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The Volatility in the Dry Bulk Panamax Segment

by

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Abstract

The world dry bulk shipping is characterized as a volatility industry and especially after the long lasted peak of 2003 the market is much more perplex. This research paper's aim is to find and analyze the volatility of the dry Panamax sector. This study is based on quantitative analysis using the Eviews 7 software. A sample of 2908 daily and 140 monthly observations of daily earnings of various Panamax routes and 1587 daily observation of the contract prices of the Forward Freight Agreements were used. The sample periods were from 1 November 2002 to 27 June 2014 and from 1 August 2007 to 2 December 2013 for the daily index, monthly index and the FFAs respectively. Applying the descriptive statistics measurements a brief overview has been obtained of the distribution of the indexes. With the application of the EGARCH there is an asymmetry impact between past shocks and current volatility. Moreover the volatility reacts differently to positive and negative shocks and the time needed for the volatility to respond to changes. Finally an analysis between the FFA contract and the underlying asset has been conducted. The analysis of these results will be useful to for ship owners/managers and charterers in the dry Panamax sector to increase their profits and mitigate their risks

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List of Abbreviations

ADF- Augmented Dicker Fuller Test

ARCH- Autoregressive Heteroscedastic Model

BCI-Baltic Capesize Index

BDI- Baltic Dry Index

BFI- Baltic Freight Index

BHSI-Baltic Handysize Index

BIFFEX- Baltic International Freight Futures Exchange

BPI –Baltic Panamax Index

BSI- Baltic Supramax Index

CAPM- Capital Asset Pricing Model

CoA- Contract of Affreightment

ConRo- Container Roll on, Roll off Ship

DWT- Deadweight Tones

EGARCH- Exponential Generalized Autoregressive Heteroscedastic Model

EMH- Efficient Market Hypothesis

FFA- Forward Freight Agreements

FFABA- Forward Freight Agreements Broker Association

GARCH- Generalized Autoregressive Heteroscedastic Model

IMO-International Maritime Organization

OTC- Over The Counter

SS- Screw Steamer

T/C- Time Charter

TGARCH- Threshold Generalized Autoregressive Heteroscedastic Model

USD- United States Dollar

VLOC- Very Large Ore Carrier

YEN- Japanese YEN

1 Introduction

1.1 Background

Shipping is a worldwide industry that is widely accepted as the lifeline of the international trade. This is based on the fact that 90% of the international trade is facilitated by the sea, as a result of the morphology of our planet. Another reason is that transportation by sea is probably the cheapest way to transport goods. This is a result of the technological developments in the vessel design and construction which promote the economies of scale of larger ships. Therefore, the markets of raw material and final goods have been expanded and helped the industrialization of many countries (i.e. China). (Haralambides, 2007)

Referring to the merchant shipping we can say that it is a sector which is involved in the transportation by sea and with all the associated services. The main scope of the merchant shipping is the transportation of cargoes and passengers. In contrast to other sectors of the economy the shipping sector is far away from been characterized as homogeneous. It is a group of different markets which are influenced by the cargo, the vessel type, the requirements of the sea routes and the geographical area. Stopford gives in Rochdale Report a definition of shipping

"Shipping is a complex industry and the conditions which govern its operations in one sector do not necessarily apply to another; it might even, for some purposes, be better regarded as a group of related industries. Its main assets, the ships themselves, vary widely in size and type; they provide the whole range of services for a variety of goods, whether over shorter or longer distances. Although one can, for analytical purposes, usefully isolate sectors of the industry providing particular types of service, there is usually some interchange at the margin which cannot be ignored." (Stopford, 1997)

This definition clarifies, several aspects of the shipping world. Firstly, it emphasizes on the importance of separating the economic from the commercial operation. For instance liner shipping transports totally different product (finished goods, semi-finished goods), provides different services and it has a totally different economic structure compared to the bulk shipping sector. Secondly, the shipping sector should be treated as a single market, because a lot of companies operate in both bulk and liner sector for example, many ships are designed to offer their services in many sectors (i.e. ConRo ships). For this reason we should not consider the shipping market as a group of segregated subsectors.Finally because of its international nature, shipping is significantly influenced by factors like the worldwide economic and political situation both on national and international level.

