-building ship construction; shipyard intends to build and give competitive bid price.

Offer Price & Counter-offer Price: Shipowners have newbuilding ships orders will inquire the shipyards already gained business relationships with them or influential shipyards. At this time the first offer is made of the offer price, ship owners feed-back is called Counter-offer price. After several bargaining by both parties, the final price is the actual transaction price.

The maximum price (Max Price): the owner at the time of demonstration for new vessels inquiry will always determine a maximum price, with this price to order a new-building ship, the ship owner cleared part of the loan and interest in the effective operating period with net income from operations section.

Marketing Price, in the international shipbuilding market with equal competition, there will always be a uniform ship price generated by the price competition, which is undifferentiated theory’s (Law of Indifference) specific performance: same commodity with same price. Deduction of tariffs and freight, the price is unity. This undifferentiated theory leads to the so-called marketing prices. Marketing price is in a period of time, one of the most useable ship's transaction price in worldwide market.

Reasonable Price, in condition of competitive market, the price generated quality of shipbuilding, construction period and reputation, and other factors of shipyards, when these prices are generally accepted by owner, that the price is reasonable.

2.3.2 Determinants to newbuilding price

The boom and bust of shipbuilding market is primarily to be reflected by the rise and fall of ship price. Needless to doubt, the shipbuilding market is sidetracked subject to shipping market. Thus, generally the shipping market is a major factor affecting the shipbuilding market. However, on specific ship, the ship price level, in addition to the shipping market by the large environmental impact, there are many other factors, including the ship itself, shipbuilding market factors, factors of trade negotiations, exchange rate and Insurance.

a) World Economy and International Trade

In the 21st century, not only the United States, Japan and European economic began to recover, the economy of China, India and Brazil and other developing countries also experienced strong growth, the development of the world economy has entered a "super cycle." The development of the world economy promoted world trade increase. It reflects the economic interdependence, mutual penetration of different countries in the world, reflects global economic activity showing a concrete manifestation of globalization trends. Ships are the main means of transport in international trade, the development of international trade led to the demand for transport ship. On the other hand, when the world economy is in depression, ship amount of dismantling and idle capacity will increase, as the global financial crisis gave the world shipping market and shipbuilding market tremendous losses. Thus, fluctuations in the world economy, will certainly bring the newbuilding ship market an impact.

b) International monetary and exchange rate

Changes in exchange rates and bank interest on loans and finance enthusiasmwill have an impact on the ship market. Changes in the international exchange rate can only affect the interests of the related shipbuilders and ship owners, rather than the long-term impact to the whole ship market. Changes in exchange rates, interest rates floating finally reflected in price of the ship, in a macro perspective, changes in exchange rates and financial markets will have an impact in the share of new ship orders, also led risk to the shipping industry and the short-term effects, but not as the long-term impact on whole new-building ship market.

c) The ship's own factors

Ships own factors mainly include the type of ship, the ship's navigation area and its flag as well as the degree of automation of the ship. Others factors may include the ship spare parts, utilization of steeland other coatings used in ship construction process.

d) Shipbuilders factors

Different shipbuilding manufacturers may have different budget which leads to great differences in the ship price. It can be concluded as shipyard conditions, equipment vendors' selection, working hours and labor conditions and determined profit targets of shipyards.

e) Trade negotiations factors

When the ship owner and shipbuilder start to invest in building new ships, several to several aspects as ship delivery period, place of delivery, ship construction loan payment and payment conditions, etc. These factors will correspondingly affect the ship price.

f) Marine insurance factor

In a ship quotation, insurance is an important part of it which primarily related to insurance coverage, the insured value, the date of insurance and other factors.

g) Subjective factors

World Shipbuilding Market Forecast is a "controllable results prediction." This prediction can be considered to be based on correct result of previous research, and control things consciously or unconsciously. To change the movement of the process or outcome of things, Corporate decision makers can refers to those predicted results, the adjust measures to derive greater benefits. If the business response to overheat, it will cause the ship market depressed slump not supposed to be. In addition, there usually be difference among the perception of the ship market and the intelligence collection, consequently subjective psychological reactions and the resulting behavior are not the same. Therefore, the new-building ship market will be affected by human subjective factors.

3. Model of newbuilding price for bulk carriers

3.1. Multiple Linear Regression for time-series data

Considering the finite sample properties, the Gauss-Markov Assumption and the Classical Linear Regression Model Assumption based on time-series data are not only have something in common, but also exist several significant differences need to describe.

A significant difference between the time series and the cross-sectional data is that the time series is in accordance with the time sequence. For instant, the data used before, the data of 2008 always follows the data of 2007. In order to analyze the time series, we must be sure that the past can influence the future, rather than the reverse.

Another difference between cross-sectional data and time series is more subtle. When use the cross-sectional data, samples are picked randomly from the appropriate population. It is not difficult to understand why the cross-sectional data should be regarded as random values: different samples from the population, usually makes the variable and dependent variable have different values. Therefore, the OLS estimates based on different random sampling method are usually different, and that is why the OLS statistics should be considered as random variables. Similarly, the time series is also stochastic. For example, we may not know what the Standard and Poor's Composite Index may be in the next trading day closing, or what the GDP of China in next year. Since these variables cannot be predicted, they certainly should be treated as random variables.

A random variable sequence labeled with time is officially called a stochastic process or a time-series process. When we have collected a set of time-series data, we got a possible outcome of the process. Since we cannot turn back time, we can see this only one outcome, and it is similar to the fact that the cross-sectional data can be only collected one random sample. All the possible combinations of time-series stochastic process can be considered as the population in the cross-sectional analysis. Assumes that we have the time-series data of the two variables (x, y), and mark the same time on y_t and x_t. Connect X and y will be a static model:

$$y_t = \beta_0 + \beta_1 x_t + u_t \text{ , t=1,2, …,n} \quad (3\text{-}1)$$

The name of the static model comes from the fact that the model reflects the relationship between Y and X in the same period. When the change of Z in time t is considered to have immediate influence on y, usually set a static model. Of course, the static model may also have several explanatory variables. When the number of explanatory variables is greater than one, the model is as follows:

$$y_t = \beta_0 + \beta_1 x_t + u_t \text{ , t=1,2, …,n} \quad (3\text{-}2)$$

3.2. Classicassumptionfor OLS of finite sample

ASSUMPTION TS.1 (LINEAR IN PARAMETERS)

$$y_t = \beta_0 + \beta_1 x_{t1} + \cdots + \beta_k x_{tk} + u_t \ (3\text{-}3)$$

In the Symbol X_{tj}, t represents period, J represents that X_{tj} is one of K explanatory variables as usual. Y_t is the dependent variable, explained variables or regression, X_{tj} is variable, explanatory variables or regress values.

The equation gives the overall model and real model a standard description. That makes it possible for us to estimate the models different from the equations. An important characteristic of this model is, it is a linear function of the parameters $\beta_0, \beta_1, \cdots, \beta_k$. As we know, y and variables can be arbitrary functions of the variables we care (such as the square sum of the natural logarithm, etc.).

ASSUMPTION TS.2 (Zero Conditional Mean)

$$E(u_t \mid X) = 0, t = 1, 2, \ldots, n. \quad (3\text{-}4)$$

Assume that TS.2 means the independent time error u_t of time t is linearly independent with all the explanatory variables in any period. We use the conditional mean to illustrate this fact which means we must properly set the function relationship between the variables and explanatory variables. If u_t is independent of X and $E(u_t) = 0$, then the assumption is automatically created.

$$E(u_t \mid x_{t1}, \ldots, x_{tk}) = E(u_t \mid x_t) = 0. \quad (3\text{-}5)$$

Whenthe equation above isestablished, wecall the x_{tk} contemporaneously exogenous. It is not appropriate to consider sampling is random in the case of time series. Therefore, we must clearly assume that the expectation of u_t is unrelated to the explanatory variables in any period. It is important that assume the TS2 never make any restrictions among the variables or among the correlations of u_t in different period. It only mentions that the average of u_t dependent to the explanatory variables in any period of time.

All the variables which cannot be observed at time t but are related to the explanatory variables in any period will lead the assumption TS.2 to be invalid. Two main possibilities leading to invalid are variables omitting and the measurement error of regression element. But strictly exogenous variables may also be invalid because of other little obvious reasons. In the simple static model:

$$y_t = \beta_0 + \beta_1 x_t + u_t \quad (3\text{-}6)$$

The Assumption TS.2 not only requires that u_t is not related to x_t, but also requires that u_t is not related to X no matter in the past or in the future. There two important points. One is that Y has no lagging effect on X, otherwise a distributed lagging model will be needed. Another is that the strictexogeneity excludes probability that the current change of the errors may influent X in the future, which denies the feedback effect of Y on X future value.

ASSUMPTION TS.3 (No Perfect Co-linearity)

"In the sample (and therefore in the underlying time series process), no independent variable is constant or a perfect linear combination of the others."[4]

If a variable in the regression equation is a linear combination of other variables, this model has encountered a perfect co-linearity problem and cannot be estimated by OLS. It is necessary to note that the assumption TS.3allowsus to explain the interdependency among the explanatory variables but not all of them. If we do not allow any correlation among variables, the multivariate regression analysis will be useless to econometrics.

THEOREM 1(Unbiasedness of OLS)

Under Assumptions TS.1, TS.2, and TS.3, the OLS estimators are unbiased conditional on X, and therefore unconditionally as well:

$$E(\hat{\beta}_j) = \beta_j,\ j = 0,1,\ldots,k. \quad (3\text{-}7)$$

At this point, we can only get the unbiased OLS, but still cannot say the model has "BLUE"[5]. In order to establish a model satisfying the Gauss Markov assumptions, we still need to increase the two assumptions.

ASSUMPTION TS.4(Homoscedasticity)

Conditional on X, the variance of u_t is the same for all t:

[4] Wooldridge, J. (2012)

[5] Best linear unbiased estimator

$$Var(u_t \mid X) = Var(u_t) = \sigma^2, t = 1, 2, \ldots, n. \quad (3\text{-}8)$$

This assumption requires that $Var(u_t \mid X)$ is independent on X and is constant in all the time. When the TS.4 is not established, we call errors are heteroscedastic. When $Var(u_t \mid X)$ does depend on X, it is often dependent on explanatory variables X_t related to time t.

Finally, the last Gauss Markov assumption is time series unique.

