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Forecast and analysis of seaborne import oil freight from South Africa to China

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Forecast and Analysis of Seaborne Import Oil Freight from South Africa to China

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ABSTRACT

Title of research paper: **Forecast and Analysis of Seaborne Import Oil Freight from South Africa to China**

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Baltic freight index for crude oil is one of the most important economic indexes in crude oil shipping market. It is considered as barometer reflecting crude oil market`s variation. Crude oil tanker freight rate forecasting has become a hot issue for academic researchers and practitioners, especially after the 2008 economic crisis. Baltic freight index for crude oil has the characters of high volatility, nonlinearity and irregularity. Though the economic crisis, the fluctuations in the crude oil tanker market are more volatile than ever. Furthermore, some important events have a significant impact on tanker freight rate fluctuation. Meantime, these characteristics also make it difficult to predict crude oil tanker freight rate. In the past decades, various methods and models were presented to predict tanker freight rate, but their forecasting performance is not satisfactory.

The analysis and prediction of crude oil tanker freight rate are from two points of view. The thesis concentrated on the crude oil demand market and tanker shipping market to analyze the crude oil shipping market. The impact factors which are proved reserves, production, and consumption and trade movements of crude oil are discussed. While the route of crude oil tankers and tanker fleets are also introduced. In this paper, tanker freight rate for crude oil on the seaborne route from South Africa to China (TD15) is the target index to be forecast. The aim to choose the index on one route is to refinement influenced factors, make the analysis more accurately.

The Baltic Dirty Tanker Index published by Baltic Mercantile and Shipping Exchange is chosen as the predictive object. A study of simulation and forecasting performance of ARIMA time series model is used to BDTI TD15. In the process of BDTI TD15 forecasting with ARIMA, stationary test should be firstly conducted. After estimating the parameters and testing, an ARIMA forecasting model is established. Analyzing the forecasting results from ARIMA model, it can be seen that risk factors are not into consideration, which affected the correct of forecasting data.

KEYWORDS: Baltic Freight Rate Index, ARIMA, Crude Oil Seaborne Trade, China, South Africa

CONTENTS

1. Introduction

1.1 Background and Significance

Oil is one of the important energy base developments and progress of human society, sustained rise in oil prices has been a worldwide problem. Continuing high demand, the limitations of existing refining technology, and the lack of follow energy are the reasons of high oil price. Based on these factors cannot be solved in the short term, high oil prices will continue to be one of the issues in the world economy.

International freight shipping market is with shipping large fluctuations, investment costs, and long payback period of capital characteristics. The market mainly constituted by the container liner shipping market, dry bulk shipping market and liquid bulk shipping market. In the case of the shipping market downturn, the tanker market due to rising market demand for crude oil and oil products, although volatile, the tanker market the overall upward trend in the state.

For seaborne crude oil import trade, one of the important indicators is the Baltic freight index for crude oil (BDTI for short), the index provides "an assessment of the price of moving the major raw materials by sea. Most directly, the index measures the demand for shipping capacity versus the supply of dry bulk market. The demand for shipping varies with the amount of cargo, being traded or moved in various markets. BDTI can simply show the change of international crude oil market, the significant change in BDTI demonstrate the sound condition of economic situation, and the smooth operation of international trade.

This paper selected South Africa to China Baltic index routes (BDTI TD15), from this one route index predictive analytics can be more intuitive, precise to get the degree of development on energy cooperation between South Africa and Chinese trade. China Freight Index has great impact by international crude oil Price index; Shanghai crude index compared with the Baltic freight index currently has limitations. This paper aims from the perspective of the global shipping market, based on Chinese imports of crude oil offshore market; improve research and analysis for crude oil freight index.

1.2 The main research results and current situation at home and abroad

According to the current literatures, there are three types of issues are about Chinese crude oil business: The first is The international market oil price fluctuations on China's economic impact study, the send is The international crude oil price forecasting model research, and the third is The price of crude oil at home and abroad interaction mechanism and its countermeasures.

The Research of International Crude Oil Price Forecasting Model (By Zheng Junyan 2011) used multi-grid search method to find the optimal parameters, and constantly trained the original data to establish the final forecasting models. The result shows that the prediction accuracy of the SVR model used in forecasting the long-term price trend increased by 10.5% and 35.7% compared to traditional regression model and neural network model. When forecasting the short-term of the oil price, the SCR model didn`t perform as well as time series model.

How the Crude Oil Price change Affect Chinese Economy? (By Wu Lili 2009) made a reference to the overseas achievement and discusses the effect of crude oil price to Chinese economy. In addition, this paper put forward three problems: How to coordinate the monetary policy between China and other countries? How to transcend derivative capital? How to readjust income distribution when assets price change so rapidly?

Analyzing the Factors Behind Crude Oil Price Increases From 2002-2007 and the Implication For the Oil Industry: A Non-Technical Assessment (By Brian P. Shephers; 2009.6) analyze how various price regimes inherent to different oil industry structures affected crude oil prices in the 20^{th} century. The results of the analysis are fairly consistent with economy theory as they elucidate the consequences of severe underinvestment in the oil industry and price volatility.

Combined Non-Linear Forecasting to International Crude oil Price set up the price of crude oil based on fuzzy neural network nonlinear combination forecasting model, including the radial basis function (RBF) neural network, the semi parametric model based on Markova chain and oil price forecasting model based on mallet wavelet decomposition. According to the empirical system in the concrete research object and nonlinear combination forecast theory of oil prices, the actual prediction research of Brent crude oil prices, crude oil price formation mechanism reform of our country the thinking.

Crude Oil Tanker Freight Rate Forecasting Based on Arima and Artificial Neural Network from the demand for crude oil transportation market and attack Angle of two oil market of various factors affecting crude oil freight index, outlines the world crude oil storage, production, consumption and import and export of the status quo, and introduced the main routes and Marine transportation of crude oil tanker fleet, provide the basis for crude oil freight index prediction. This article selects BDTI as prediction objects, based on the ARIMA model of linear and nonlinear two methods based on BP neural network to predict. By compares the prediction results of two kinds of model, found that for long-term prediction neural network model to predict the effect is good, but due to unexpected factors such as does not take into account the financial crisis, the influence of two models is a big room for improvement.

Research on Volatility Characters in International Tanker Shipping are introduced according to the actual situation of the original freight market, financial market analysis market fractal theory of nonlinear complex system, through the analysis of the study found that the fractal characteristics of crude oil shipping market is significant, and estimate the crude oil shipping market of the cycle of about 1000 working days.

1.3 The main contents of this paper

The second chapter introduces the world oil market, has an intuitive understanding for world oil market from the current situation in the world oil market and the world's major crude oil transportation routes. Status of the world crude oil market mainly describes the current demand for crude oil is still in the rising phase;

introducing the world's crude oil transportation routes, and also describes the major ports and appropriate carrying amount of each route. Third and fourth chapters are the focus of this article, the establishment of a TD15 BDTI linear prediction model based on ARIMA models. Firstly, introduce the main factors of crude oil on the route from West Africa to China, the impact of freight index; then introduce the concept of time series sample data based on the ARIMA model and a stable stationary test sequence, the model parameter estimation and testing; finally tested to determine the model of BDTI TD15 predicted. In the end of Chapter Four, we would forecast the BDTI TD15 from Jul 2005 to January 2014. Chapter five would give a conclusion for the whole paper.

1.4 Contribution of this article

Based on the analysis of the results of previous studies, the main contribution of this article is， for the crude freight index of the route from West Africa to China, the analysis and forecast, including the consideration of regional factors, are more unique. Meanwhile, all the needed data for establishing the model are from the lasted data, published by Clarkson, with immediacy.