Bulk shipping is probably the most simple and straightforward sector in shipping. Bulk shipping's main notion is to reduce the transport costs by carrying as many goods as possible in simply designed ships. This dates back to the ancient times when the Greeks, Egyptians and Romans used ships to carry goods like olive oil and grain around the Mediterranean. Coal was the main driver based on which the industrialization in England begun. It was then, when one of the first steam driven colliers was built. Colliers are considered to be among the first modern dry bulk vessels.

A unique example was the iron hulled, water ballasted and steam screw propulsion John Bowes with a carrying capacity of 650 tons of coal, which was the first collier and probably the most successful. (Chronicle, 2004). Since the 19th century the volume of the seaborne trade has increased dramatically but only small changes can be observed in the design of bulk carriers. Nowadays around 5000 bulk carriers' trade around the world representing one third of the total fleet. (IMO, 2014) The success of the bulk industry lies on the fact that the cost is extremely low. According to (Stopford, 1997) *"Bulk transport has been so successful at reducing costs that coal can be shipped across the world for much the same price per ton as it would have cost 125 years ago."*

Since the building of the first ocean going steamship the SS Savanah almost two centuries ago in 1818 (Chapelle, 1961), shipping can be characterized by intelligence, professionalism, profits and disasters. From the rise of the successful Greek ship-owners like Onassis and Latsis, to disasters with the intentional sinking of ships to gain money from the insurance companies. Also the shipping according to many ship-owners/operators is not just cargo trading but also ship trading. For instance during period 1986-1992 the value of a five year old Panamax rose from $5.5m in 1986 to $24.25m in 1991. This rise of 341% gave the opportunity to many ship owners/operators to increase their wealth. (Stopford, 2008) However shipping is not a rose-strewn path, as the periods crisis in shipping are not few and usually are very harsh, with dramatic decreases in the freight rates and in the values of the ships leading to losses for the ship owners/operators.

1.2 Scope of Research

The peak period of the world bulk shipping market has been from 2003 until mid-2008 with an increase of 300% in the freight rates. However, this remarkable increase was followed by a big drop reaching historically low levels and this can depict that the markets are much more complex than before. Obviously the freight rates are highly related with the earnings and therefore with the profit of the ship owners/operators and the charterers. The owner can charter his ships on the spot market, in which case he accepts full market risk, or time charter which shifts that risk to the charterer. It is obvious that freight rates have a significant variability because of changes in factors that affect them. However this variability gives the incentive to people to get involved with shipping industry as this means higher opportunities for profit but also possibilities of losses. In other words high volatility increases the risk that the parties face. Numerous factors strengthen this high volatility in the market and lead industry to find means to reduce risks. This volatility made imperative the use of freight derivatives. In the past the freight derivatives market concerned mainly the participants of the physical freight who were seeking to hedge their risks. Nowadays there is a shift, with more and more people (i.e. hedge funds, investment banks and other traders) who are not trading in the underlying physical market, investing in the freight derivative market leading to the commoditization of the freight market. (Alizadeh & Nomikos, 2009). Consequently each shipping company tries to survive in a sequence of booms, recessions and depression.

1.3 Objective

The purpose of this study is to provide a clear up to date estimation of the volatility of the dry bulk industry Freight Rates and Forward Freight Agreements (FFAs'), but focusing more specifically on the Panamax type vessels and the corresponding freight indexes and FFAs'. The understanding of this context will give a clear insight in the structure of this particular segment of the dry bulk market

1.4 Research Question

This thesis will focus on investigating how volatile is the dry bulk shipping industry of Panamax type vessel. The approach will be based on finding variance of various indexes of the Baltic Panamax Index and of the FFAs average 4TC contract prices. This thesis is explanatory, based on secondary data from electronic databases. Therefore, the main research question is:

"How volatile is the Panamax Dry Bulk Shipping Industry?"

In order to answer the main research question, which is quite general a series of sub research questions have been posed. These sub research question are:

What is the volatility of spot index?

What is the volatility of spot index settlement (monthly average)?

What is the volatility of daily closing prices of FFA contract prices?

1.5 Thesis Structure

The remainder of this thesis is organized as follows.