ASSUMPTION TS.5(No Serial Correlation)

Conditional on X, the errors in two different time periods are uncorrelated:

$$Corr(u_t, u_s \mid X) = 0, \text{for all } t \neq s. \quad (3\text{-}9)$$

The simplest way to understand this assumption is to ignore the condition of X. Then, the assumption TS.5 becomes:

$$Corr(u_t, u_s) = 0 \text{, for all } t \neq s. \quad (3\text{-}10)$$

When the equation is not established, the equation's error is sequence dependent or self-related. And the reason is the errors are correlated in different periods. Consider the errors from adjacent period: when u_{t-1}, in general, the next period error will be also be positive. Then get $Corr(u_t, u_{t-1}) > 0$ and the errors are serial-correlated. What's important, the assumption TS.5 never mentions the problems of the variables' relativity about the time. In some time series, variables in different periods are almost inevitably related. But this relativity is independent to the establishment of TS.5. When the assumption TS.1-TS.5 are established, usually, the error variance estimates are unbiased and the Gauss–Markov theory is effective.

THEOREM 2(Unbiased Estimation of σ^2)

Under Assumptions TS.1 through TS.5, the estimator $\hat{\sigma}^2 = SSR/df$ is an unbiased estimator of σ^2, where $df = n - k - 1$.[6]

THEOREM 3(GAUSS-MARKOV Theorem)

Under Assumptions TS.1 through TS.5, the OLS estimators are the best linear unbiased estimators conditional on X.[7]

In order to be able to use the usual OLS standard error, T statistic, F statistic, we need to increase one final assumption:

ASSUMPTION TS.6 (Normality)

The errors u_t are independent of X and are independently and identically distributed as Normal(0,σ^2).[8]

The assumption TS.6 contains TS.3, TS.4, TS.5, but it is stronger for it also assumes the independence and the normality.

THEOREM 4(Normal Sampling Distributions)

Under Assumptions TS.1 through TS.6, the CLM assumptions for time series, the OLS estimators are normally distributed, conditional on X. Further, under the null hypothesis, each t statistic has a t distribution, and each F statistic has an F distribution. The usual construction of confidence intervals is also valid.[9]

Theorem 4 is very important. It tells that when establish TS1-TS6, T statistics can be used to test the statistical significance of some explanatory variables, and F statistics can be used to test the joint significance. Although we already have theorem 4, the classical linear model assumption cannot be satisfied in some study about events'

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6 Wooldridge, J. (2012)
7 Wooldridge, J. (2012)
8 Wooldridge, J. (2012)
9 Wooldridge, J. (2012)

sequence. So we cannot use theorem 4 to select model variables. In this case, we have to get the help from large sample properties of OLS.

THEOREM 5(Asymptotic Normality of OLS)

Under TS.1 through TS.5, the OLS estimators are asymptotically normally distributed. Further, the usual OLS standard errors, t statistics, F statistics, and LM statistics are asymptotically valid.[10]

3.3. Model summary

According to the second chapter of the relationship between supply and demand of the market of ship, supply and demand in the market determine the price of a product, production cost determine the product value, and the price fluctuate around the product value. So our OLS model will not only take the market supply and demand into account but also the production cost.

Firstly, we start from the view of demand perspective:

As described in chapter second, the demand of the market of ship is equal to the shipping market supply, the shipping market supply is equal to the shipping market demand. So:

$$Q_D^V = Q_S^S = Q_D^S \text{ (3-11)}$$

Where represents the demand of the market of ship, represents the shipping market supply, and represents the shipping market demands. The shipping market demand can be expressed as the following model:

$$Q_D^S = f(\overset{+}{Freight}, \overset{-}{Cost}, \overset{+}{Trade}) \text{ (3-12)}$$

Shipping supply must be a function of the market freight rate, transportation cost and the volume of global trade. Because the shipping market freight rate determines the shipping market supply and demand, the transportation cost decides the basic freight

10 Wooldridge, J. (2012)

rate level, and the trade volume is the most direct embodiment of the transport market demand.

For shipping market supply, demand model can be described as follows:

$$Q_S^S = f(\overset{+}{Contract}, \overset{+}{Newbuilding}, \overset{-}{Investment}, \overset{+}{ER}) \quad (3\text{-}13)$$

Contractrepresents the market contracts signed number, suggesting the condition of idle ships. The larger the contract number is, the more prosperous the shipping market is, the lower the idle rate of ships, vice versa.

Newbuildingrepresents the new shipbuilding price. Since a better shipping market will drive the prosperity of the market of ship and lead to the higher new shipbuilding price, the new shipbuilding ships price are positively correlated with the supply of shipping market.

Investmentrepresents the income brought from the investment in other fields. Expressed by Beenstock, ships are capital assets.[11]That means, for the ship owners, the ship is a kind of investment just like the other investments. For investors, an investment depends on the benefits. So when the investment incomes of other areas are very high, the investors should prefer to invest in those areas instead of ships. So we will this variable into consideration.

ERshort for expected return. As mentioned earlier, the ship is a kind of capital assets. For investors, the expected benefit is the vital one. So ER will impact the supply of the market of ship.

So according to the equation (3-11), (3-12) and (3-13), we can get:

$$Q_D^V = f(\overset{+}{Freight}, \overset{-}{Cost}, \overset{+}{Trade}, \overset{+}{Contract}, \overset{+}{Newbuilding}, \overset{-}{Investment}, \overset{+}{ER}) \quad (3\text{-}14)$$

Next we look at supply of the market of ship

[11]Beenstock (1985)

$$Q_S^V = f(\overset{+}{Newbuilding}, \overset{+}{Orderbook}, \overset{+}{Scrap}, \overset{-}{Libor}, \overset{-}{Exchange}, \overset{-}{Construction}) \quad (3\text{-}15)$$

Q_S^V - represents the supply of the market of ship

Newbuildingrepresents the new shipbuilding price. Needless to say, the new shipbuilding price will affect the supply of the market of ship. Firstly, the higher price inspires the shipyards to build more ships. Secondly, the higher price leads to shipyard blossom everywhere. However, when the ship price falls back, some small shipyard will go bankrupt because of no income. So we will take the newbuilding price into the model.

Orderbook as well as the fleet sizeinfluences the value of a second price. Nevertheless, for the time-series data of fleet size and orderbook both have unit root problem; it is incorrect to use both of them in the equation. But either fleet size or orderbook is too important to leave out. So, another variable will be constructed in this paper, lets the orderbook be a percentage of the total fleet. This variable is sensitive to both the fleet size and orderbook that is a better market indicator. Furthermore, it expects the development of the market. If the orderbook compared to current fleet is large, it may donate negative expectations and lead the second-hand price slide. What's more, a large orderbooke probably shows a market segment which is potentially lucrative and its ships cannot satisfy its demand.

Scrap represents ship price. The shipping industry has three main markets, shipping market, Ships market and Scrap market. There exists mutual influence among them. The annual number of Scrap ship will affect the scale of the whole market of ship, while the scrap price is a very useful data of reflecting the scrap number. So our model will describe the condition of eliminating old ships by using scrape price.

Libor represents the interbank lending rate. The purchase of ship are often accompanied by bank financing. So the improvement of bank lending rates often suggests the increment of financing costs. Namely, Libor will impact the supply of the market of ship.

Exchange represents the euro dollar exchange rate. As the common settlement currency of the whole world, the US dollar has a most vital financial position. Given that more ship owners are from Europe, the euro dollar exchange rate will affect the financing cost. Since the European ship owners have to pay more to the bank load when the dollar's exchange rate fluctuates or the euro falls. So this item will also affect the supply of the market of ship.

Construction represents the ship construction costs. As mentioned earlier, the product cost determines the product value. The product price is fluctuating around the value. On the other hand, the higher ship construction cost means the shipyard profits being squeezed, which will affect the enthusiasm of shipyard. So the ship construction costs will undoubtedly influence the supply and demand of the market of ship.

According to the economic supply and demand theory, we can get the balance equation:

$$Q_D^V = Q_S^V \quad (3\text{-}16)$$

Integrating equation (3-14), (3-15), (3-16), we can get a new shipbuilding price model:

$$P_{NB} = f(\overset{+}{Freight}, \overset{-}{Cost}, \overset{+}{Trade}, \overset{+}{Contract}, \overset{-}{Investment}, \overset{+}{ER}, \overset{+}{Orderbook}, \overset{+}{Scrap}, \overset{-}{Libor}, \overset{-}{Exchange}, \overset{-}{Construction})$$
(3-17)

P_{NB} - represents the new shipbuilding price

Then we consider the relation between the second-hand ship and the new shipbuilding: second-hand ships and new shipbuilding are mutual substitutes in the market of ship. This is easy to understand, the ship owners investing the money into the market of ship is not to satisfy their own needs, but for shipping operation and wealth. So when the new shipbuilding price is high, the ship owners will turn to the second-hand ship as investment objects. While the higher second-hand ship prices will lead new shipbuilding become second-hand ship alternatives. So we can get the following:

$$P_{NB} = f(\overset{+}{P_{SH}}) \quad (3\text{-}18)$$

P_{SH} - represents the second-hand ship price

Integrating equation (3-17) (3-18), we can get a equation:

$$P_{NB} = f(\overset{+}{Freight}, \overset{-}{Cost}, \overset{+}{Trade}, \overset{+}{Contract}, \overset{-}{Investment}, \overset{+}{ER}, \overset{+}{Orderbook}, \overset{+}{Scrap}, \overset{-}{Libor}, \overset{-}{Exchange}, \overset{-}{Construction}, \overset{+}{P_{SH}})$$

(3-19)

Namely, the ultimate new shipbuilding price model has been established.

3.4. Data Collection

This paper will choose PANAMAX ship as an sample, study on the determinants of its newbuilding price. So according to the model described earlier, we choose the data as follows:

For the ratio of Newbuilding/P_{NB}, the data of 75000 to 78000 DWT Panamax Bulkcarrier Newbuilding Prices were selected as Y

For the Freight, Panamax, 1997/98-built, Average Spot Earnings will be involved in use our model.

Cost: we will use 380cst bunker prices, Rotterdam, represents the ship's operation cost. There are two reasons to do so. First, the operating cost related scope is wide, time series data is not easy to get. Second, bunker cost accounted for more than 40% in ship variable costs, so the choice of bunker cost on behalf of the ship's operation cost is appropriate.

Trade: since the target of our research is the PANAMAX ship, a bulk vessel, we choose Australia Iron Ore Exports data as our variable.

Contract: Panamax Bulker Contracting will be used.

Investment: we will choose 3-Year U.S Treasury Bond as a risk-free return, aiming to compare the ship investment income and risk-free return. If risk-free return is very high while the ship investment income is low, obviously, ship owners should not invest too much money into the market of ship.

ER: we will use the 6 Month Timecharter Rate 75,000 dwt Bulkcarrier to measure PANAMAX expected return. Since the timecharter rate reflect the contract price of long-term carriage, representing the ship owners' expectation trend about the shipping market, it is appropriate to select it as expected return.