2. Overview of world crude oil market

2.1 Current situation of world crude oil market

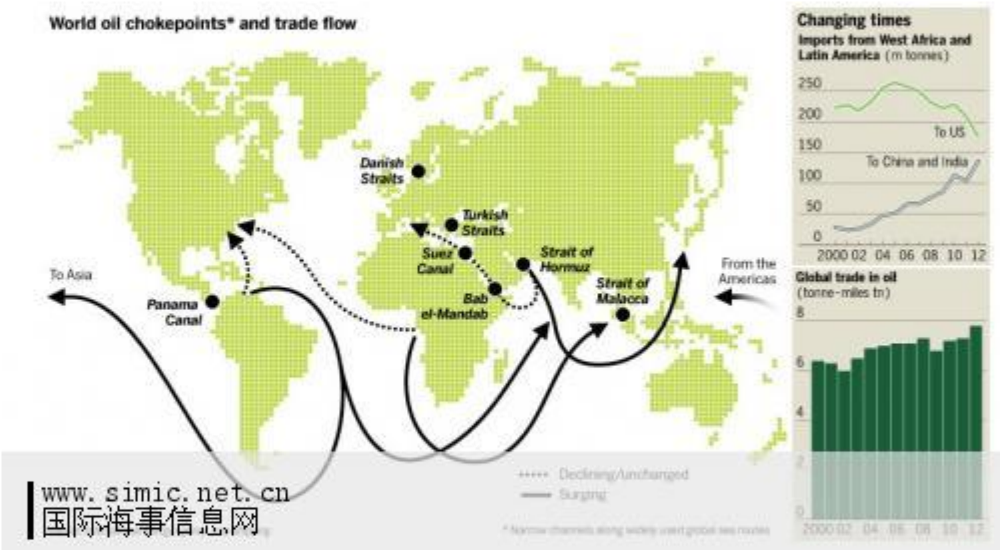

Chart 1: World Oil trade flow

With the rapid development of world economy, world demand for oil is increasing. Before 2008 world economic crisis, crude oil price was grown sharply, though shipping industry was hit hard when the crisis began, till this year, the whole business is recovery. Chart 1 show that during 2000 to 2012, the main route of world oil trade has a trend to shift from west to east; it will be a big chance for east region countries, including China. If the international crude oil prices will continue to rise in the future, its impact on the international shipping markets should not be underestimated. Shipping market is affected by trade market, one of the conditions for shipping market increased is that the world economy developed; the world economy at the same time lead to the demand for crude oil grows, increasing demand for crude oil further stimulates the growth of demand for shipping market. From a certain extent, the international crude oil trade and international shipping synchronous growth produce correlation. For example, currently, most of vessels are powered by oil. When crude oil price grows, it may raise the oil productions` prices, which lead to shipping company’s bunker cost increase. In order to solve this problem, a slow steaming strategy usually is introduced in shipping companies to reduce the oil consumption, while there exists trade-off between oil consumption saving and voyage time extending.

2.2 Major routes of world crude oil seaborne trade

The world's major exporter of crude oil have in the Middle East, Latin America, West Africa and the Asia-Pacific region and other major importing areas in North America, Europe, Japan, China and Southeast Asia. Import and export of crude oil are separated by the decision of the majority of the region's crude oil in international trade are required to be completed by the sea, and the import and export between these regions form the seven major oil transport routes

A. Southeast Asia, the Middle East Gulf to Japan route

On the route and traffic of up to about 450 million tons annually, sailing route is filled with crude oil from the Persian Gulf in a port, through the Strait of Hormuz into the Arabian Sea, the Indian Ocean, east along the west coast of the Indian peninsula by Colombo and the Strait of Malacca or Lombok Strait to Port unloading Japan, Korea and other countries.

B. North Africa to North-West Europe route

In the route up to more than 9000 tons of traffic, navigation routes is filled with crude oil from the North African Mediterranean in a way through the Strait of Gibraltar harbor to reach an oil port unloading Northwest Europe.

C. Middle East and Persian Gulf via the Cape of Good Hope route to Western Europe or the Americas traffic

On the route up to about 170 million tons of crude oil annually. Ships sailing route for oil from the Persian Gulf in a harbor, via the Strait of Hormuz into the Arabian Sea, the Indian Ocean, south along the east coast of Africa, across the Mozambique Channel, around the Cape of Good Hope into the Atlantic, and then along the northwestern coast of Africa northward along the coast to western Europe countries, or the Cape of Good Hope across the Atlantic to reach the American East Coast ports.

D. Middle East and Persian Gulf via the Suez Canal route to Western Europe or the Americas routes

Through the Persian Gulf and the Middle East Cape of Good Hope route is realized crude oil trade and transport in Western Europe or North America, the

Middle East and between the annual volume of up to more than 100 million tons, the difference is the route in departure from the Persian Gulf oil port, through the Strait of Hormuz into the Arabian Sea, the west line, by Peter Strait, the Red Sea, the Suez Canal, the Mediterranean, the Strait of Gibraltar into the Atlantic, if along the Atlantic coast northward to western Europe each oil port; If transatlantic, up the east coast of North America, the oil harbor.

E. Northwest Africa to North America routes

On this route, the ship is only limited by the loading port, and the annual transport capacity is 9000 tons.

F. West Africa to Western Europe routes

On this route, the ship is only limited by the loading port, and the annual transport capacity is 4000 tons.

G. Latin American routes to North America, the Caribbean routes

The route is generally used Aframax and Panamax tankers, and the annual volume is 180 million tons.

Crude oil volume on these seven routes of the total volume as much as 72%, in addition to the Black Sea - Mediterranean, Middle East - Australia, Arab - the United States, Gulf of Mexico - Caribbean, Mexico - Japan, Southeast Asia - date The China - Japan regional routes. But in comparison to seven major routes described above, these routes has shorter voyage, volume is also smaller, and more generally applicable to small and medium sized tankers.

2.3 The reason for research on BDTI TD15

South Africa is Africa's largest economic community, the bilateral trade between China-Africa has developed rapidly since 2000.The bilateral cooperation between China and Africa reached a new stage of $126.911 billion in 2011. The proportion of Africa foreign trade in China has increased significantly from 2.23% in 2000 to 4.57% in 2011. The imports on the route from Africa to China, increasing from 2.47% in 2000 to 5.35% in 2011. We can say that 2011 is a important point for China-Africa trade since the economic crisis, it is not only said to restore

Sino-African trade, but also one of the reasons that why the predictive value of BDTI TD15 in 2011 is volatility than the actual value. In 2013, China's dependence on foreign crude oil reached 57.39%, South Africa was biggest exporters of crude oil to China. On March 26, 2013, China and South Africa's national oil company signed a world-scale project - Dikembe Mutombo refinery project. Cooperation Framework Agreement defined the scope of mutual cooperation in oil and gas exploration and development projects carried out in South Africa and its neighboring countries. The two sides also discussed other areas of cooperation, including downstream investment opportunities in southern Africa, or the acquisition of new logistics facilities agreement. This cooperation will continue to boom the crude oil seaborne trade between China and South Africa. BDTI TD15 is one of the sample route in BDTI cover the route from Middle East to Southeast Asia , which closely related the crude oil seaborne trade between China and South Africa, so we choose this typical route as our target in the following research.

3. Influence factors of BDTI TD15 and model selection

3.1 Factors analysis on BDTI TD15

There many factors can influence the BDTI TD15, in this paper we consider the possible variables in six areas: 1）Oil Demand. For the crude oil demand market, just analyze China`s crude oil import volume is far than enough, we also need to think about possible factors that may impact the China`s crude oil import volume, such as America`s crude oil import volume during the same period (Because the per unit time for total amount of crude oil is certain, if the United States and China import crude oil from South Africa at the same time, the increasing volume of United States imports may lead to a decline of China`s crude oil imports volume under a constant demand); The development of oil powered fleet(Currently, most of seaborne trade fleets are still using oil for vessels` main power resource, so the development of fleet might stimulate the increasing of oil demand in home country);　2）Oil Supply. In the crude oil supply side, except China`s crude oil export volume and crude oil volume in product country, Crude oil exports and production in various regions of the world are likely to affect China's crude oil supply market. The reason is similar with the demand market, in an extent world crude oil production, every country`s crude oil supply market is connected with each other, when one region change the production, the whole pattern of crude oil supply market can be changed immediately). 3）Oil Price. Due to there are many market standards for crude oil index, and different regions use different criteria index, here we are mainly considering the BCTI, which is closely impact with BDTI, and Brent crude oil price, which is same as Baltic index, influencing the world crude oil market deeply. 4) World Economy. World economy is changing every second, it also change the BDTI in the same time, in the world economy side we mainly analyze S&P500，LIBOR，Exchange Rate，and Inflation Indicator. 5）Shipping Capacity. Due to on the TD15, only VLCC fleet is used for crude oil seaborne trade, in shipping capacity side we choose VLCC Average Demolition Prices, Tanker Secondhand/Newbuilding Prices Ratio, Total Tanker Fleer Development, Total Tanker 10K+DWT Deliveries, Tankers 10K+DWT Orderbook DWT, and Tankers 10K+DWT Contracting to be our variables. 6）Freight Earnings. Except three dominant factors on China-South Africa route: VLCC Average Long Run Historical Earnings, Bonny Off - Ningbo VLCC 260K Worldscale Rates, Average Clean Products Earnings, we also analyze Suezmax Average Long Run Historical Earnings, and add two seasonality factors Dummy1(Jan,Feb) and Dummy2(Jun,Nov).