Chapter 2

This chapter aims to examine the related literature review and it is divided into two parts. The first part deal with the volatility and risk of the shipping industry describing past researches. Whereas the second part gives a brief description of the freight derivatives and the interaction they have with the market.

Chapter 3

The main target of this chapter is to provide the reader with the main definitions that will be used and also to give a brief overview of how the market functions.

Chapter 4

In this chapter we will discuss the methodology used. The basics of the methodological approach will be presented as well as the software and the characteristics of the statistical and econometric model that were used.

Chapter 5

Description of the dataset and preliminary statistical analysis.

Chapter 6
Analysis of the results obtained in relation to research question.

Chapter 7

Discussions and conclusions. A brief summary of the research is presented, as well as the answer to the research question, the unexpected findings and the limitations.

2 Literature Review

Pricing in shipping services or in other words shipping freight markets is determined by the interaction of supply and demand for freight services. (Kavussanos, 2001).In particular demand is influenced by several factors like the economy of the commodities transported, world economic activity and macroeconomic variables related to the economy. (Stopford, 1997) On the other hand supply of shipping services is related to the stock of the fleet available for trading, the shipbuilding production, the scrapping rate and losses (physical supply), the fleet productivity and level of freight rates in the market. (Alizadeh, 2011) Consequently, obviously the freight rates are determined by the demand and supply for shipping services. Until 2008 freight rates had a huge increase but due to the financial crisis this resulted in a slump of the rates.

The dry bulk cargo shipping market has a significant role in the international shipping market representing the one third of the whole market. Moreover, it is characterized as a submarket with high risk and volatility because it is related to the uncertainties caused by factors such as the volume and pattern of world trade, the global economy and government policy. (Lu Jing, 2008) These macroeconomic variables are in many cases non-stationary, following seasonal patterns. [(D.R., 1990), (Beaulieu, 1992), (Dickey, 1993)] and of course some commodities like grains and petrochemicals are characterized by seasonality (Kavussanos, 2001). From the ship owner's/operator's and charterer's perspective significant volatility is unattractive as it can possibly disturb the cash flow and the profits earned by the trade and the operations. In the business world, especially in shipping, which is a high risk industry uncertainty is one of the major factors influencing the decision-making process. Business risk is described as the possible fall in a shipping company's value due to shifts in variables that affect profitability. The risks can be divided into two categories, the risks caused by operating cash flows and the risks cause by the changes in the market value of assets. (Stefan Albertijn, 2011). The risks caused by operating cash flows include the freight rate risk, operating costs and counterparty risk. In more detail freight rate risk concerns the variability of the freight rates which are the major source of income for the shipping companies. The volatility of the operating costs is also a risk for the companies. Manning, repairs and maintenance, stores and lubes, insurance and administration are examples of operating cost. The cost of fuel ("bunkers") is related to the voyage costs and is the most important as it constitutes the 50-60% of the total operating costs depending on the type of the vessel. (Council, 2008) Furthermore, changes of the interest rates and exchange rates are risky for the shipping companies, as most of the financing in shipping is done with floating rates and in US Dollars. The relation between the parties is crucial, the two parties must trust each other and they must both fulfill their obligations. The probability that one of the two parties does not fulfill its contractual agreements constitutes the counterparty risk. Counterparty risk is highly correlated with the volatility of the freight rates, which means that high volatility increases the counterparty risk. As far as the risk from changes in the market value of assets is concerned the fact that an increasing number of shipping companies are listed, obliged them to report the value assets increasing the transparency. Finally we cannot omit the pure risk which refers to a decrease of the value of a vessel due to accidents, physical damage and losses. (Stefan Albertijn, 2011) Therefore, we can observe from the aforementioned that the most important risk derives from the volatility in freight rates, like the Baltic Freight Index which indicate one of the most volatile indexes. According to Xu, Yip and Marlow *"Freight volatility denotes the variability or the dispersion of the freight rate"* (Jane Jing Xu, 2011). High volatility indicates more fluctuations on the freight rates and therefore, more uncertainty. Consequently it is of paramount importance to calculate that risk and try to minimize it. (Alizadeh, 2011)

The BFI as it reflects the volatility of the market draw the attention of researchers who tried to identify the cause of that volatility using of econometrical models. In particular, using the Dickey-Fuller test for the monthly rates of three panama routes for the period from September 1983 to August 1993 Veenstra and Franses concluded that the existence of long term relationship between freight rate series does not meliorate the forecasting which confirms the efficient market hypothesis (EMH). The term EMH means that the prices includes all the information and are determined by that information.