Fleet Size: use Panamax Bulker fleet size

Orderbook: use Panamax Bulker Orderbook

Scrap: use Panamax Bulker Scrap Value

Libor: use London LIBOR Interest Rates

Exchange: use Exchange Rates Euro

Construction: it is difficult to measure shipbuilding costsand benchmark among different countries, particularly over a suitable length of time analyzing econometric. As a result, use the price of steel plates in Japan here as a newbuilding cost indicator, and compared with Jin's approach using labor costs as a proxy of shipbuilding costs. Approximately 30% of newbuilding prices are steel plates, and the fluctuations of steel plates provide a reliable proxy for the total shipbuilding costs.

P_{SH}: use Panamax 75K Bulkcarrier 10 Year Old Secondhand Prices

Dummy variable: One dummy variable is set from 2005/6 to 2006/4. Since the 2005 imported iron ore contract prices reached 71.5%, Chinese government adopted a series of macro-control policies to control the growth of investment in fixed assets and reduce building steel consumption; cancel the steel billet export tax rebate policy; add the ore in the processing trade ban list. In this way, from the source to reduce the amounts of imported iron ore and can strengthen the domestic mine rectification, standardize the domestic iron ore market, mobilize domestic mines to expand production to ensure the supply for domestic steel mills. So, the macro-control from Chinese government is the reason that the iron ore prices plummeted this time, and affects the Panamaxnewbuilding price.

Each variable has its time series of monthly statistics from 2001/03 to 2014/1. This is because the data specific to the quarter are not sufficient, and it is the only data form could meet the requirements of the sample size. We collect all the data from Clarckson Sin Database. The one-to-one correspondence of each variables and its definition are presented in Table 3.1.

Table 3.1 Definition of variables

	Model Variable	**Data Collected**	**Units**
Y	PNB	Panamax75-77K DWT BulkcarrierNewbuilding Prices	$ Million
X_1	Freight	Panamax, 1997/98-built, Average Spot Earnings	$/Day
X_2	Cost	380cst bunker prices, Rotterdam	$/Tonne
X_3	Trade	Australia Iron Ore Exports	Million Tonnes
X_4	Contract	Panamax Bulker Contracting	$ Million
X_5	Investment	3-Year U.S Treasury Bond	%
X_6	ER	6 Month Timecharter Rate 75,000 dwt Bulkcarrier	$/Day
X_7	Orderbook	Panamax Bulker Orderbook/ Panamax Fleet size	%
X_8	Scrap	Panamax Bulker Scrap Value	$ Million
X_9	Libor	London LIBOR Interest Rates	%
X_{10}	Exchange	Exchange Rates Euro	$/€
X_{11}	Contstruction	Japan Steel Ship Plate Commodity Price	$/Tonne
X_{12}	PSH	Panamax 75K Bulkcarrier 10 Year Old Secondhand Prices	$ Million
X_{13}	/	Dummy 1	/

3.5. Data Pre-process

Thus, we have already selected the suitable data for establishing the linear regression model. But, at first, we have to ensure the data selected is stationary andweakly dependent. The weakly dependent suggests that the Law of Large Numbers and the Central Limit Theorem were established, and take the place of assuming random sampling.Since it requires for steady and some form of weakly dependent properties, steady and weakly dependent time series is one of the most ideal time series for multiple regression analysis.

The ADF (Augmented Dickey-Fuller) Unit Root Test is used to test stationarity. Firstly, put these data into the Eviews and test the stationarity of each variable. Unstationary variables can be very serious mistakes in the establishing multiple linear regression model for it may lead to spurious regression. From the test, we can say that all of the variables require for stationary. Since lack of enough data and the data related shipping with great volatility, choose 10% as the significant level. Table 3.2 shows the result of ADF test.

Table 3.2 Result of ADF test

Null Hypothesis: Unit root (individual unit root process)		
Series: Y, X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13		
Date: 03/23/14 Time: 11:32		
Sample: 2001M03 2014M03		
Exogenous variables: Individual effects		
Automatic selection of maximum lags		
Automatic selection of lags based on SIC: 0 to 3		
Total number of observations: 2139		
Cross-sections included: 14		
Method	Statistic	Prob.**
ADF - Fisher Chi-square	40.8352	0.0556
ADF - Choi Z-stat	-1.64831	0.0496
** Probabilities for Fisher tests are computed using an asymptotic Chi		
-square distribution. All other tests assume asymptotic normality.		
Intermediate ADF test results PANAMAX		

Series	Prob.	Lag	Max Lag	Obs
Y	0.5222	1	13	153
X1	0.1388	1	13	153
X2	0.4120	1	13	153
X3	0.9990	3	13	151
X4	0.1415	2	13	152
X5	0.5212	1	13	153
X6	0.0467	1	13	153
X7	0.2964	3	13	151
X8	0.2021	0	13	154
X9	0.6401	1	13	153
X10	0.1901	1	13	153
X11	0.1925	1	13	153
X12	0.1544	1	13	153
X13	0.0610	0	13	154

According to the results in table 3.2, only the variables X6, X10 do not contain a unit root. So we use the first difference of all the variables and process the unit root test again under significant level 10%. The results shown in Table 3.3:

Table 3.3 Result of ADF test for first difference

Null Hypothesis: Unit root (individual unit root process)				
Series: Y, X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13				
Date: 03/23/14 Time: 11:34				
Sample: 2001M03 2014M03				
Exogenous variables: Individual effects				
Automatic selection of maximum lags				
Automatic selection of lags based on SIC: 0 to 2				
Total number of observations: 2137				
Cross-sections included: 14				
Method			Statistic	Prob.**
ADF - Fisher Chi-square			787.903	0.0000
ADF - Choi Z-stat			-25.7134	0.0000
** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.				
Intermediate ADF test results D(PANAMAX)				
Series	Prob.	Lag	Max Lag	Obs
D(Y)	0.0000	0	13	153
D(X1)	0.0000	0	13	153

D(X2)	0.0000	0	13	153
D(X3)	0.0000	2	13	151
D(X4)	0.0000	1	13	152
D(X5)	0.0000	0	13	153
D(X6)	0.0000	0	13	153
D(X7)	0.0459	2	13	151
D(X8)	0.0000	0	13	153
D(X9)	0.0000	0	13	153
D(X10)	0.0000	0	13	153
D(X11)	0.0000	0	13	153
D(X12)	0.0000	0	13	153
D(X13)	0.0000	0	13	153

According to Table 3.3, we find that all the variables' probabilities are less than 0.1, so we cannot reject the null hypothesisand variables do not contain unit root. Therefore, variables can be used for regression model.

3.6. Data Process, Analysis and Results

After first difference, the data have been qualified to apply to the multiple linear regression. Then we will test the six assumptions mentioned in previous section one by one.

a) Assumption TS.1:

In this research, the equation of the linear regression is assumed as:

$$y_t = \beta_0 + \beta_1 x_{t1} + \beta_2 x_{t2} + \cdots + \beta_{12} x_{t12} + u_t \quad (3\text{-}20)$$

Where, β_0 is constant, β_1 to β_{12} is the coefficient of each independent variable from x_1 to x_{12}. And in this model, the Assumption TS.1 is automatically met.

b) Assumption TS.2:

The significance of TS2 is that we must correctly set the relationship between explanatory variables and Y. According to the formula, given all the X, , this require for all the effects of Y variables in our model. However, in fact, it is almost impossible. First of all, for some not quantified variables, we cannot guarantee that they are stated correctly in the model. Since there also doesn't exist any practical method to test whether we have omitted variables, we cannot guarantee that Xij is contemporaneously exogenous. Even if Assumption TS.2 is not realistic, we still need to assume that TS.2 was established, and take it as a starting point to get the OLS unbiased conclusion. Therefore, this hypothesis model can meet TS.2.

c) Assumption TS.3:

Assuming that, TS.3 tolerates the existence of correlation except completely linear correlation between the explanatory variable in the model. When the independent variables correlate highly, multicollinearity happens. Therefore, checking the correlations table of variables is the easiest way to measure multicollinearity. Table 3.4 shows the results of correlation test.

Table 3.4 Correlation table of variables

	X1	X2	X3	X4	X5	X6
X1	1	0.285082	0.176283	-0.0357	0.102581	0.916874
X2	0.285082	1	0.062869	0.017713	0.231843	0.416826
X3	0.176283	0.062869	1	0.162299	-0.01044	0.110351
X4	-0.0357	0.017713	0.162299	1	-0.01327	-0.00993
X5	0.102581	0.231843	-0.01044	-0.01327	1	0.120917
X6	0.916874	0.416826	0.110351	-0.00993	0.120917	1
	X7	X8	X9	X10	X11	X12
X1	0.03674	0.401274	-0.05479	0.293352	-0.12692	0.572278
X2	0.122881	0.301205	0.1226	0.454855	0.041352	0.493137
X3	-0.21662	-0.03513	0.113596	0.145392	0.053802	0.078618
X4	-0.37455	-0.11265	0.077345	0.051227	0.037769	0.057628
X5	-0.0635	0.058194	0.411539	-0.09539	-0.03471	0.148649
X6	0.078896	0.516746	-0.07733	0.341261	-0.14032	0.737065
	X7	X8	X9	X10	X11	X12
X7	1	0.127104	-0.09717	0.003659	0.142521	0.140836
X8	0.127104	1	-0.33346	0.281818	-0.03973	0.642034
X9	-0.09717	-0.33346	1	-0.10865	-0.00608	-0.08489
X10	0.003659	0.281818	-0.10865	1	0.071112	0.277844
X11	0.142521	-0.03973	-0.00608	0.071112	1	0.003175
X12	0.140836	0.642034	-0.08489	0.277844	0.003175	1

From Table 3.4, we find that the explanatory variables X_1 and X_6 are highly related. If we place these two variables in the model, the OLS model may have multiple linear correlations and will be bias. At the same time, if missing the necessary variables, the model will be the bias, too. So after screening, we decided to remove X1 out of the model. The reason is that X_1 represents just the current freight rate while X6 represents the 6 month period freight. In a certain sense, the newbuilding prices is long-term prices reflecting buyers' expectation to the market after two years. So from above point of view, the 6 month timecharter rate is able to reflect the ship owners' view of the market. So we choose to keep the X6.