Freight Index	**Internal Determinants**	**External Determinants**	**Explanatory Variables for Regression**
BDTI	Route & Haul	Oil Demand	Total Containership Fleet Development
			Total RoRo Fleet Development
			USA Crude Oil Imports
			China Seaborne Oil Products Imports
			China Seaborne Crude Oil Imports

		Oil Supply	Global Oil Production
			OPEC: Crude Oil Production
			Mid-East Oil Production
			China Seaborne Oil Products Exports
			China Seaborne Crude Oil Exports
			ME Refinery Throughput
			Red Sea Crude Oil Exports
			E. Med. Crude Oil Exports
	Cost & Revenue	Oil Price	Brent Crude Oil Price
			BCTI
		World Economy	S&P 500
			LIBOR
			Exchange Rates China
			Inflation Indicator
	Vessel Specification	Shipping Capacity	VLCC Average Demolition Prices
			Tanker Secondhand/Newbuilding Prices Ratio
			Total Tanker Fleet Development
			Total Tanker 10K+DWT Deliveries
			Tankers 10K+DWT Orderbook DWT
			Tankers 10K+DWT Contracting
		Freight Earnings	VLCC Average Long Run Historical Earnings
			Average Clean Products Earnings
			Bonny Off - Ningbo VLCC 260K Worldscale Rates
			Suezmax Average Long Run Historical Earnings
			Dummy1(Jan,Feb)
			Dummy2(Jun,Nov)

Table1. Explanatory Variables of BDTI

All the variables displayed above are obtained from Clarkson for the period from June 2005 to May 2014 monthly.

Particularly, the seasonality of BCTI, which is a qualitative factor caused by the volatility of the crude oil demands, varies across markets depending on vessel size and market condition. As the freight of VLCC account for a large proportion of BCTI, it is necessary to add seasonality dummy variables for VLCC freight rate.

According to precious study on VLCC shipping market, freight rates increase significantly during June and November, drop in January and February. Hence we included 2 dummy variables (Dummy1 and Dummy2) into the regression model for the 3 categories of seasonality as is shown as below:

Deterministic seasonality in tanker freight rate series; Sample: 1978:1–1996:12

$\Delta X_t = \beta_0 + \sum_{i=2}^{12} \beta_i Q_{i,t} + \varepsilon_t$ Eq. (1)

Month	Coef	VLCC	Suezmax	Aframax	Handysize
Const.	β_0	0.004 (0.350)	0.004 (0.443)	0.003 (0.347)	0.002 (0.239)
Jan.	β_1	**−0.110 (−2.933)**			
Feb.	β_2	**−0.067 (−1.695)**	**−0.049 (−2.034)**	**−0.030 (−1.900)**	
Mar.	β_3				
Apr.	β_4		**−0.048 (−2.056)**	**−0.041 (−2.662)**	**−0.059 (−2.701)**
May	β_5				
June	β_6	**0.105 (2.951)**			
July	β_7			**−0.052 (−3.068)**	
Aug.	β_8				
Sept.	β_9				
Oct.	β_{10}				
Nov.	β_{11}	**0.066 (1.847)**	**0.105 (4.321)**	**0.110 (4.725)**	**0.077 (4.894)**
Dec.	β_{12}			**0.033 (1.832)**	
$\bar{R}^2$		0.059	0.074	0.084	0.048
L−B(1)		1.464 [0.226]	0.915 [0.339]	1.702 [0.192]	2.516 [0.113]
L−B(12)		24.44 [0.017]	10.43 [0.578]	17.60 [0.128]	16.82 [0.156]
ARCH(12)		1.039 [0.413]	1.774 [0.054]	1.857 [0.042]	1.264 [0.242]
White		0.463 [0.496]	0.121 [0.728]	0.008 [0.929]	0.812 [0.367]
J−B		20.58 [0.000]	18.00 [0.000]	46.54 [0.000]	74.59 [0.000]
LL		53.461	152.513	142.009	160.615
AIC		56.870	155.240	146.100	162.660
HQC		53.461	152.513	142.009	160.615
SBIC		48.432	148.489	135.974	157.597

Table2 Deterministic seasonality in tanker freight rate series

Source: Manolis G. Kavussanos, Amir H. Alizadeh-M(2001). Seasonality patterns in tanker spot freight rate markets. Economic Modelling 19 (2002). 747-782

Table 2 shows that when considering the world crude oil seaborne route, it was significantly affected by seasonality in January or February, June or December:

$$\text{Dummy1} = \begin{cases} 0, & \text{if month} \neq \text{Jan,Feb} \\ 1, & \text{if month} = \text{Jan or Feb} \end{cases} \quad ; \quad \text{Dummy2} = \begin{cases} 0, & \text{if month} \neq \text{Jun,Nov} \\ 1, & \text{if month} = \text{Jun or Nov} \end{cases}$$

3.2 Model selection and introduction

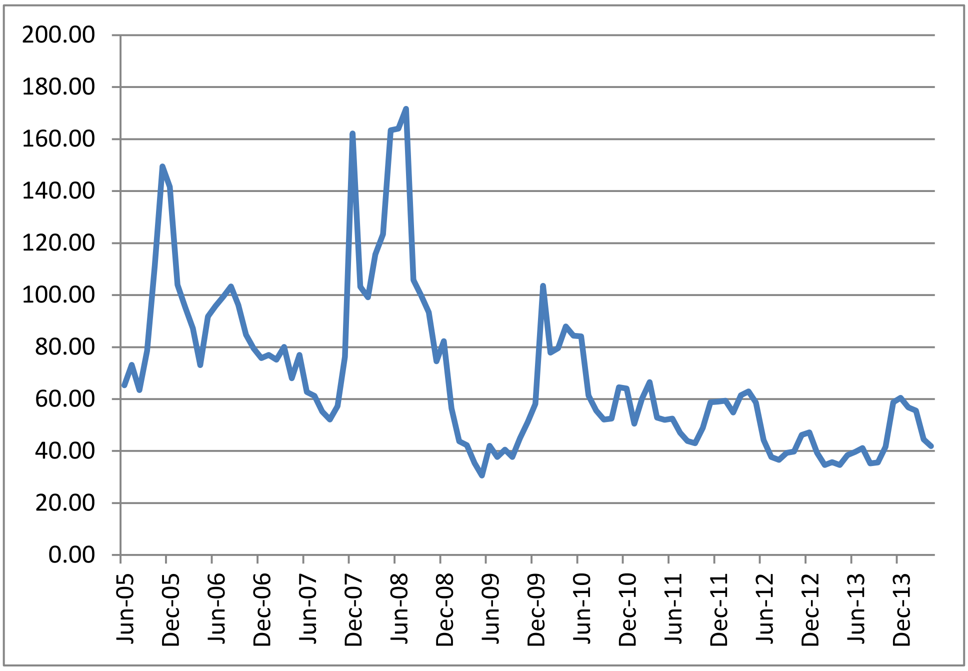

Chart 2: Time series graph of BDTI TD15

As we can see from the Chart 2, the BDTI TD15 time series changed volatile during December 2007 to June 2009, however, in the long-run, it changed with some potential regularity for it was affected by some factors like political, economy, natural and etc. So this paper chooses an autoregressive integrated moving average (ARIMA) model to forecast the BDTI TD15.

An autoregressive integrated moving average (ARIMA) model is a generalization of autoregressive moving average (ARMA) model. These models are fitted to time series data either to better understand the data or to predict future points in the series (forecasting). They are applied in some cases where data show evidence of non-stationarity, where an initial differencing step (corresponding to the "integrated" part of the model) can be applied to remove the non-stationary. The model is generally referred to as an ARIMA(p,d,q) model where parameters p, d, and q are non-negative integers that refer to the order of the autoregressive, integrated, and moving average parts of the model respectively. ARIMA models form an important part of the Box-Jenkinsapproach to time-series modeling.

Given a time series of data X_t where t is an integer index and the X_t are real numbers, then an ARMA (p' ,q) model is given by:

$$\left(1-\sum_{i=1}^{p'}\alpha_i L^i\right)X_t=\left(1+\sum_{i=1}^{q}\theta_i L^i\right)\varepsilon_t$$

Where L is the lag operator, the α_i are the parameters of the autoregressive part of the model, the θ_i are the parameters of the moving average part and the ε_t are error terms. The error terms ε_t are generally assumed to be independent, identically distributed variables sampled from a normal distribution with zero mean.