In his article Tvedt (Tvedt, 2003) argues that freight rates in the dry bulk market and the vessels prices are relatively stable. With the use of statistical tools and test on time series data of the freight rates, the random walk hypothesis is not accepted most of the times. Therefore, the results show the existence of traditional market models, which means that the freight rates might be stationary. In particular Tvedt by converting the prices from USD to YEN, came to the conclusion that the prices become less variable, a fact that is observed on any type of vessels (handymax, panamax and on a small scale in capsize).[1] This empirical results confirm what the traditional model states. High freight rates increase the demand for new building and more intensive use of the already existed tonnage and low freight rates leads to lay up and scrap of ships.

The market of dry bulks is influenced by the Asian market as far as the demand of shipping services and the construction of new ships is concerned. As mentioned above in the shipping industry the USD is mainly used in transactions. This research concludes that analyzing the transactions in USD is misleading and probably prices expressed in YEN reflect better changes in the markets, making them more reliable data for the researchers.

Xu et al (Jane Jing Xu, 2011) examine the relation between the time-varying freight rate volatility of dry bulk freight rates and the change of the supply of fleet trading in dry bulk markets. The authors examined the volatility of the freight rates against changes in the size of the fleet and some other variables of the market for the period January 1973–October 2010. Using AR-GARCH model for the calculation of the volatility and the GMM regression to figure out the relation between the freight volatility and the fleet size they concluded that first of all the freight rates are time-varying and secondly the volatility depends on the fleet size with a positive correlation. There have been several others attempts to understand the characteristics of the time-varying freight volatility. (Kavussanos, 1996), (Lu Jing, 2008).

The Capital Asset Pricing Model (CAPM) is a widely acceptable model in the risk management economics, a model which can be wrapped in a phrase "high risk means high returns". However risk cannot be easily determined and calculated but is highly correlated with the state of the market. Under normal conditions with a slow and

[1] However this statement is not in accordance with the author's opinion. A decrease in the volatility might arise for Japan based companies

expected growth in trade, the changes of the fleet's size reflect steady growth conditions and the freight market comes to an equilibrium. If a surge in the demand occurs the freight rates will unexpectedly rise, leading to a rise in the physical supply. The increasing uncertainty for the future need in ships and the risk of over tonnage leads to an extended period of unbalance. The freight rate risk is an issue of great importance for shipping. Kavussanos extended the AutoRegressive Conditional Heteroskedasticity (ARCH) model to examine the volatility of spot rates and the time charter rates. From the model Kavussanos observed that time charter rates are more volatile and more risky than spot rates in the dry bulk market and bigger size ships are characterized as more volatile than smaller ships. (Kavussanos, 1996)

Lu et al (Lu Jing, 2008) using the General AutoRegressive Conditional Heteroskedasticity (GARCH) model for Capesize, Panamax and Handymax vessels, confirm the time-varying behavior of the freight rates and examines the volatility of the dry bulk market for different vessel types. The authors aim to focus on the empirical results of the different vessels types and the asymmetry of the volatility under different circumstances. In particular they examine the daily spot rates for the period 01/03/1999-23/12/2005 proving that shocks do not have the tendency to decrease and the volatility reacts differently according to the changes in the bulk market because of the distinct flexibility.