At this point, according to theorem 1, our model's OLS results can be proved to be unbiased. Then we carried out OLS on the model, observe the results of OLS and test next assumption:

Table 3.5 first result of OLS

Dependent Variable: D(Y)
Method: Least Squares
Date: 03/23/14 Time: 11:36
Sample (adjusted): 2001M04 2014M01
Included observations: 154 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
D(X2)	-0.005194	0.003005	-1.728582	0.0861
D(X3)	-0.005607	0.026234	-0.213721	0.8311
D(X4)	0.00017	0.000138	1.232549	0.2198
D(X5)	-0.679525	0.362676	-1.873643	0.063
D(X6)	2.63E-05	2.20E-05	1.196881	0.2334
D(X7)	20.92603	6.289049	3.327376	0.0011
D(X8)	0.171874	0.20845	0.824532	0.411
D(X9)	1.557793	0.419862	3.710251	0.0003
D(X10)	2.067701	2.796369	0.739424	0.4609
D(X11)	0.004367	0.001405	3.107495	0.0023
D(X12)	0.114139	0.03264	3.496887	0.0006
D(X13)	-1.056999	0.637771	-1.657333	0.0997
C	0.059316	0.072514	0.817995	0.4147

R-squared	0.417694	Mean dependent var	0.045455
Adjusted R-squared	0.368136	S.D. dependent var	1.10275
S.E. of regression	0.876575	Akaike info criterion	2.655049

Sum squared resid	108.342	Schwarz criterion	2.911415
Log likelihood	-191.4388	Hannan-Quinn criter.	2.759184
F-statistic	8.428389	Durbin-Watson stat	1.63902
Prob(F-statistic)	0		

From the results of OLS, most of the variables are not rejected null hypothesisof T test according to the T test. But for we have not verified the presence of heteroskedasticity and autocorrelation, so we can't say that T test result is valid. Because according to Gauss Markov Theorem, if the errors is not only same-order but also unrelated in sequences, the OLS is not BLUE when there exist serial correlation or heteroskedasticity. More importantly, the usual OLS standard errors and test statistics are no longer in effect, even the asymptotic effect. So then we continue the rest of the assumption.

d) Assumption TS.5:

Before the test of Assumption TS.4, we must examine autocorrelation for the model firstly. The reason is that the error cannot be sequence related. Any autocorrelation will make heteroscedasticity invalid. Heteroscedasticity test must be made after autocorrelation problem is cleaned.

In TS.5, assume that residuals of the regression model do not have autocorrelation problem. Autocorrelation means that the next-period return is correlated with this period value of a variable. Speaking simply, there is no pattern in the errors. Otherwise, the residuals from a model are auto-correlated. Usually, we apply Breusch-Godfrey test for autocorrelation. The lag value chose is 12 because monthly data we used in model. The significant level is 10%. The result of Breusch-Godfrey test shows in Table 3.6.

Table 3.6 Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.104662	Prob. F(12,129)	0.3619
Obs*R-squared	14.3503	Prob. Chi-Square(12)	0.2789

Test Equation:			
Dependent Variable: RESID			
Method: Least Squares			
Date: 03/23/14 Time: 11:37			
Sample: 2001M04 2014M01			
Included observations: 154			
Presample missing value lagged residuals set to zero.			
R-squared	0.093184	Mean dependent var	1.15E-17
Adjusted R-squared	-0.075526	S.D. dependent var	0.841497
S.E. of regression	0.872697	Akaike info criterion	2.713078
Sum squared resid	98.24631	Schwarz criterion	3.206089
Log likelihood	-183.907	Hannan-Quinn criter.	2.913338
F-statistic	0.552331	Durbin-Watson stat	1.99242
Prob(F-statistic)	0.953782		

As the result shows, the Prob. Chi-Square is 0.3619 > 0.1 which means null-hypothesis can be rejected and the residuals do not have autocorrelation (complete result please see appendix 3). The model has met the assumption. And then we can test Assumption TS.4.

e) Assumption TS.4:

We call the variance of errors homoscedasticity if it is constant. Otherwise, we call it is heteroscedastic which is not wanted to be seen in our model. In this paper, we use White General Test for heteroscedasticity and the results are shown in table 3.7.

Table 3.7 Heteroskedasticity Test: White

F-statistic	3.63315	Prob. F(79,74)	0
Obs*R-squared	122.4338	Prob. Chi-Square(79)	0.0013
Scaled explained SS	397.8374	Prob. Chi-Square(79)	0
Test Equation:			
Dependent Variable: RESID^2			
Method: Least Squares			
Date: 03/23/14 Time: 11:38			
Sample: 2001M04 2014M01			
Included observations: 154			
Collinear test regressors dropped from specification			

According to table 3.7, test cannot reject the null hypothesisand the model has heteroscedasticity problem (complete result please see appendix 4). As known, according to theorem 6, model is a progressive force under the assumption TS.1-TS.5. So we can examine variables by T test and results of F joint significance test. But when TS.4 is not in force, the validity of the OLS will not be affected and the estimate of OLS value will not be bias, but validity of the T test and F test will be influenced. At this time, we can adjust the standard error of OLS, t statistic and F statistic to heteroscedasticity. So we use heteroskedasticity-robust statistic to adjust these statistics. After the adjustment, we get the new regression.

Table 3.8 Second Result of OLS

Dependent Variable: D(Y)
Method: Least Squares
Date: 03/23/14 Time: 11:39
Sample (adjusted): 2001M04 2014M01
Included observations: 154 after adjustments
White Heteroskedasticity-Consistent Standard Errors & Covariance

	Coefficient	Std. Error	t-Statistic	Prob.
D(X2)	-0.005194	0.003181	-1.632603	0.1048
D(X3)	-0.005607	0.025116	-0.223236	0.8237
D(X4)	0.00017	0.000129	1.315767	0.1904
D(X5)	-0.679525	0.462828	-1.468202	0.1443
D(X6)	2.63E-05	2.56E-05	1.028695	0.3054
D(X7)	20.92603	6.74446	3.102699	0.0023
D(X8)	0.171874	0.21897	0.784922	0.4338
D(X9)	1.557793	0.792166	1.966498	0.0512
D(X10)	2.067701	2.413594	0.85669	0.3931
D(X11)	0.004367	0.001622	2.692887	0.0079
D(X12)	0.114139	0.025844	4.416415	0
D(X13)	-1.056999	0.411335	-2.56968	0.0112
C	0.059316	0.068097	0.871053	0.3852

R-squared	0.417694	Mean dependent var	0.045455
Adjusted R-squared	0.368136	S.D. dependent var	1.10275
S.E. of regression	0.876575	Akaike info criterion	2.655049
Sum squared resid	108.342	Schwarz criterion	2.911415

Log likelihood	-191.4388	Hannan-Quinn criter.	2.759184
F-statistic	8.428389	Durbin-Watson stat	1.63902
Prob(F-statistic)	0		

After adjustment, we can make T test and F test for the model. From Table 3.8, only the P-value of X7, X9, X11, X12 is less than 0.1, which means they are significant under the T test. So we will make F joint test for the remaining variables. If the test results show that null hypothesis is not rejected then we can remove such variables from our model safely. Wald-test result shows in Table 3.9.

Table 3.9 Wald Test

Test Statistic	Value	df	Probability
F-statistic	1.671937	(6, 141)	0.1321
Chi-square	10.03162	6	0.1233
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(1) - C(9)		-2.072895	2.415319
C(2) - C(9)		-2.073308	2.422308
C(3) - C(9)		-2.067532	2.413628
C(4) - C(9)		-2.747226	2.470538
C(5) - C(9)		-2.067675	2.413599
C(7) - C(9)		-1.895827	2.401625
Restrictions are linear in coefficients.			

From the result, Probability of F-test is 0.1321 and is larger than confidence value of 0.1, which means null hypothesis cannot be rejected. Then, $x_2, x_3, x_4, x_5, x_6, x_8, x_{10}$ can be removed from our model safely. After rejecting, the multiple linear regression has to be retested and the result is shown in Table 3.10.

Table 3.10 Final Result of OLS

Dependent Variable: D(Y)
Method: Least Squares
Date: 03/23/14 Time: 11:43
Sample (adjusted): 2001M04 2014M01

Included observations: 154 after adjustments				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
	Coefficient	Std. Error	t-Statistic	Prob.
D(X7)	17.71731	5.797107	3.056234	0.0027
D(X9)	0.966399	0.54582	1.770546	0.0787
D(X11)	0.004161	0.001817	2.290342	0.0234
D(X12)	0.131371	0.016266	8.07667	0
D(X13)	-1.205194	0.427579	-2.818648	0.0055
C	0.052632	0.069739	0.754704	0.4516
R-squared	0.370487	Mean dependent var		0.045455
Adjusted R-squared	0.34922	S.D. dependent var		1.10275
S.E. of regression	0.889599	Akaike info criterion		2.64209
Sum squared resid	117.1252	Schwarz criterion		2.760413
Log likelihood	-197.4409	Hannan-Quinn criter.		2.690152
F-statistic	17.42047	Durbin-Watson stat		1.556736
Prob(F-statistic)	0			

From Table 3.10, the F-statistic is 17.42047 while the Adjusted R-squared is 0.349220. Probability of F-statistic is 0.0000 again also represents the confidence belief when choose model. Then, the variables and constant C all have a Probability less than 0.1, which means that all these coefficients can pass the t-statistic test under significance 10%. Thus, the final formula of the multiple linear regression model is as following:

$$\Delta y = 17.71731 \Delta x_7 + 0.966399 \Delta x_9 + 0.004161 \Delta x_{11} + 0.131371 \Delta x_{12} - 1.205194 \Delta x_{13}$$

(3-21)

3.7. Results Analysis

As we can see, the sign of the coefficients agrees with the sign in the correlation test, which presents the variables impacts the Panamaxnewbuilding price positively or negatively. The formula of the model describes that the newbuilding price of Panamax (y) would increase 17.71731 $ Million correspondently when the amount of order book (x7) increases 1%, the newbuilding price of Panamax (y) would increase

0.966399 $ Million correspondently when London LIBOR Interest Rates (x9) increases 1%, the newbuilding price of Panamax (y) would increase 0.004164 $ Million correspondently, when Japan Steel Ship Plate Commodity Price(x11) increases 1 $/Tonnage, the newbuilding price of Panamax (y) would increase 0.131371 $ Million correspondently , when Panamax 75K Bulkcarrier 10 Year Old -+9(x12) increases 1 $ Million.

The orderbook is valid in our model which means orderbook and fleet size both influence newbuilding price of Panamax strongly. It is easy to understand because orderbook reflects the ship owners' expectations of the future market while on the other hand it also hinted at the possibility of future ship surplus. Once the ship number on orderbook increased a lot, the demand of shipping market cannot keep up the supply after two years. According to the economic theory of supply and demand, price will naturally fall and lead the ship owners lose confidence in the market so as to reduce the book of new ship. The ship price will decline correspondently. In addition, fleetsize is the most direct expression of ship supply, so as orderbook, will have a tremendous impact on ship price.