Assume now that the polynomial $\left(1-\sum_{i=1}^{p'}\alpha_i L^i\right)$ has a unitary root of multiplicity d. Then it can be rewritten as:

$$\left(1-\sum_{i=1}^{p'}\alpha_i L^i\right)=\left(1-\sum_{i=1}^{p'-d}\phi_i L^i\right)(1-L)^d.$$

An ARIMA(p,d,q) process expresses this polynomial factorization property with p=p'−d, and is given by:

$$\left(1-\sum_{i=1}^{p}\phi_i L^i\right)(1-L)^d X_t=\left(1+\sum_{i=1}^{q}\theta_i L^i\right)\varepsilon_t$$

and thus can be thought as a particular case of an ARMA(p+d,q) process having the autoregressive polynomial with d unit roots. (For this reason, every ARIMA model with d>0 is not wide sense stationary.)

The above can be generalized as follows.

$$\left(1-\sum_{i=1}^{p}\phi_i L^i\right)(1-L)^d X_t=\delta+\left(1+\sum_{i=1}^{q}\theta_i L^i\right)\varepsilon_t$$

This defines an ARIMA(p,d,q) process with drift δ/(1−Σφi).

In this chapter, Eviews6.0 is used as computational tools to analyze and forecast data.

4. Model Test and Forecast

4.1 Model Test

4.1.1 Stationary test

If the time series are not stationary, it will probably lead to spurious regression. To ensure the series that we will utilize in regression model are stationary, one unit root test --- Augmented Dickey-Fuller test will be applied to diagnose.

Take the time series --- “Bonny Off - Ningbo VLCC 260K Worldscale Rates” as an example, as is shown below:

Series: X30 Workfile: DATA::Untitled\

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Augmented Dickey-Fuller Unit Root Test on X30

Null Hypothesis: X30 has a unit root
Exogenous: None
Lag Length: 0 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.236042	0.1977
Test critical values:	1% level	-2.587607	
	5% level	-1.943974	
	10% level	-1.614676	

*MacKinnon (1996) one-sided p-values.

Table 3: “Bonny Off - Ningbo VLCC 260K Worldscale Rates” ADF test result in Level

Series: X30 Workfile: DATA::Untitled\

View | Proc | Object | Properties | Print | Name | Freeze | Sample | Genr | Sheet | Graph | Stats | Ident

Augmented Dickey-Fuller Unit Root Test on D(X30)

Null Hypothesis: D(X30) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.44404	0.0000
Test critical values:	1% level	-3.495677	
	5% level	-2.890037	
	10% level	-2.582041	

*MacKinnon (1996) one-sided p-values.

Table 4: “Bonny off - Ningbo VLCC 260K Worldscale Rates” ADF test result in first difference

The result of unit root test in level does not reject the Null Hypothesis that “Bonny Off - Ningbo VLCC 260K Worldscale Rates” has a unit root while the test in first difference rejects the Null Hypothesis, which means Scrap Price time series is stationary in first difference rather than in level. The results of the ADF test for each variable at the 5% significant level are as following (dummy variables are not included):

Stationary in level	Total RoRo Fleet Development,
	Exchange Rates China,
	Average VLCC Long Run Historical Earnings,
Stationary in second difference	Tankers 10k + DWT Orderbook
Stationary in first difference	All other variables

Table 5: Stationary Test Results

Noticed the units of different variables ranges widely while the time series in first difference have the same unit and they have been passed the stationary test, except the variable of "Tankers 10K + DWT Orderbook", it is more appropriate to transfer all the variables in fist differences in regression model. To avoid extreme observations which would cause heteroscedasticity, we converted the series into log return: when stationary in level, Rt= Ln(X); when stationary in first difference, Rt= Ln (Xt / Xt-1) *100%; when stationary in second difference, Rt= Ln (Xt / Xt-2) *100%.

We can see that the variable of "Tankers 10K + DWT Orderbook" is not pass the one unite root test, so it has to be removed.

4.1.2 Descriptive Statistics

Descriptive statistics is the discipline of quantitatively describing the main features of a collection of information, or the quantitative description itself. The result of descriptive statistics is below:

	Baltic Exchange Dirty Tanker Index Index	Total Tanker (10k+ DWT) Fleet Development Million DWT	Total Tanker 10k+ DWT Deliveries Million DWT	Tankers 10k + DWT Orderbook DWT	Tanker Secondhand/Newbuilding Prices Ratio %	BCTI	Brent Crude Oil Price $/bbl	Mid-East Oil Production M bpd	N. Sea Oil Prod. M bpd
	Y	X1	X2	X3	X4	X5	X6	X7	X8
Mean	-0.13582	0.420028	-0.27772	-0.53087	-0.23966	-0.50452	0.685983	0.027904	-0.55021
Median	-0.2613	0.4062	0	-1.075	-0.0381	-1.7674	1.5298	0.1291	-1.1257
Maximum	75.5099	1.3664	136.3305	19.63	12.8797	47.6083	20.1194	9.3457	88.7853
Minimum	-48.374	-0.2412	-111.621	-12.4055	-21.6014	-40.4879	-35.626	-10.3541	-75.6517
Std. Dev.	18.62715	0.310677	53.41771	6.154084	3.644837	14.29415	8.811294	2.04722	12.98887
Skewness	0.644799	0.113581	0.179879	1.051912	-1.79163	0.42608	-1.31267	-0.40701	1.27399
Kurtosis	5.600361	2.856949	2.761536	4.680724	15.40078	4.197056	6.182486	11.8207	33.34276
Jarque-Bera	36.15703	0.309285	0.799495	31.11847	715.0737	9.26623	73.04682	336.7558	3979.127
Probability	0	0.856721	0.670489	0	0	0.009724	0	0	0
Sum	-13.9899	43.2629	-28.6053	-54.68	-24.6845	-51.9653	70.6563	2.8741	-56.6712
Sum Sq. Dev.	35391.01	9.845092	291052	3863.021	1355.054	20840.91	7919.167	427.493	17208.5
Observations	103	103	103	103	103	103	103	103	103

Table 6.1 The result of descriptive statistics 1

	OPEC: Crude Oil Prod. M bpd	China Seaborne Oil Products Exports M tons	Global Oil Prod. M bpd	ME Refinery Throughput (M BPD)	Total Container ship Fleet Development Million DWT	Total RoRo Fleet Development Million DWT	USA Crude Oil Imports m bpd	China Seaborne Oil Products Imports M tons	China Seaborne Crude Oil Imports M tons
	X9	X10	X11	X12	X13	X14	X15	X16	X17
Mean	-0.0146	0.412883	0.083525	0.030217	0.707911	2.221832	-0.63102	0.251861	0.888094
Median	0.1989	0.6231	0.0842	0	0.6944	2.245	-0.1198	0.4264	1.4016
Maximum	2.7615	57.4629	2.7771	8.8553	1.6668	2.2762	21.1382	63.4149	36.9851
Minimum	-5.2848	-78.0745	-3.6376	-7.6647	-0.1665	2.1102	-26.2364	-42.3584	-37.0888
Std. Dev.	1.481143	23.79523	0.923911	3.094062	0.395312	0.049498	6.931548	18.98486	14.17863
Skewness	-0.971	-0.27802	-0.60701	0.050111	0.111173	-0.67755	-0.33448	0.233302	-0.18494
Kurtosis	4.81682	3.790883	5.127203	3.883025	2.324829	2.007501	5.434789	3.140928	2.687054
Jarque-Bera	30.35148	4.011287	25.74503	3.389462	2.168555	12.10822	27.36236	1.01961	1.007439
Probability	0	0.134574	0.000003	0.183649	0.338146	0.002348	0.000001	0.600613	0.604279
Sum	-1.5038	42.527	8.6031	3.1124	72.9148	228.8487	-64.9947	25.9417	91.4737
Sum Sq. Dev.	223.766	57753.74	87.06843	976.4681	15.93972	0.249901	4900.729	36763.36	20505.41
Observations	103	103	103	103	103	103	103	103	103