The importance of recognizing the dynamics of freight rate volatility and understanding changes when estimating volatility is significant. This is known as volatility clustering and was first approached by Mandlebrot (Mandelbrot, 1963) in the stock market, finding that small rise changes have the tendency to be by followed small prices changes and vice versa. The variability of other economic and financial time series attract many researchers who tried to model that behavior. For example Klein (Klein, 1977) investigated the importance of uncertainty regarding the rate of price change, where price uncertainty was measured by the variability of the rate of price change. Klein understood these dynamics of stocks with the use of a rolling sample method. Engle (Engle, 1982) was the first to introduce a solid econometrical model of the variance of a time series. Engle introduced an autoregressive conditional heteroscedasticity model (ARCH) model using the square of lagged disturbances. In the linear regression models the residuals ε_t must be (IID) which means that the residuals are independent, normally distributed, with the mean equaling zero (μ=0) and constant variance [$\varepsilon \sim IN(0,\sigma^2)$]. Also $V(\varepsilon_t)=\sigma^2$ Assuming that the y_t is the dependent variable, $x_{1,t}$ to $x_{p,t}$ explanatory variables of the regression, ε_t are the residuals and α_0, $\alpha_1 \ldots \alpha_p$ are the parameters.

$$y_t = a_0 + a_1 x_{1.t} + \cdots + a_p x_{p.t} + \varepsilon_t$$

This model however is not complete as the variance is not always constant and the residuals are not homoscedastic. According to Engle the variance σ^2 of the dependent variable can be derived from the following equation

$$\sigma_t^2 = \beta_0 + \sum_{i=1}^{p} \beta_i \varepsilon_{t-i}^2$$

With $\beta_0>0$ and $0<\Sigma\beta_i<1$ and i=1….m are the parameters of the lagged error terms.

According to Bollerslev (Bollerslev, 1986) the ARCH model can be over parameterized. He introduced a more simple model know as General Autoregressive conditional heteroscedasticity model (GARCH). In particular in GARCH the variance depends on both the lagged squared error terms and the lagged values of variance.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} a_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p'} \beta_i \sigma_{t-j}^2$$

Where the parameters must not be negative q>0, p≥0, $\alpha_0>0$, $a_i \geq 0$(i=1,….. ,q) and $\beta_i>0$ (i=1,….,p'). Moreover for the theory of finite-dimensional ARCH process,$\sum_{i=1}^{q} a_i + \sum_{i=1}^{p'} \beta_i < 1$ in order to have a defined conditional variance.

The term β_i shows the dependence of the variance to its lagged values. It is worth mentioning that if the α_i is not statistical significant the variance is constant, a fact that it is also observed in the ARCH model. The terms p and q determine the number of lagged error and variance respectively and the model can be presented as GARCH (q,p) and ARCH(q). The most common GARCH model is the GARCH (1,1)
It is commonly known that different shocks in an economy influence differently the volatilities of times series. For instance negative shocks have different impact than positive shocks even the same weight; a phenomenon known as leverage effect. (Stephen Figlewski, 2000). Although GARCH models handle lagged residuals with symmetrical effect on the variance, this model leads to biased results and unreliable forecast in case we have leverage effect. This asymmetric impact of shocks to volatility concerned Glosten et al (Lawrence R. Glosten, 1993). To solve that problem Glosten et al add an extension to the GARCH model, hence they add a dummy 9(d_t) to the equation. In particular d_t=1 when the shock is negative (ε_t<0) and d_t=0 when ε_t>0 (positive shock), this model is known as TGARCH.

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} a_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p'} \beta_i \sigma_{t-j}^2 + \gamma d_{t-1} \varepsilon_{t-i}^2$$

However according to (Nelson, 1991), ARCH and GARCH models have three major drawbacks. First of all GARCH models do not take into account the non-positive relation between current and future returns in contrast to the findings from previous studies, relation which was proved to exist. Secondly, the restrictions for the parameters are usually not taken into account as these restrictions immensely restrain the capabilities of the models. Finally, often these models are misleading depending on whether the shocks are persisting or not. Nelson proposed an extension to the GARCH models as a solution to the aforementioned setbacks named as EGARCH which will be analyzed on Chapter 4.

From all the above it is obvious that ship owners/operators and charterers are exposed to significant volatility of the earnings and expenses (freight rates). In order to mitigate the risk from the early 1980's freight derivatives were used. The first example was the Baltic International Freight Futures contract (BIFFEX) as a hedging instrument.

However examples of derivatives can be found even in the ancient times Aristotle in his "*Politics*" refers to Thales a philosopher from Miletus, who purchased olive presses, taking advantage of his talent to forecast the olive trees production.