In our model, the variable X9 also have great influence on the new shipbuilding price of PANAMAX. From the view of economics, Libor reflects the fluctuations of the world economy, and also is a measurement of enterprise financing cost index. The Libor rising will inevitably lead to the owner financing cost rise sharply, and may also suggest the world economy lacks of liquidity. This phenomenon precisely reflect the world economic crisis. So Libor should be fluctuate in the opposite direction of ship price's fluctuation. But in our model, they are positively correlated. This may be due to the European Central Bank's long-time maintaining low interest rates after the financial crisis. Since when the savings interest rates decline, a large number of idle funds will leave savings accounts to invest, which can drive the market to accelerate the recovery from the crisis.

From the variables X11, Japan Steel Ship Plate Commodity Price, we can see that the impact of steel prices change per unit on the ship price is still relatively small. However, if considering the huge number of steel used for hull, this influence is also considerable. Because in the process of ship construction, steel costs account for 30% of the cost of the whole ship. When construction costs rise, in order to cover the increasing of the cost, especially in the market better circumstances, the shipyards will naturally improve ship price. So we can conclude that their relationship is positive correlation.

The variable X12 represents the second-hand ship price. As said before, the second-hand ship and newbuilding can replace each other in the market. So when one of them pushed up its price, the rest price will increase correspondently. So it is normal that there is a positive correlation between them. The variable X13 is a dummy variable. Its coefficient does not have practical reference value. But our model proved that, the macroeconomic regulation and control policy on imported iron ore in 2005-2006 from Chinese government indeed influenced the world iron ore trade, and affected the PANAMAX ship price.

However, it is surprised to find out that exchange rate fluctuations don't impact newbuilding pieces. But there are two facts need to pay attention to. One is that the shipbuilding costs significantly effect newbuilding prices. The other is that the shipyard purchase most of ship building materials in local currency while quote to the ship buyers in dollars. Both this two facts reflects that exchange rate fluctuations still effect the determination of newbuilding prices importantly, just not directly and visibly at first sight.

380cst bunker prices, Rotterdam as operational cost of ships, Australia Iron Ore Exports, Panamax Bulker Contracting, 3-Year U.S Treasury bond and Panamax Bulker Scrap Value were found not to have an impact on newbuilding prices.

3.8. Residual Analysis

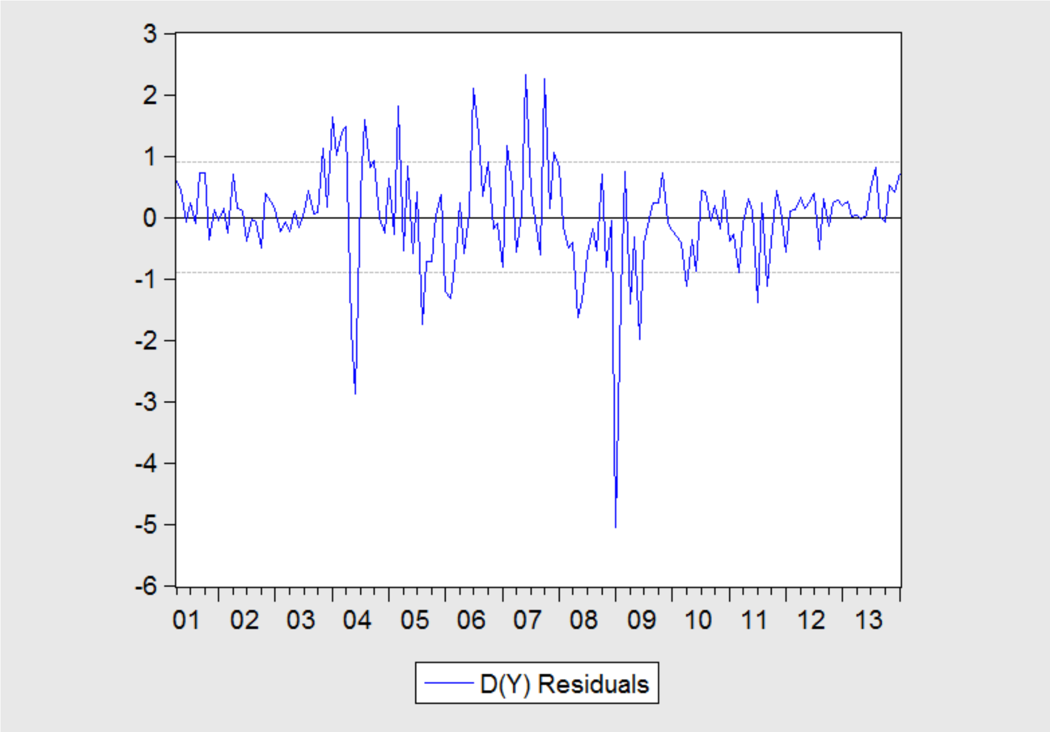


Figure 3.1 Residuals of model

From Graph 3.1, we can see that the model has large residuals in 2004, which may be caused by dry bulk shipping market changing radically in 2004. The BDI index from 861 points in November 23, 2001 climbed to 5551 points in January 30, 2004, and in 2004 dropped back to 2742 points, but by the end of 2004 climb to a new peak of 6092 points again.

From Graph 3.1, residuals of the model fluctuated hugely from 3rd season of 2008 to 1st season of 2009, which means the actual values and fitted values fitted in a very low fitting precision at that time. In 20th May 2008, BDI reached 11793 which is its highest level. But in the last six months of 2008, it declined to the historically lowest point which is 663. The drastic decline can be explained by the economic crisis happened in 2008, which had an effect on the whole world economy. This crisis leaded to a decrease of demand for dry bulk cargo. What’s more, CVRD in Brazil not only defaulted the contract with China ISA but also asked for increasing price for iron ore. There was also an economic crisis explored in FFA market. Credit crisis reducing liquidity in the market had led FFA players choose to leave the market.

So, it has been more difficult than before to forecast the trend of BDI in 2008, which can explains the low precision of our model using in 2008.

4. Forecast

4.1. model introduction

4.1.1. Stationary time series model

a) Autoregressive Model

Since the development of things have relevance and inheritance in the time sequence, the observed value of y at t dependents on the values observed before t in many cases. Generally, it is expressed as y_t which dependent on the lag values $y_{t-1}, y_{t-2}, \dots, y_{t-n}$. The expression of an autoregressive model of order p-AR(p) can be:

$$y_t = \mu + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + u_t \quad (4\text{-}1)$$

Where, $c, \phi_1, \phi_2, \dots, \phi_n$ are unknowns, u_t is an affecting factor of Y but cannot be observed directly.

Or using the lag operator notation:

$$Ly_t = y_{t-1} \; L^i y_t = y_{t-i} \quad (4\text{-}2)$$

$$y_t = \mu + \sum_{i=1}^{p} \phi_i L^i y_t + u_t \quad (4\text{-}3)$$

b) Moving Average Model

In practical applications, fitting the stationary time series can be realized by computing the moving average of white noise, and it is defined as the moving average model. Commonly, call the form $y_t = \mu + \theta_1 u_{t-1} + \theta_2 u_{t-2} + \cdots + \theta_q u_{t-q}$ as g-order moving average model, express it as MA(q), notice that $\theta_1, \theta_2, \dots, \theta_n$ are unknowns. It is called a moving average, because in a sense, the right side of model is a weighted sum of u_t, similar to an average of items.

c) Autoregressive Moving Average Model

In order to make the model more flexibility in fitting the actual data, the model may include both the autoregressive model and the moving average model. It is Autoregressive Moving Average Model, and expressed as:

$$y_t = y_t = \mu + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \theta_1 u_{t-1} + \theta_2 u_{t-2} + \cdots + \theta_q u_{t-q} + u_t \quad (4\text{-}4)$$

With E(u_t)=0; E($u_t{}^2$)= δ^2; E($u_t u_s$)=0, $t \neq 0$.

4.1.2. Non-stationary time series forecasting model

In practical, Autoregressive Integrated Moving Average Model always deals with the non-stationary time series. First, stabilize and smooth the non-stationary time series, that is to say, process d-order differential and make them become stationary time series. Then analysis with stationary time series forecasting model. And we get an Autoregressive Integrated Moving Average Model, its d-order differential form is the ARMA (p, g) model which is stable and smooth.

4.1.3. Modeling steps

In order to find the statistical regulars and characteristics from the massive time-series experimental data, first should establish a time series model. The modeling process includes type identification of the model, estimation of the model parameters, and model order determination, etc. The modeling idea of B.J method proposed by Box-Jenkins guides the practical modeling process, including several important steps:

1. Do the stationary test to the original series. If the series is non-stationary, process d-order differential or other transforming methods and make them meet the requirements of stationarity and smooth;
2. Analyze the characteristic of the stationary series after step 1, especially its Autocorrelation and Partial Autocorrelation, helping to determine the form of the model;

3. Estimate the model parameters, judge whether the model is stable according to the reciprocal of the lag polynomial root, and determine the fitting effect and rationality of the model;
4. Test the stationarity of the model residuals, mainly test whether the residual series of the model estimation results meet the requirements of randomness or not;
5. Confirm the model form as there may be multiple model, evaluate and analyze the models comprehensively, choose the proper, concise, effective model.

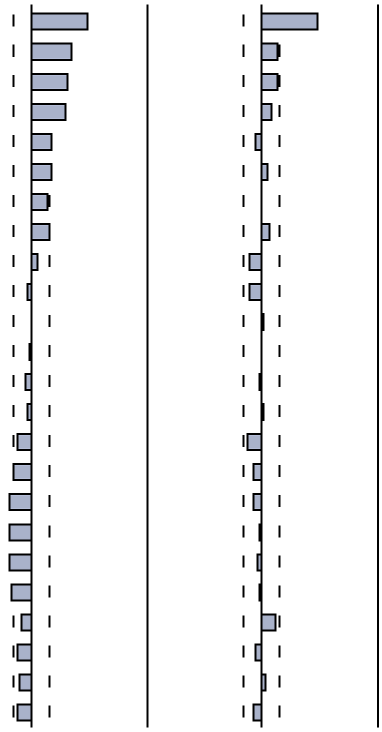
4.2. Data process

4.2.1. Model identification

Firstly, choose the newbuilding price of PANAMAX which is used in the previous chapter as the analysis samples, and divide the data into two parts. The first part as in-sample data is named as ISY, collected from 2001/3 to 2012/12, is used to train the model. The second part as out-of-sample data, collected from 2013/1 to 2014/1, is used to test the accuracy of the model.Using software EViews, check the series correlation diagram of the in-sample data as figure 4.1.