Table 6.2: The result of descriptive statistics 2

	Dummy 1 Jan,Feb	Dummy2 Jun,nov	S&P 500	LIBOR %	Exchange Rates China RMB/$	Average Clean Products Earnings $/Day	Average Suezmax Long Run Historical Earnings $/Day	Bonny Off - Ningbo VLCC 260K Worldscale Rates	Average VLCC Long Run Historical Earnings $/Day
	X18	X19	X20	X21	X22	X23	X24	X25	X26
Mean	0.165049	0.165049	0.403812	-2.29138	1.937123	-0.69876	0.358885	-0.30112	10.33051
Median	0	0	1.3499	-1.3903	1.9213	-2.813	4.1504	-0.6734	10.3982
Maximum	1	1	11.3523	33.3627	2.1126	72.6138	118.8324	75.8375	12.1748
Minimum	0	0	-22.8094	-38.1656	1.8066	-87.4668	-103.797	-50.4798	7.8709
Std. Dev.	0.37304	0.37304	4.199156	10.07417	0.092719	25.66599	44.34927	18.63659	0.899923
Skewness	1.804577	1.804577	-1.97396	-0.28838	0.435705	0.158222	0.006699	0.535075	-0.46589
Kurtosis	4.256498	4.256498	11.32637	5.502657	1.905799	3.766922	3.007177	5.317729	2.885045
Jarque-Bera	62.67884	62.67884	364.4251	28.30756	8.397207	2.95398	0.000991	27.96917	3.782735
Probability	0	0	0	0.000001	0.015017	0.228324	0.999504	0.000001	0.150865
Sum	17	17	41.5926	-236.012	199.5237	-71.9719	36.9652	-31.0156	1064.043
Sum Sq. Dev.	14.19417	14.19417	1798.557	10351.87	0.876872	67191.79	200619.5	35426.89	82.6059
Observations	103	103	103	103	103	103	103	103	103

Table 6.3: The result of descriptive statistics 3

This result presents descriptive statistics of monthly series. Jarque-Bera value indicate that the series of Total Tanker (10k+ DWT) Fleet Development, Total Tanker 10k+ DWT Deliveries, China Seaborne Oil Products Exports, ME Refinery Throughput, Total Containership Fleet Development, China Seaborne Oil Products Imports, China Seaborne Crude Oil Imports, Average Clean Products Earnings, Average Suezmax Long Run Historical Earnings, and Average VLCC Long Run Historical Earnings are normally distributed. Considering both the value of Skewness and the value of Kurtosis, there are four situations:

Situations	Series
Right significantly & Mesokurtic distribution	Exchange Rates China
Right significantly & Leptokurtic distribution	Baltic Exchange Dirty Tanker Index
	Tankers 10k + DWT Orderbook
	BCTI
	N. Sea Oil Production
	Bonny Off - Ningbo VLCC 260K Worldscale Rates
Left significantly &	Total RoRo Fleet Development

Mesokurtic distribution	
Left significantly & Leptokurtic distribution	Tanker Secondhand/Newbuilding Prices Ratio
	Brent Crude Oil Price
	Mid-East Oil Production
	OPEC: Crude Oil Production
	Global Oil Production
	USA Crude Oil Imports
	S&P 500
	LIBOR

Table 7: The value of Skewness and the value of Kurtosis

4.1.3 Multicollinearity Measurement

Statistical problems will arise when independent variables are highly correlated even though the OLS is still BLUE:

(1) Small changes in the data produce wide swings in the parameter estimates.

(2) Coefficients may have very high standard errors and low significance levels even though they are jointly significant and the R2 for the regression is quite high.

Therefore, we need to measure the correlation between variables and to eliminate multicollinearity problem.

	Baltic Exchange Dirty Tanker Index %	BCTI%	Total Containership Fleet Development %	Total RoRo Fleet Development %	Average Clean Products Earnings %	Bonny Off - Ningbo VLCC 260K Worldscale Rates%	Exchange Rates China %	Average VLCC Long Run Historical Earnings %
Baltic Exchange Dirty Tanker Index%	1.00	0.39	-0.13	0.04	0.29	0.97	0.03	-0.23
BCTI%	0.39	1.00	-0.08	-0.02	0.84	0.40	0.02	-0.08
Total Containership Fleet Development %	-0.13	-0.08	1.00	0.51	-0.08	-0.10	0.67	0.55
Total RoRo Fleet Development %	0.04	-0.02	0.51	1.00	-0.05	-0.04	0.73	0.69
Average Clean Products Earnings %	0.29	0.84	-0.08	-0.05	1.00	0.33	0.00	-0.07
Bonny Off - Ningbo VLCC 260K Worldscale Rates%	0.97	0.40	-0.10	-0.04	0.33	1.00	0.02	-0.23
Exchange Rates China %	0.03	0.02	0.67	0.73	0.00	0.02	1.00	0.64
Average VLCC Long Run Historical Earnings %	-0.23	-0.08	0.55	0.69	-0.07	-0.23	0.64	1.00

Table 8: The result of correlation between parts of variables

The table 8 is a part of correlation between all the influenced factors of BDTI TD15, chose the high correlation variables to ease of analysis.

As can be seen from the table, Total Containership Fleet Development & Exchange Rates China, Total RoRo Fleet Development & Exchange Rates China, Average Clean Products Earnings & BCTI, Bonny Off-Ningbo VLCC 260K Worldscale Rates & BDTI, Average VLCC Long Run Historical Earnings & Total RoRo Fleet Development are highly correlated(Value is over 0.65%). Therefore we remove Total Containership Fleet Development, Total RoRo Fleet Development, Average Clean Products Earnings and Bonny Off - Ningbo VLCC 260K Worldscale Rates from the regression model.

4.1.4 Auxiliary Regression

The growth rates of Average Long Run Historical Earnings of VLCC and Suezmax are supposed to be highly correlated, which also reflects in the line graph below, therefore we utilize auxiliary regression for those three variables to measure the correlation between them.

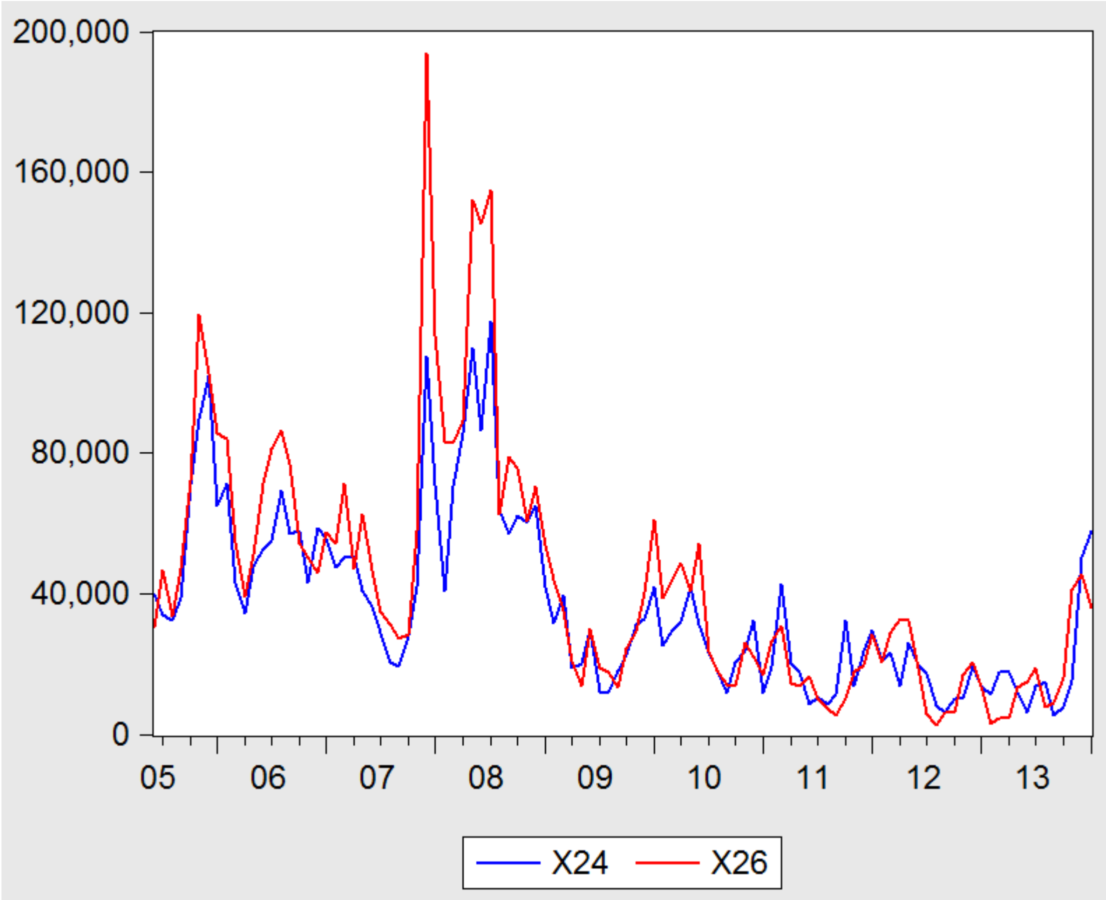

Chart 3: Auxiliary regression between VLCC and Suezmax Average Long Run Historical Earnings

Among all the route of BDTI TD15, VLCC has the largest size and carries crude oil on the main route, so here we take VLCC Earnings as dependent variable, Suezmax Earnings as independent variable to establish the auxiliary multilinear regression。