The freight derivatives have been little analyzed compared to other derivatives. However, several studies have been conducted. Kavussanos and Nomikos studied how biased the BIFFEX contracts were. According to (Kavussanos & Nomikos, 1999) one month and two month BIFFEX contracts are unbiased estimators of the rates in the spot market and also according to Haigh the three month BIFFEX contract is also an unbiased estimator of the spot market (Haigh, 2000). One of the major reasons why the BIFFEX contracts were abandoned was that although ship owners knew about that contracts and understood the mechanism, they had doubts about the effectiveness as a hedging tool. Similarly surveys have been conducted in order to understand how useful the Forward Freight Agreements are. According to (Kavussanos, et al., 2007) based on a survey posed to 31 Greek ship owners, who were aware of the FFAs' although the shipping derivatives and risk management are at a primitive stage. In order to adapt these new tools the business strategy of the companies must change so that the new risk management concepts can be materialized. The main setbacks are the lack of knowledge and education (Dinwoodie & Morris, 2003) and also the existence of liquidity and credit risk. Whether a financial derivative is successful or not depends on the capability to accomplish its task I, which in this case is the price discovery and risk management. If the derivatives fulfill both these economic functions it will be beneficial to the parties. On the other hand if the derivative fails it will eventually be unattractive and the derivative will no more be traded. Also (Dinwoodie & Morris, 2003) through a questionnaire to 22 tanker ship owners from seven countries concluded that FFAs' was well known hedging tool but most of them haven't used it as they were concern about the default risk of these forwards and the counterparty risk they will might face if they use them. Another important issue is the pricing of futures and FFAs' as mispriced derivatives means investment opportunities for the investors (arbitrage). However (Kavussanos & Visvikis, 2004) identify that freight services are non-storable as the underlying commodity of freight futures contracts and FFAs', eliminate the arbitrary possibilities and are leading to the pricing of this contracts. According to (Alizadeh & Nomikos, 2009) the price of FFA contracts is determined based on the expectations of the economy's market agents regarding the spot prices that will be settled at the end of the contract. The relationship between the forward prices and the expected spot prices and the lead-lag relationship in variance and rate of return of spot and forward prices have been examined for various routes of the BPI. [the Atlantic voyage route P1 (US Gulf/Antwerp–Rotterdam–Amsterdam), the Atlantic time-charter route P1A (Transatlantic round to Skaw–Gibraltar range), the Pacific voyage route P2 (US Gulf/Japan) and the Pacific time-charter route P2A (Skaw Passero–Gibraltar/Taiwan-Japan]. Using cointegration techniques and in particular VECM framework (Kavussanos, et al., 2004) analyzed the unbiased expectations of the forward prices. Therefore up to two months before the expiry date FFAs' give unbiased prediction of the realized spot prices. However, three months before the maturity FFA prices are good estimators for P2 and P2A routes but for P1 and P1A FFA prices are biased. (Kavussanos & Visvikis, 2004) studied the lead-lag relationship between the spot and the forward markets regarding the volatility and the returns. Causality tests showed that there is a bi-directional causal relationship among spot and FFA prices, short-term dynamics and price movements which were examined using VECM model.

Another issue is the forecasting ability of the freight derivatives. A Box-Jenkins methodology to the BFI was applied (Cullinane, et al., 1999) for the period 1993-1996 compared to the period 1985-1988 in order to examine whether there have been major changes to the BFI since the removal of the handysize routes from the estimation variables of the BFI. Furthermore a comparison between the partial autocorrelation function and the autocorrelation function for the period before and after 1993 revealed a small deviation. Thy concluded that with the changes in the weightings and the composition of the routes the BFI was not affected significantly. Derivatives can be used as tools to mitigate risks.

Finally (Kavussanos, et al., 2004) "investigate the impact of the introduction of Forward Freight Agreement (FFA) trading on spot market price volatility in two panamax Atlantic (1 and 1A) and two panamax Pacific (2 and 2A) trading routes of the dry-bulk shipping industry" using GJR-GARCH type model. The results showed that the introduction of the FFAs' in the market decreased the spot rate volatility in all the above routes, influenced the asymmetry of volatility in the Pacific routes and enhanced the flow of information in terms of speed and quality for P1, P1A and P2 routes. Furthermore, after inserting control variables in only the voyage routes P1 and P2, the volatility decreases as a result of the onset of FFA. These results do not give a clear answer, however whether the decrease in spot rate volatility in the routes P1A and P2A is due to the FFA trading. Taking into concern all the aforementioned, we can realize that the volatility of the freight rates and the freight derivatives is a quite significant issue of the shipping industry. Therefore, relevance of the research question posed in Chapter 1.4 is high and tackle with it, offers a valuable knowledge for all the affected parties.