Date: 03/23/14 Time: 19:04
Sample: 2001M03 2014M12
Included observations: 154

Autocorrelation / Partial Correlation



	AC	PAC	Q-Stat	Prob
1	0.495	0.495	38.485	0.000
2	0.361	0.154	59.131	0.000
3	0.330	0.138	76.405	0.000
4	0.296	0.086	90.460	0.000
5	0.177	-0.065	95.484	0.000
6	0.182	0.058	100.88	0.000
7	0.149	-0.002	104.49	0.000
8	0.165	0.069	108.97	0.000
9	0.048	-0.113	109.34	0.000
10	-0.028	-0.109	109.47	0.000
11	-0.006	0.017	109.48	0.000
12	-0.010	-0.005	109.49	0.000
13	-0.057	-0.021	110.04	0.000
14	-0.039	0.009	110.30	0.000
15	-0.122	-0.133	112.87	0.000
16	-0.162	-0.079	117.46	0.000
17	-0.202	-0.076	124.60	0.000
18	-0.198	-0.019	131.49	0.000
19	-0.202	-0.029	138.75	0.000
20	-0.177	-0.014	144.37	0.000
21	-0.088	0.123	145.77	0.000
22	-0.122	-0.058	148.46	0.000
23	-0.107	0.032	150.56	0.000
24	-0.136	-0.066	154.00	0.000

Figure 4.1correlation diagram of newbuilding price of Panamax

The Autocorrelation if the series is exponential decay, but delay very slowly, so it can be considered that the series is non-stationary. At the same time, we perform a unit root test for the series Y, take the significance 0.05 and can also see the series have unit root, the results are shown in Table 4.1.

Table 4.1 ADF Test

Null Hypothesis: ISY has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.460482	0.5505
Test critical values:	1% level	-3.482035	
	5% level	-2.884109	
	10% level	-2.578884	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ISY)
Method: Least Squares

Date: 03/23/14 Time: 19:08				
Sample (adjusted): 2001M05 2011M12				
Included observations: 128 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
ISY(-1)	-0.013639	0.009339	-1.460482	0.1467
D(ISY(-1))	0.501072	0.076875	6.518012	0
C	0.496814	0.334187	1.486636	0.1396
R-squared	0.261545	Mean dependent var		0.054688
Adjusted R-squared	0.24973	S.D. dependent var		1.194202
S.E. of regression	1.034396	Akaike info criterion		2.92867
Sum squared resid	133.7468	Schwarz criterion		2.995515
Log likelihood	-184.4349	Hannan-Quinn criter.		2.95583
F-statistic	22.13621	Durbin-Watson stat		2.167097
Prob(F-statistic)	0			

So we process first difference to series Y, then take ADF test to it, the result is shown in Table 4.2.

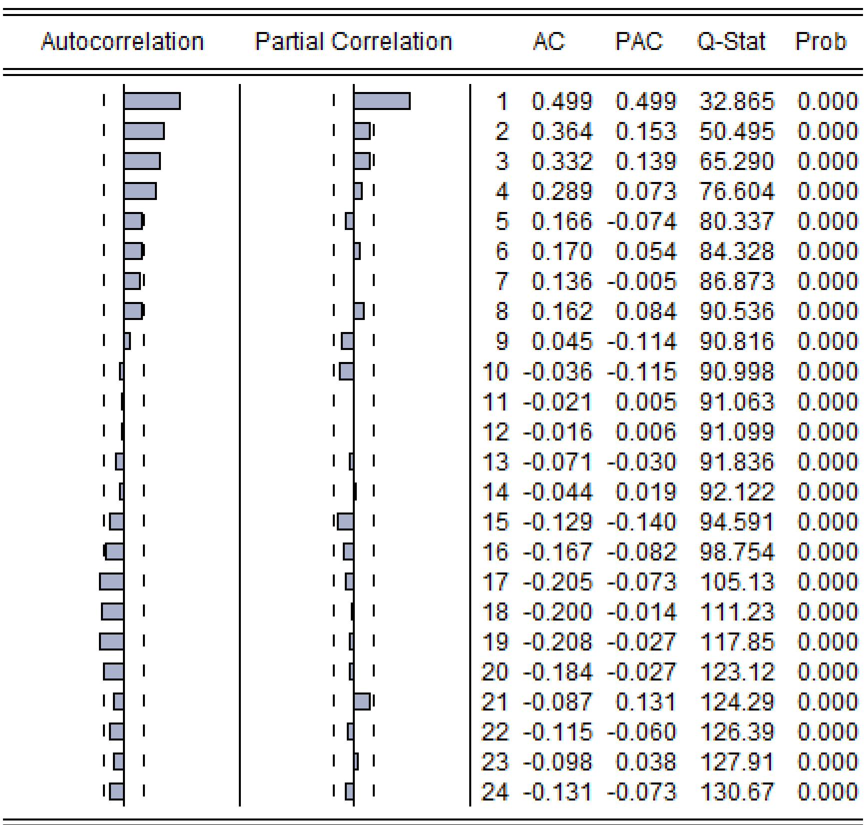
Table 4.2 ADF TEST After first difference

Null Hypothesis: D(ISY) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic based on SIC, MAXLAG=12)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.489873	0.0000
Test critical values:	1% level	-3.482035	
	5% level	-2.884109	
	10% level	-2.578884	
*MacKinnon (1996) one-sided p-values.			
Augmented Dickey-Fuller Test Equation			
Dependent Variable: D(ISY,2)			
Method: Least Squares			
Date: 03/23/14 Time: 19:09			
Sample (adjusted): 2001M05 2011M12			
Included observations: 128 after adjustments			

	Coefficient	Std. Error	t-Statistic	Prob.
D(ISY(-1))	-0.501057	0.077206	-6.489873	0
C	0.027402	0.091936	0.298051	0.7662
R-squared	0.250528	Mean dependent var		0

Adjusted R-squared	0.24458	S.D. dependent var	1.195464
S.E. of regression	1.039036	Akaike info criterion	2.929966
Sum squared resid	136.0291	Schwarz criterion	2.974529
Log likelihood	-185.5178	Hannan-Quinn criter.	2.948072
F-statistic	42.11845	Durbin-Watson stat	2.15289

From Table 4.2, the first order difference of series Y does not have a unit root. It is stationarity that it can be used in the next forecasting model. Before estimate the model parameters, the model type should be determined first. The model type can be identified by analyzing Auto-correlation (AC) and Partial Auto-correlation(PAC), for every random process has its typical Auto-correlation(AC) and Partial Auto-correlation(PAC).So we shall observe the correlation diagram of the first order differential of series Y. The diagram is shown is Fig.4.2.



Date: 03/23/14 Time: 19:10
Sample: 2001M03 2014M12
Included observations: 129

	AC	PAC	Q-Stat	Prob
1	0.499	0.499	32.865	0.000
2	0.364	0.153	50.495	0.000
3	0.332	0.139	65.290	0.000
4	0.289	0.073	76.604	0.000
5	0.166	-0.074	80.337	0.000
6	0.170	0.054	84.328	0.000
7	0.136	-0.005	86.873	0.000
8	0.162	0.084	90.536	0.000
9	0.045	-0.114	90.816	0.000
10	-0.036	-0.115	90.998	0.000
11	-0.021	0.005	91.063	0.000
12	-0.016	0.006	91.099	0.000
13	-0.071	-0.030	91.836	0.000
14	-0.044	0.019	92.122	0.000
15	-0.129	-0.140	94.591	0.000
16	-0.167	-0.082	98.754	0.000
17	-0.205	-0.073	105.13	0.000
18	-0.200	-0.014	111.23	0.000
19	-0.208	-0.027	117.85	0.000
20	-0.184	-0.027	123.12	0.000
21	-0.087	0.131	124.29	0.000
22	-0.115	-0.060	126.39	0.000
23	-0.098	0.038	127.91	0.000
24	-0.131	-0.073	130.67	0.000

Figure 4.2 Correlation diagram after first difference

From Fig.4.2, for the Auto-correlation(AC) and Partial Auto-correlation(PAC) of the series Y are trailing, we build ARIMA(p,d,q) for series Y. The first difference of series Y is stationarity, so d=1. Since the Partial Autocorrelation(PAC) of series Y is significant in lagging 1 order, the autoregressive process of ARIMA model may be 1 order, that is to say p=1. The Auto-correlation(AC) of series Y becomes smaller till the lagging 6 order, so the moving average process may be 1,2,3,4 order. All things considered, estimate four model types, ARIMA(1,1,1) ， ARIMA(1,1,2), ARIMA(1,1,3)，ARIMA(1,1,4).

Then deal with the six model with regression processing, and select the optimal models according to the coefficient of determination R-square (Goodness of Fit), the Akaike information criterion (AIC criterion) and the Schwarz Criterion (SC criterion).

The Akaike information criterion means selecting the AIC criterion function value as the minimum model when you want to pick an optimal model from several alternative models. The AIC criterion function is defined:

$$AIC = -2L(\hat{\beta}) + 2kL(x) \qquad (4\text{-}5)$$

Where, k is the number of independent parameters, $\hat{\beta}$ is the maximum likelihood estimates of the parameters, and $L(x)$ is the Likelihood function.

Therefore,the AIC function consists of two terms. The first shows the goodness of fit of the model, and becomes smaller with the increase of the model order; the second represent the number of the model parameters, and it increased with increasing the model order. Taking the minimum value between this two items implies a trade-off for the two volume.Contrasting with the Akaike information criterion (AIC criterion), the Schwarz Criterion (SC criterion) has large-sample properties, that is to say, when deal with large samples the Schwarz Criterion (SC criterion) performs more effective the he Akaike information criterion (AIC criterion). Table 4.3 shows the goodness of fit(the adjusted coefficient of determination R-square) ,AIC value, and SC value for ten estimated models.

Table 4.3 R-square, AIC and SC

Model	R-Squire	AIC	SC
ARIMA(1,1,1)	0.267099	2.905247	2.972092
ARIMA(1,1,2)	0.263207	2.918138	3.007263
ARIMA(1,1,3)	0.259056	2.931283	3.042690
ARIMA(1,1,4)	0.253084	2.946772	3.080461

From table 4.3, the R-square of the adjusted model ARIMA(1,1,1) is the largest, the AIC value is the smallest, and the SC value is also relatively small. Therefore, it is properly to select the ARIMA(1,1,1).