4.1.5 Estimate Regression Model

After the procedure mentioned above, the variables now are stationary and uncorrelated and are suitable to be used to estimate regression model. We run regression with the left variables and remove the most insignificant explanatory variable one by one (data of BDTI TD15 as the Y):

Dependent Variable: Y
Method: Least Squares
Date: 05/22/14 Time: 21:24
Sample: 2005M07 2014M01
Included observations: 103

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-42.31931	46.35707	-0.912899	0.3640
X1	-6.641929	7.503302	-0.885201	0.3787
X2	-0.002320	0.037294	-0.062206	0.9506
X3	-0.048009	0.370914	-0.129433	0.8973
X4	0.749860	0.544779	1.376447	0.1725
X5	0.360377	0.133999	2.689407	0.0087
X6	-0.216305	0.225015	-0.961294	0.3393
X7	2.329637	1.053175	2.212014	0.0298
X8	-0.003725	0.150644	-0.024725	0.9803
X9	-0.891144	1.720188	-0.518050	0.6058
X10	0.038605	0.076574	0.504161	0.6155
X11	2.531125	2.809950	0.900772	0.3704
X12	-0.596818	0.571646	-1.044033	0.2996
X15	0.019447	0.276796	0.070256	0.9442
X16	0.120424	0.099258	1.213235	0.2286
X17	0.049325	0.136045	0.362565	0.7179
X18	-7.582860	5.242632	-1.446384	0.1519
X19	10.15682	4.640194	2.188879	0.0315
X20	0.199901	0.524270	0.381293	0.7040
X21	0.031419	0.176706	0.177805	0.8593
X22	54.28259	27.78645	1.953564	0.0542
X26	-5.854484	2.780679	-2.105415	0.0384

R-squared	0.385864	Mean dependent var	-0.135824
Adjusted R-squared	0.226644	S.D. dependent var	18.62715
S.E. of regression	16.38084	Akaike info criterion	8.617007
Sum squared resid	21734.89	Schwarz criterion	9.179764
Log likelihood	-421.7758	Hannan-Quinn criter.	8.844943
F-statistic	2.423458	Durbin-Watson stat	2.189431
Prob(F-statistic)	0.002455		

Table 9: The result of estimate regression model

After re-estimating the model for several times, we have obtained the model of which all the variables are statistical significant, Prob. < 5%(except the constant term):

Dependent Variable: Y
Method: Least Squares
Date: 05/22/14 Time: 21:27
Sample: 2005M07 2014M01
Included observations: 103

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-30.47293	35.22007	-0.865215	0.3890
X7	2.629882	0.823487	3.193591	0.0019
X19	10.02746	4.517575	2.219655	0.0287
X22	57.55823	23.37484	2.462401	0.0155
X26	-8.023676	2.412262	-3.326204	0.0012

R-squared	0.211239	Mean dependent var	-0.135824
Adjusted R-squared	0.179044	S.D. dependent var	18.62715
S.E. of regression	16.87743	Akaike info criterion	8.537157
Sum squared resid	27915.06	Schwarz criterion	8.665056
Log likelihood	-434.6636	Hannan-Quinn criter.	8.588961
F-statistic	6.561362	Durbin-Watson stat	1.887044
Prob(F-statistic)	0.000101		

Table 10: The result of statistical significant variables

These variables are Mid-East Oil Production, Dummy2, Exchange Rates China, and Average VLCC Long Run Historical Earnings.

4.1.6 Residual Diagnostic Test

Since the residual of the model we have received should follow the 5 assumptions of CLRM to ensure the BLUE properties of OLS estimator, this section will test the autocorrelation, heteroskedasticity and normality for the residual term.

Breusch-Godfrey Serial Correlation LM Test with12 lags of the residuals and the White test are applied to test autocorrelation and heteroskedasticity respectively. Since both of the reports shows that the F statistics is greater than critical value on the significant level of 5%, serial correlation and heteroskedasticity exist in the residuals.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.184205	Prob. F(12,86)	0.3074
Obs*R-squared	14.60604	Prob. Chi-Square(12)	0.2637

Table 11: The result of LM Test

Heteroskedasticity Test: White

F-statistic	1.544038	Prob. F(13,89)	0.1175
Obs*R-squared	18.95498	Prob. Chi-Square(13)	0.1245
Scaled explained SS	37.42615	Prob. Chi-Square(13)	0.0004

Table 12: The result of White Test

The consequence of ignoring autocorrelation is that the coefficient estimates are inefficient, R2 is likely to be inflated and the distribution that is assumed for the test statistics will be inappropriate. Meanwhile, heteroskedasticity leads the OLS estimates no longer have the minimum variance and inappropriate statistics test.

Therefore ARMA model would like to be applied as a remedy to cure the problems. With the figure of correlogram of residuals, add different orders of ARMA into the previous model and test autocorrelation and heteroskedasticity for each model.

Firstly, we made a diagram autocorrelation of smooth sequence X:

Date: 05/22/14 Time: 21:32
Sample: 2005M07 2014M01
Included observations: 103

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.035	-0.035	0.1318	0.717
		2	0.064	0.062	0.5637	0.754
		3	0.069	0.074	1.0847	0.781
		4	-0.065	-0.065	1.5530	0.817
		5	0.138	0.126	3.6535	0.600
		6	-0.242	-0.238	10.201	0.116
		7	0.006	-0.007	10.205	0.177
		8	0.144	0.162	12.572	0.127
		9	-0.052	-0.003	12.877	0.168
		10	0.004	-0.066	12.879	0.231
		11	0.056	0.114	13.253	0.277
		12	-0.131	-0.192	15.307	0.225

Table 13: The result of autocorrelation model

To further illustrate the data is stability, test unit root again, it can be seen the value of ADF is less than all the critical value. Thus, it can be proved that the time series is smooth.

P	1	2	3	4	（2,4）	（1,3）
Q	1	2	2	4	4	（1，3）
AIC	8.5420	8.534	8.4354	8.3672	8.4281	8.4284

Table 14: Different AIC for p,q

Dependent Variable: Y
Method: Least Squares
Date: 05/22/14 Time: 22:56
Sample (adjusted): 2005M11 2014M01
Included observations: 99 after adjustments
Convergence achieved after 29 iterations
MA Backcast: 2005M07 2005M10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-23.08835	44.27017	-0.521533	0.6033
X7	2.400265	0.672358	3.569924	0.0006
X19	9.207357	4.936101	1.865310	0.0655
X22	55.52748	30.76228	1.805051	0.0746
X26	-8.306357	2.965118	-2.801358	0.0063
AR(1)	-0.375976	0.090524	-4.153330	0.0001
AR(2)	0.762910	0.095663	7.974970	0.0000
AR(3)	-0.278128	0.081633	-3.407069	0.0010
AR(4)	-0.569769	0.075586	-7.538056	0.0000
MA(1)	0.471592	0.018501	25.48955	0.0000
MA(2)	-0.963038	0.026762	-35.98557	0.0000
MA(3)	0.434734	0.018428	23.59052	0.0000
MA(4)	0.952013	0.014346	66.36163	0.0000

R-squared	0.424788	Mean dependent var	-0.680464
Adjusted R-squared	0.344526	S.D. dependent var	18.44787
S.E. of regression	14.93564	Akaike info criterion	8.367232
Sum squared resid	19184.32	Schwarz criterion	8.708005
Log likelihood	-401.1780	Hannan-Quinn criter.	8.505109
F-statistic	5.292510	Durbin-Watson stat	1.953506
Prob(F-statistic)	0.000001		

Inverted AR Roots	.67-.56i	.67+.56i	-.85+.17i	-.85-.17i
Inverted MA Roots	.74+.64i	.74-.64i	-.98-.15i	-.98+.15i

Table 15: The result of ARMA Model

DW statistic in the vicinity of two, there is no residual first-order autocorrelation, but need for further analysis of residuals

Date: 05/22/14 Time: 22:58
Sample: 2005M11 2014M01
Included observations: 99
Q-statistic probabilities adjusted for 8 ARMA term(s)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.017	0.017	0.0294	
		2	0.095	0.095	0.9594	
		3	-0.029	-0.032	1.0470	
		4	-0.063	-0.072	1.4649	
		5	0.005	0.014	1.4680	
		6	-0.030	-0.018	1.5637	
		7	0.091	0.087	2.4581	
		8	-0.219	-0.226	7.7233	
		9	-0.077	-0.089	8.3797	0.004
		10	0.030	0.086	8.4794	0.014
		11	-0.108	-0.102	9.8144	0.020
		12	0.086	0.047	10.661	0.031