3 What is the Dry Bulk Industry?-A Brief Description

The aim of this chapter is to give an insight to the reader about the main definitions that we will face in this thesis. All the transactions on seaway transportation are negotiated under the freight market. According to Stopford the freight market is a marketplace in which sea transport is bought and sold. (Stopford, 1997). The freight market in other words determines the freight rate (price) for the transportation of a commodity under certain agreements like voyage contracts, time-charter contracts and Contract of Affreightment (CoA). Risk management is crucial in a business sector like shipping where seasonality, volatility of prices and capital intensiveness are some of the major characteristics. (Kavussanos & Visvikis, 2006). The risk management (hedging) can be accomplished through the use of derivatives, which do not include transaction of commodities but where only cash flows are traded.

The physical market consists of three major parties, the ship-operator, the charterer and the broker. The ship owner is an entity which owns a vessel or part of a vessel and his main goal is to maximize the earnings by providing transport services to the charterers. However, it is not mandatory that a ship owner manages his vessel. There are ship management companies that own or charter vessels aiming to gain income by providing freight services. The charterer's purpose is to move commodities from an origin A to a destination B. Dry bulk commodities are commodities which are shipped in large unpacked quantities. The dry bulk commodities are divided into two categories, major bulks commodities like iron ore, coal and grain and minor bulks such as sugar, cement and fertilizers. Generally as bulk shipping mainly transports raw materials which are essential inputs for the industrial production facilitates the production. (Stopford, 1997, p. 229). The two parties usually come into an agreement with aid of a broker. Broker's main function is to bring the cargo and the carrier together. The role of the three participants will be analyzed further on this chapter.

3.1 Dry Bulk Market

The dry bulk market is usually segregated into various separate submarkets according to the vessels design like the Very Large Ore Carriers (VLOC's), Capesize, Post Panamax, Panamax, Supramax, Handymax and Handy vessels.

Table 3.1: Bulk Carriers sizes

Vessel Type	Deadweight Tons (DWT)	Holds	Gears
Handysize	20,000-35,000	4	25-35 tons Cranes
Handymax	36,000-49,000	5	25-35 tons Cranes
Supramax	50,000-64,000		25-36 tons Cranes and Grabs
Panamax/Kamsarmax	65,000-82,000	7	Usually Gearless
Post Panamax	87,000-115,000	7	Gearless
Capesize	120,000-200,000	9	Gearless
VLOC	220,000-400,000	9	Gearless

Source: (Exchange, 2014)

Handysize vessels is a classification of ships with a Dead Weight Tonnage (DWT) less than 64,000 tons. Handysize vessels usually carry minor bulk cargoes. The Handysize category includes the Supramax vessels with a carrying capacity of which varies between 50,000-64,000 DWT, followed by vessels with a DWT 36,000-49,000 named Handymax. The smallest group of vessels is the Handy vessels which are able to carry 20,000-35,000 tons. Usually the Handysize, Supramax and Handymax vessels are the ships geared, which means that the ships are equipped with cranes.

The second category is the Panamax, which are the largest vessels that can pass through the Panama Canal locks. This means that the vessels must have a length less than 275 meters and a breadth of 32.31 meters maximum, leading to a carrying capacity of around 65,000 tons. Additionally, the Kamsarmax refers to a new type of vessels that are suitable for berthing at the Port of Kamsar, the length of that vessels is limited to 229 meters (Ships.gr, 2014) and are suitable to transport 82,000 DWT.

The third category includes ships between 87,000 and 115,000 DWT and it includes ships larger than the Panamax and therefore they are not capable to pass through the Panama Canal and for this reason are called Post-Panamax vessels.