4.2.2. Model testing

No matter build a stationary time series model or a non-stationary time series model, there is a vital assumption that the residual series is white noise. But the residual of the model should be processed a white noise test when we distinguish whether the time series model established is reasonable or not. It can be considered that the model is reasonable if the residual could pass the test successfully, if not, other models are needed. Model testing usually consist two steps:

(1) Compare and analyze the Autocorrelations of the original series samples and of the model-generated samples. If there exists significant difference between these two Autocorrelations, the effectiveness of this model should be questioned and be confirmed again;

(2) If there exists little difference between these two Autocorrelations, we shall process the white noise test to the residual series of the model, that is to say, test the

randomness of the residual series: for the lagging period residual k≥1,test whether the Autocorrelations of the residual series is approximate to zero.

The white noise test of residual series usually uses the Q statistic. The original assumption is the residual series u_t is non-auto-correlative. Then, we process the autocorrelation test to the residuals of the ARIMA (1, 1, 1) model estimated. Firstly, obtain the residual series of the ARIMA (1, 1, 1) model, and named it as resid. Secondly, observe the correlation diagram and Q statistic of the resid, shown in Fig4.3.

Date: 03/23/14 Time: 19:17
Sample: 2001M03 2014M12
Included observations: 128

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.003	0.003	0.0010	0.975
		2	0.016	0.016	0.0351	0.983
		3	0.013	0.013	0.0568	0.996
		4	0.045	0.045	0.3335	0.988
		5	0.088	0.088	1.3871	0.926
		6	0.071	0.070	2.0722	0.913
		7	0.034	0.031	2.2272	0.946
		8	0.129	0.126	4.5335	0.806
		9	-0.004	-0.011	4.5357	0.873
		10	-0.090	-0.110	5.6801	0.841
		11	-0.021	-0.042	5.7443	0.890
		12	0.022	0.001	5.8148	0.925
		13	-0.033	-0.061	5.9742	0.947
		14	0.067	0.060	6.6364	0.948
		15	-0.081	-0.067	7.6023	0.939
		16	-0.040	-0.042	7.8402	0.953
		17	-0.103	-0.093	9.4419	0.925
		18	-0.073	-0.049	10.255	0.923
		19	-0.084	-0.084	11.337	0.912
		20	-0.101	-0.112	12.906	0.881
		21	0.053	0.084	13.351	0.896
		22	-0.040	-0.019	13.605	0.915
		23	0.004	0.055	13.607	0.938
		24	-0.073	-0.013	14.464	0.935

Figure 4.3 correlation diagram of resid

From Fig4.3, the Autocorrelations of the residual series are within the 95% confidence interval. The probabilities are far larger the test level 0.05. Therefore cannot reject the null hypothesis, that model ARIMA (1, 1, 1) residual series does not exist correlation.

4.3. Time series predicting

According to the above analysis, the ARIMA (1, 1, 1) model established is appropriate and can be used to predict. In this section, we talk about the price predicting of the PANAMAX from 2012/1 to 2014/1, and compared with the out-of-sample values which is exactly the actual values. Observe the MSE, MAE and MAPE values of the prediction model.

Table 4.4 shows the MSE, MAE and MAPE of the model. As we can see, MSE is 6.12 which is quite high. It means the average difference between forecast value and target value is 6.12.

Fig4.4 shows the predicting results acquired by the software EVIEWS. The red dotted line is the predicted confidence interval. It is can be observed that the predicted confidence interval gets bigger as the predicting period increasing. That is to say the predicting accuracy of the model is getting worse with the predicting period increasing.

Table 4.4 MSE, MAE and MAPE

	MSE	MAE	MAPE
ARIMA(1,1,1)	6.12	2.29	8.7%

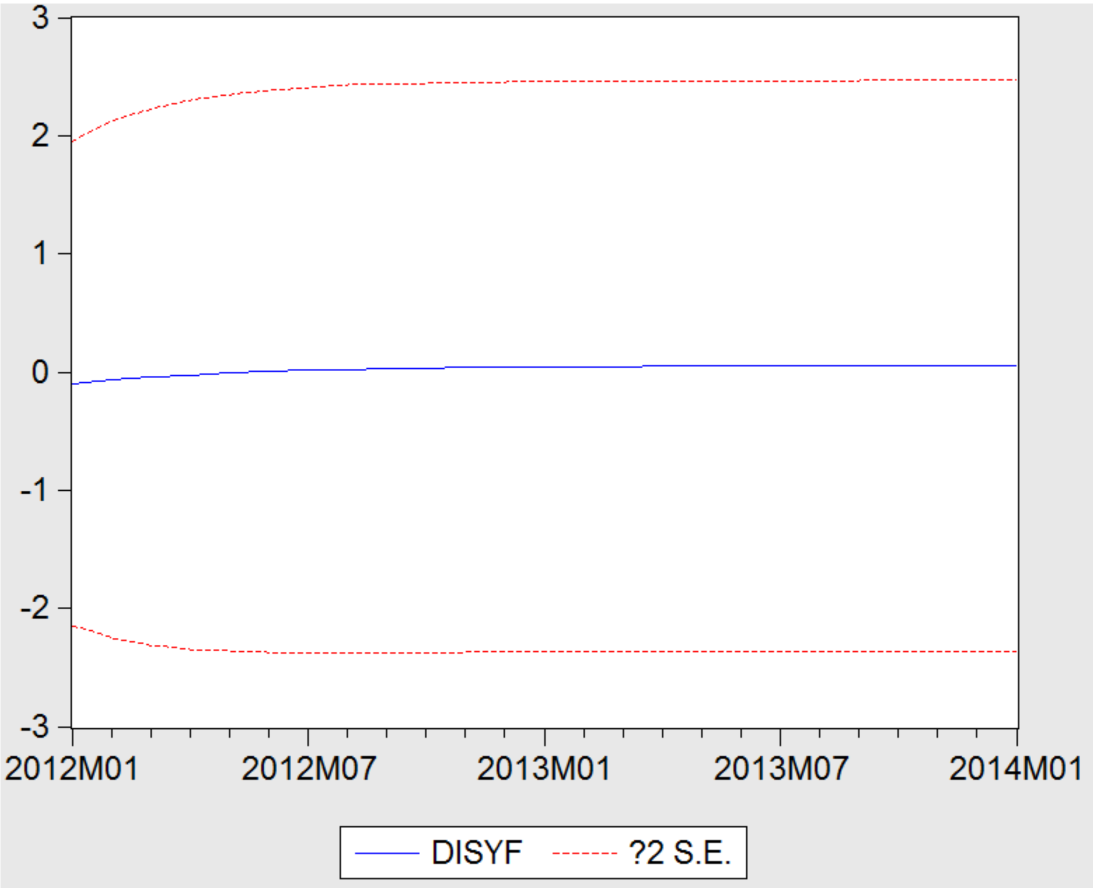


Figure 4.4 Predicting results

5. Conclusion

5.1. Summary of findings

Chapter One shows the research orientation at the beginning, then introduce the dissertation's structure and methods in detail.

Chapter Two describes the features of newbuilding market. This market is one of the main supply sources to shipping market, with features of heavy investment, long duration of capital recovery, intensive labor and capital, etc. Next, this chapter reviews the recent situation of shipping market and the global merchant fleets. In the end, some terms will be presented for further explanation of influence factor of pricing in the next chapter.

Chapter Three focuses on quantitative analysis of pricing, and set up econometric model for newbuilding's price by combining Theory of Supply and Demand with Cost Theory. I choose Panamax as my research object, and I have collected a lot of relative data spanning from March 2001 to January 2014 via Clarksons's database. Based on Markov's time series assumption, I optimize the model and work out my model is blue. The result reveals that fleets capacity, orderbook, financing cost, building cost as well as price of second-hand have great influence to price of newbuilding.

In the Chapter Four, ARIMA model is introduced to make prediction of price trend for ship owners' reference.

5.2. Contribution of the research

The economic benefit of newbuilding market is closely related to the performance of shipping market. Therefore, it's necessary to find out the influence factor of newbuilding's price.

The contributions of the research can be merely concluded as it has updated the major determinants in the newbuilding price.

Although this research may only represent the major determinants for a couple of years, it can still be very convincing as it provides the methodology based on not only the qualitative research but also the quantitative research. The combination of two different research methods shows the reliability and the integrity of the whole work. Thus, maybe five years later, a new research can imitate the similar research methodology and give a new version of the coal determinants. The determinants may change as time goes by, but the methodology would remain.

5.3. Limitations of the Research

The limitation of this study is also mentioned previously that it may be only valid in a certain period of timedepending on the market condition. That is to say, the major determinants that influence the newbuilding price would change in the future. Another shortcoming of this study is that some of the major determinants are difficult to be quantified but can only be qualitatively analyzed. Further study is required for investigating into these determinants more deeply.

Newbuilding market is also liable to be influenced by the fluctuation of the world's economy which will probably fluctuate drastically in the short run.So it's hard to make long-term prediction. Meanwhile, as ARIMA model will be less accurate with time goes by, I will focus on short-term prediction. For medium-term prediction, there are still no appropriate models yet to predict.

In conclusion, this paper analyzes both the newbuilding dry bulk ship market as well as the shipping market and review the market condition of the recent years and then the world dry bulk fleet. In this paper, the model for the newbuilding ship price is set up by EViews and according to the multiple linear regression method and based on the data of the recent years, I find out the influencing factors to the newbuilding ship price. ARIMA model is used to predict the ship price in a short-term period and hopefully it could give some help in the related field.

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Appendices

Appendix 1 Raw data (Part of data)

Date	Panamax 75-77K DWT BulkcarrierNewbuilding Prices	Panamax, 1997/98-built, Average Spot Earnings	380cst bunker prices, Rotterdam
	$ Million	$/Day	$/Tonne
Mar-01	22	12035	119.8
Apr-01	22	11657	116.75
May-01	22	11211	122
Jun-01	21.5	10175	121.6
Jul-01	21.5	8944	118
Aug-01	21	6189	125.4
Sep-01	21	5834	130.12
Oct-01	21	5991	110.62
Nov-01	20.5	6094	101.9
Dec-01	20.5	5860	103.75
Jan-02	20.5	6444	104.5
Feb-02	20.5	6212	103.25
Mar-02	20.5	6717	120.5
Apr-02	21.25	5978	136.12
May-02	21.5	6368	140.8
Jun-02	21.5	5790	135
Jul-02	21	5956	142.75
Aug-02	21	5947	145.9
Sep-02	21	7266	161.38
Oct-02	21	8475	154
Nov-02	21.25	9627	125.7
Dec-02	21.5	11845	134.38
Jan-03	22	12151	173.5
Feb-03	22.25	11571	175.12
Mar-03	22.25	12461	148.25
Apr-03	22.25	14713	126.38
May-03	22.5	15828	137.9
Jun-03	22.5	14875	147.5
Jul-03	23.25	15972	170.5
Aug-03	24	15576	159.7
Sep-03	24.25	17108	147.75
Oct-03	24.5	32760	151.9

Appendix 2 Correlation table

	X5	X6	X7	X8
357	0.102581	0.916874	0.03674	0.
713	0.231843	0.416826	0.122881	0.
299	-0.01044	0.110351	-0.21662	-0.
1	-0.01327	-0.00993	-0.37455	-0.
327	1	0.120917	-0.0635	0.
393	0.120917	1	0.078896	0.
455	-0.0635	0.078896	1	0.
265	0.058194	0.516746	0.127104	
345	0.411539	-0.07733	-0.09717	-0.
227	-0.09539	0.341261	0.003659	0.
769	-0.03471	-0.14032	0.142521	-0.
328	0.148649	0.737065	0.140836	0.