Table 16: The result of new autocorrelation model

As can be seen from the figure, no longer exists residuals autocorrelation, indicating a good model fit, fit figure below：

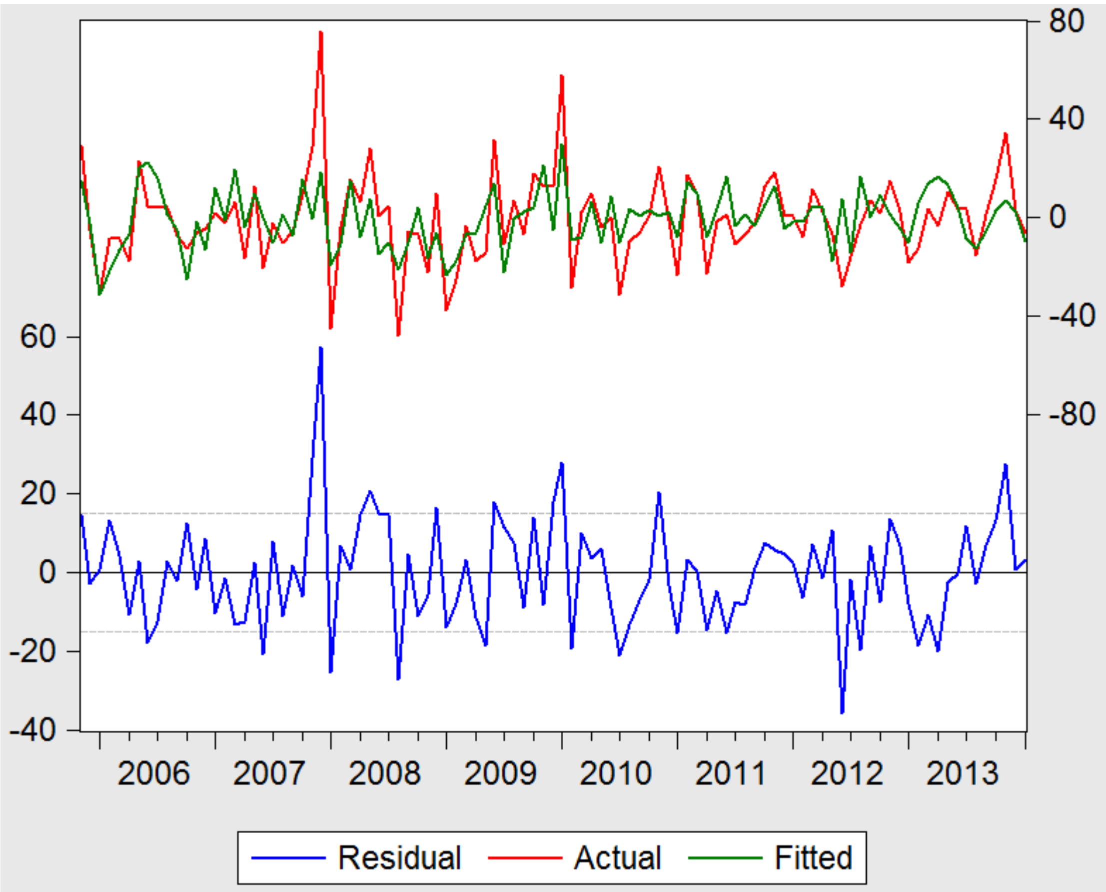

Chart 4: The result of new autocorrelation test

4.1.7 Normality Test

The last assumption is that u_t is normally distributed. This assumption is required if we want to inferences about the population parameters from the sample parameters. When u_t is normally distributed, the skewness of residual is 0 and the kurtosis of residual is 3.In our project, we use JB statistics which should asymptotically follow $\chi^2(2)$ to make sure if u_t is normally distributed. The formula is showed as follow.

$$JB_{asy} \sim \chi^2(2)$$

$$JB = \frac{n}{6}\left[S^2 + \frac{1}{4}(K-3)^2\right] \sim \chi^2(2)$$

If JB is smaller than $\chi^2_{\partial}(2)$, then u_t follows normal distribution.

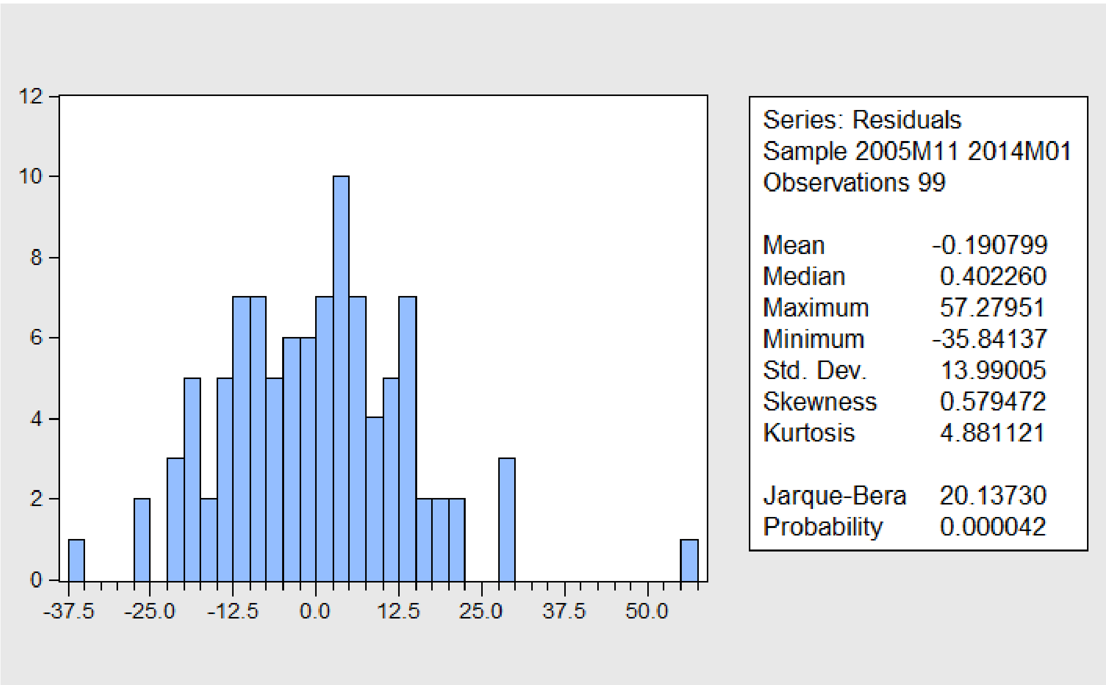

Chart 5: Normality Test

The skewness of residual is 0.58 and the kurtosis of residual is 4.88 which are both near those of normal distribution. JB (3.68) is smaller than 5.99 which is the critical value of $\chi^2(2)$ when the significant level is 5%. So the u_t in our project is normally distributed.

4.1.8 Ramsey`s Reset Test

We have previously assumed that the appropriate functional form is linear. To test if the assumption is true, Ramsey's Reset Test will be applied by adding higher order terms of the fitted values into an auxiliary regression.

Ramsey RESET Test:

F-statistic	6.721299	Prob. F(2,84)	0.0020
Log likelihood ratio	14.69622	Prob. Chi-Square(2)	0.0006

Table 17: Ramsey Test

4.2 BDTI TD15 Forecast

For now, we can use the ARMA(4,4) model to forecast the BDTI TD15 data.