Appendix 3 Breusch-Godfrey Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.104662	Prob. F(12,129)	0.3619
Obs*R-squared	14.3503	Prob. Chi-Square(12)	0.2789

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 03/23/14 Time: 11:37
Sample: 2001M04 2014M01
Included observations: 154
Presample missing value lagged residuals set to zero.

	Coefficient	Std. Error	t-Statistic	Prob.
D(X2)	-0.000301	0.003185	-0.094526	0.9248
D(X3)	0.008044	0.026642	0.301946	0.7632
D(X4)	0.000105	0.000146	0.715988	0.4753
D(X5)	0.067592	0.377669	0.178972	0.8582

D(X6)	3.72E-06	2.27E-05	0.163664	0.8703
D(X7)	1.570855	6.463034	0.243052	0.8084
D(X8)	-0.042804	0.213752	-0.20025	0.8416
D(X9)	0.0774	0.435394	0.177769	0.8592
D(X10)	0.329538	2.902846	0.113522	0.9098
D(X11)	-0.002175	0.001621	-1.341549	0.1821
D(X12)	-0.013139	0.033498	-0.392219	0.6955
D(X13)	-0.234327	0.694145	-0.337577	0.7362
C	0.00851	0.072448	0.117463	0.9067
RESID(-1)	0.244023	0.098138	2.486542	0.0142
RESID(-2)	0.050205	0.089639	0.560083	0.5764
RESID(-3)	-0.094649	0.09367	-1.01045	0.3142
RESID(-4)	0.153114	0.093034	1.64579	0.1022
RESID(-5)	0.037026	0.09307	0.397829	0.6914
RESID(-6)	0.019232	0.091083	0.211145	0.8331
RESID(-7)	0.058116	0.091311	0.636467	0.5256
RESID(-8)	0.115157	0.094959	1.2127	0.2275
RESID(-9)	-0.062949	0.092236	-0.68248	0.4962
RESID(-10)	-0.060387	0.095743	-0.630724	0.5293
RESID(-11)	0.035554	0.092401	0.384783	0.701
RESID(-12)	-0.098639	0.093753	-1.052117	0.2947

R-squared	0.093184	Mean dependent var	1.15E-17
Adjusted R-squared	-0.075526	S.D. dependent var	0.841497
S.E. of regression	0.872697	Akaike info criterion	2.713078
Sum squared resid	98.24631	Schwarz criterion	3.206089
Log likelihood	-183.907	Hannan-Quinn criter.	2.913338
F-statistic	0.552331	Durbin-Watson stat	1.99242
Prob(F-statistic)	0.953782		

Appendix 4 White Test

Heteroskedasticity Test: White

F-statistic	2.708112	Prob. F(79,74)	0.0000
Obs*R-squared	114.4224	Prob. Chi-Square(79)	0.0057
Scaled explained SS	78.42041	Prob. Chi-Square(79)	0.4973

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 05/25/14 Time: 17:26

Sample: 2001M04 2014M01

Included observations: 154

Collinear test regressors dropped from specification

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	65.29346	12.42346	5.255657	0.0000
D(X2)	-0.492598	0.504594	-0.976228	0.3321
(D(X2))^2	-0.002476	0.013284	-0.186394	0.8526
(D(X2))*(D(X3))	-0.134298	0.146174	-0.918754	0.3612
(D(X2))*(D(X4))	0.001110	0.001001	1.108301	0.2713
(D(X2))*(D(X5))	5.250099	2.406765	2.181392	0.0323
(D(X2))*(D(X6))	-8.09E-05	0.000132	-0.611399	0.5428
(D(X2))*(D(X7))	-62.84677	45.34298	-1.386031	0.1699
(D(X2))*(D(X8))	0.700803	1.113611	0.629307	0.5311
(D(X2))*(D(X9))	-3.203309	2.782062	-1.151415	0.2533
(D(X2))*(D(X10))	28.64228	18.19998	1.573753	0.1198
(D(X2))*(D(X11))	0.036068	0.021188	1.702265	0.0929
(D(X2))*(D(X12))	-0.173740	0.287447	-0.604426	0.5474
(D(X2))*(D(X13))	-5.968687	16.97820	-0.351550	0.7262
D(X3)	2.824974	3.669967	0.769755	0.4439
(D(X3))^2	-0.914658	0.727900	-1.256571	0.2129
(D(X3))*(D(X4))	-0.014287	0.009459	-1.510349	0.1352
(D(X3))*(D(X5))	19.24496	20.18120	0.953608	0.3434
(D(X3))*(D(X6))	0.000374	0.001576	0.237584	0.8129
(D(X3))*(D(X7))	-343.8281	377.8422	-0.909978	0.3658
(D(X3))*(D(X8))	11.19724	12.78654	0.875705	0.3840
(D(X3))*(D(X9))	-39.41514	31.07227	-1.268499	0.2086
(D(X3))*(D(X10))	155.4972	129.7760	1.198197	0.2347
(D(X3))*(D(X11))	0.084285	0.175128	0.481273	0.6317
(D(X3))*(D(X12))	0.344558	2.821290	0.122128	0.9031

(D(X3))*(D(X13))	-50.84355	239.1423	-0.212608	0.8322
D(X4)	0.022861	0.028625	0.798628	0.4271
(D(X4))^2	2.02E-05	2.65E-05	0.761198	0.4490
(D(X4))*(D(X5))	-0.125650	0.099440	-1.263571	0.2104
(D(X4))*(D(X6))	2.31E-06	7.59E-06	0.304072	0.7619
(D(X4))*(D(X7))	0.835569	2.309296	0.361829	0.7185
(D(X4))*(D(X8))	0.114543	0.074720	1.532950	0.1296
(D(X4))*(D(X9))	0.396168	0.144111	2.749045	0.0075
(D(X4))*(D(X10))	1.704268	0.645955	2.638369	0.0102
(D(X4))*(D(X11))	0.000473	0.001414	0.334259	0.7391
(D(X4))*(D(X12))	-0.017242	0.017779	-0.969807	0.3353
D(X5)	-70.08961	42.43212	-1.651806	0.1028
(D(X5))^2	321.2562	137.4984	2.336435	0.0222
(D(X5))*(D(X6))	0.034086	0.014562	2.340818	0.0219
(D(X5))*(D(X7))	-4089.367	4616.138	-0.885885	0.3785
(D(X5))*(D(X8))	35.42083	232.5625	0.152307	0.8794
(D(X5))*(D(X9))	-241.0928	318.4985	-0.756967	0.4515
(D(X5))*(D(X10))	-685.1756	2054.191	-0.333550	0.7397
(D(X5))*(D(X11))	1.266870	2.261847	0.560104	0.5771
(D(X5))*(D(X12))	-57.14715	34.16099	-1.672877	0.0986
D(X6)	0.001420	0.002950	0.481415	0.6316
(D(X6))^2	-8.84E-08	6.14E-07	-0.144019	0.8859
(D(X6))*(D(X7))	0.934343	0.343114	2.723125	0.0081
(D(X6))*(D(X8))	0.023553	0.015455	1.524006	0.1318
(D(X6))*(D(X9))	-0.031045	0.026661	-1.164458	0.2480
(D(X6))*(D(X10))	-0.068648	0.149449	-0.459341	0.6473
(D(X6))*(D(X11))	-3.22E-05	0.000127	-0.253009	0.8010
(D(X6))*(D(X12))	-0.002556	0.002310	-1.106481	0.2721
D(X7)	4846.467	798.7517	6.067552	0.0000
(D(X7))^2	39507.42	49673.11	0.795348	0.4290
(D(X7))*(D(X8))	171.6495	2597.300	0.066088	0.9475
(D(X7))*(D(X9))	28.77997	6971.182	0.004128	0.9967
(D(X7))*(D(X10))	30699.04	35189.57	0.872390	0.3858
(D(X7))*(D(X11))	63.16620	37.43830	1.687208	0.0958
(D(X7))*(D(X12))	-1840.918	817.6648	-2.251433	0.0273
D(X8)	-20.42212	29.57252	-0.690577	0.4920
(D(X8))^2	-60.76017	70.05073	-0.867374	0.3885
(D(X8))*(D(X9))	48.92363	224.6351	0.217792	0.8282
(D(X8))*(D(X10))	-1511.895	1382.051	-1.093951	0.2775
(D(X8))*(D(X11))	-1.365372	1.961161	-0.696206	0.4885
(D(X8))*(D(X12))	-9.610767	22.36531	-0.429718	0.6686
D(X9)	-97.19173	68.90093	-1.410601	0.1626
(D(X9))^2	18.67419	207.3495	0.090061	0.9285
(D(X9))*(D(X10))	-25.44774	2759.793	-0.009221	0.9927

(D(X9))*(D(X11))	-2.989751	3.156632	-0.947133	0.3467
(D(X9))*(D(X12))	108.2709	61.29628	1.766353	0.0815
D(X10)	-113.2347	341.4505	-0.331629	0.7411
(D(X10))^2	-5275.459	8519.985	-0.619186	0.5377
(D(X10))*(D(X11))	2.851124	19.67888	0.144882	0.8852
(D(X10))*(D(X12))	347.8424	286.4166	1.214463	0.2284
D(X11)	-0.201887	0.647297	-0.311893	0.7560
(D(X11))^2	-0.001775	0.002817	-0.630083	0.5306
(D(X11))*(D(X12))	-0.021089	0.228842	-0.092157	0.9268
D(X12)	-15.39819	6.651939	-2.314843	0.0234
(D(X12))^2	2.038395	2.310790	0.882120	0.3806

R-squared	0.743003	Mean dependent var	66.97130
Adjusted R-squared	0.468641	S.D. dependent var	85.91697
S.E. of regression	62.62865	Akaike info criterion	11.41840
Sum squared resid	290253.7	Schwarz criterion	12.99603
Log likelihood	-799.2165	Hannan-Quinn criter.	12.05923
F-statistic	2.708112	Durbin-Watson stat	1.399285
Prob(F-statistic)	0.000012		