Forecast graph is below:

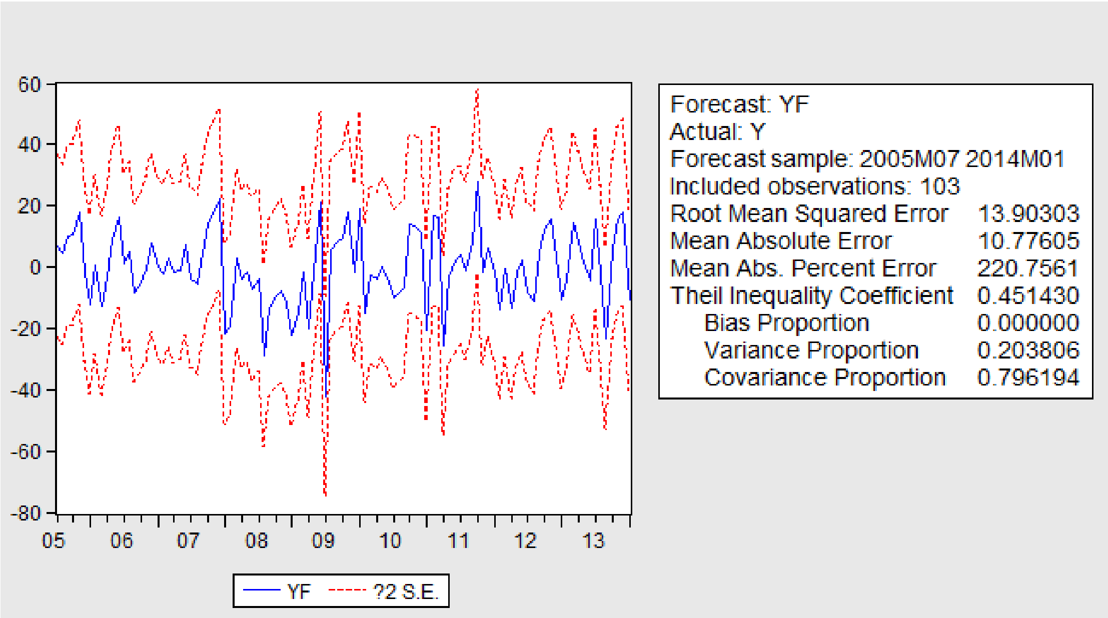

Chart 6: Forecast graph

The solid line represents the predicted values of BDTI TD15, the two dotted lines provides a 2 sigma confidence interval. The right figure is a list of some of the standard evaluation predictable, such as the average squared prediction error sum of squares (RMSE), Theil inequality coefficient and its decomposition. As can be seen, Theil is 0.45, the covariance proportion is 0.79. It can be proved that the model has a good predictive ability and the forecast results are in an acceptable range

In order to assess the ARMA (4, 4) model more intuitively, here is the fitting diagram of forecast and actual data:

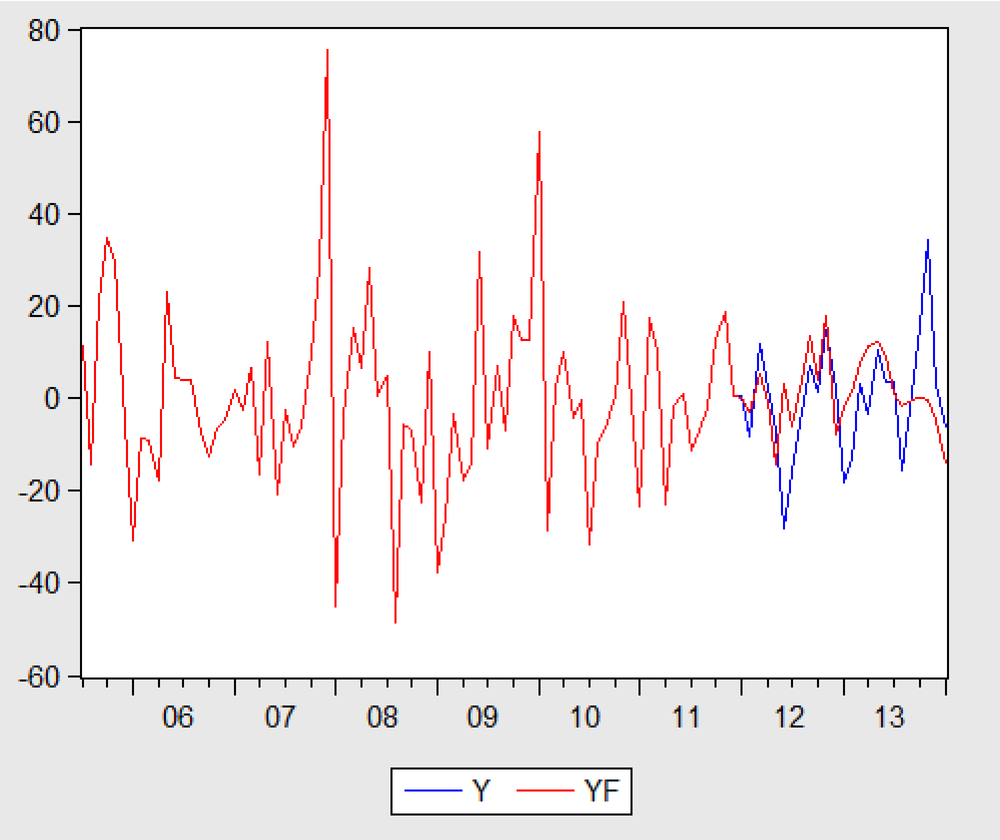

Chart 7: The fitting diagram of forecast and actual data

We can see that from 2005 to 2011, the forecast data and actual data is fully fit, which illustrates our model has the ability to predict BDTI TD15. After 2011, the forecast data line is more volatile than the actual data line, the reason of this part should considered the economic adjustment in China during the economy recovery, and further develop cooperation relations between China and countries in South Africa.

4.3 Analysis

Nowadays, the study of BDTI worldwide is considered the relationship between BDTI and influenced factors based on demand-supply side, mainly considered from five side: International oil tanker capacity, Global seaborne trade of crude oil, International oil tanker new order, International oil tanker scrapping, International oil deliveries. There five factors, respectively, represents the capacity of crude oil supply, transport demand, the new shipbuilding market, demolition and second-hand ship market changes. In this paper, the result is that there are four factors have a significant impact on BDTI: Mid-East Oil Production, Dummy2 (June, December), Exchange Rates China, and Average VLCC Long Run Historical Earnings. We can see that, except Dummy2 (June, December) randomness, the other four factors actually represent crude oil supply, shipping demand and Economic market change, respectively. In this article, the used data are collected from Oil demand & supply, Oil price, World economy, Shipping Capacity and Freight Earnings, largely in line with the need of general research considering the impact factors of BDTI. A concrete analysis of this paper shows that, the object of study is one of the specific routes, so considering influence factors to conform to the course of specific trade between countries. Although, the impact factors such as oil tanker capacity, oil tanker scrapping and oil tanker new order are in the considering factors, the conclusion of this paper is more in line with BDTI TD15.

5. Conclusion

5.1 Main Conclusion

For the world crude oil transportation market, it is complex and affected by a large number of market factors. Basing on the demand and supply in the oil market, the paper selected China - South Africa route, introducing the current situation of the world's crude oil transportation markets, including crude oil demand the market and oil tanker market.

This paper select Baltic Crude Oil Freight Index, China - South Africa route as the research object, using the traditional econometric model - Autoregressive Integrated Moving Average Model(ARIMA forecasting model), which is the most commonly used economic models for time series, and its linear characteristics of time series analysis fitting predicted to get better results. The model presents that BDTI TD15 is significantly influenced by Mid-East Oil Production, Dummy2 (June, December), Exchange Rates China, and Average VLCC Long Run Historical Earnings, which means: 1) The increase and decline of Mid-East Oil Production can change the crude oil market from South Africa to China; 2) Every year in June or December, there is change for crude oil market on the route from South Africa to China, but it is not sure that in June/December, the crude oil freight price could grows or not; 3) With the value developing of RMB, the BDTI TD15 will be more and more benefit for Chinese shipping company; 4) There is a correlation between BDTI TD15 and Average VLCC Long Run Historical Earnings, as the only type of vessel on the route from South Africa to China for crude oil seaborne trade, VLCC fleet could impact the BDTI TD15 deeply. Comparing the forecasting data with actual data, it is sure that ARMA (4, 4) model can correctly forecast BDTI TD15 from July 2005 to June 2011, even during the economic crisis. We believe that if there are more useful data, adding more dummy variables, such as risk variables, social variables and politic variables, the forecasting results of BDTI TD15 would be more fitted with the real market.

5.2 Recommendation

There are still some deficiencies in the study, mainly in the following areas:

A. This paper introduces the world's crude oil transportation market is more general, factors not considered exhaustive, other indicators of maritime transport market, or have a greater impact on the international shipping market events, especially China and South Africa, the two domestic economic policies the adjustment did not develop a detailed description of the data.

B. During the quantitative study, there is lack of adequate data. Reliability of the research is mostly from the full support of the part of data, especially for crude oil transportation market, which is long cycle and regularity is not strong, to be study. The data is from July 2005 to January 2014, which is not enough; this also has a certain extent, to effect the accuracy of the study.

C. Forecasting method is not perfect In this paper, we use economic models ARIMA model to predict freight index for crude oil, but crude oil transportation market is a complex non-simple evolution market. For crude oil freight index, such high-noise, non-stationary sequence, only linear analysis and forecasting cannot get good results, although the overall trend broadly in line with the actual, but the model does not reflect the financial crisis, the impact of national economic policy adjustment factors, and international development relations, resulting in a pre-beta phase error is larger, finally can affect the whole prediction.

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List of Tables & Charts