Capesize vessels or ‘Capes” are ships with a cargo-carrying capability from 120,000 up to 200,000 DWT. Regularly Capes service the ore and iron markets between Australia/Indonesia and Asia, Brazil to EU and Asia and South Africa to EU and Asia. As long as the Capesize vessels are restricted due to their size to cross the Panama Canal, they transit via Cape Horn (South America) or the Cape of Good Hope (South Africa) from where they take their name.

Finally, the largest bulk carriers are the Very Large Ore Carriers (VLOC) or Chinamax and Valemax. These ships can carry up to 400,000 DWT and they mainly serve the Chinese market. However the Baltic Exchange defines different categories for the dry cargo indices. In particular, the Handysize, the Supramax, the Panamax and the Capesize vessels, where each of this type corresponds to a different index. The Baltic

Handysize Index (BHSI), the Baltic Supramax Index (BSI), the Baltic Panamax Index (BPI) and the Baltic Capesize Index (BCI) respectively.

In this thesis we will deal with the Panamax category and consequently with the vessels of this category. The BPI is calculated based on four different routes for a ship of 74,000 DWT nor over 12 years, a maximum length overall of 225 meters, a draft of 13.95 metres and a speed of 14 knots.

Table 3.2: Baltic Exchange Ship Definitions

Vessel Type	DWT (Grain Capacity)	Gears
Handysize	28,000 dwt (37,523 cbm)	Cranes
Supramax	52,454 dwt (67,756 cbm)	Cranes and grabs
Panamax	74,000 dwt (89,000 cbm)	Gearless
Capesize	180,000 dwt (198,000 cbm)	Gearless

Source: (Exchange, 2014)

3.2 Baltic Dry Index (BDI)

The daily average price to ship raw materials is reflected in the Baltic Dry Index. In particular it is the cost that a shipping company has to pay in order to transport raw materials by sea. Based on US dollars the BDI is probably affected by fluctuations in the value of this currency. The index calculates the demand for shipping capacity in relation to physical supply of dry bulk vessels. Indirectly the BDI reflects the global demand and supply of materials and product transported by dry bulk vessels. (McMorris, 2009)

The BDI index is since November 1st 1999 the successor of the Baltic Freight Index (BFI). From July 1st 2009 the BDI is calculated as follows:

$$BDI = \left(\frac{BCITCavg + BPITCavg + BSITCavg + BHSITCavg}{4}\right) * 0.110345333$$

Where:

- BCI= Baltic Capesize Index
- BPI= Baltic Panamax Index
- BSI= Baltic Supramax Index
- BHSI= Handysize Index
- TCavg= Time Charter Average

For example in 11 August 2014 the rates where the following and by using the above equation, we derived the BDI index.

Table 3.3: BDI calculation

BCI Tcavg	BPI Tcavg	BSI Tcavg	BHSI Tcavg	BDI
9654 $/day	5042 $/day	8564 $/day	5448 $/day	792

3.2.1 Baltic Capesize Index (BCI)

The BCI freight rate is used to understand the freight market of the capesize vessel and it is constituted of four voyage routes and five time charter routes with different weighting for each route as depicted in Table 3.4. The unit of measurement is for the voyage route US$/ton and for the time charter routes is the US$/day.

Table 3.4: Composition of BCI

Route	Route Description	Vessel Size	Cargo	Weighting
C8-14	DeliveryGibraltar-Hamburg range, laydays/cancelling 3/10 days from index date, transatlantic round voyage, redelivery Gibraltar-Hamburg range, duration 30-45 days.	180,000 mt	T/C	25%
C9-14	Delivery ARA range or passing Passero, laydays/cancelling 3/10 days from index date, redelivery China-Japan range, duration about 65 days.	180,000 mt	T/C	12.5%
C10-14	Delivery China-Japan range, laydays/cancelling 3/10 days from index date, redelivery China-Japan range, duration 30-40 days	180,000 mt	T/C	25%
C14	Delivery Qingdao spot or retroactive up to a maximum 15 days after sailing from Qingdao, round voyage via Brazil, redelivery China-Japan range, duration 80-90 days	180,000 mt	T/C	25%
C16	Delivery North China-South Japan range, 3-10 days from index date for a trip via Australia or Indonesia or US west coast or South Africa or Brazil, redelivery UK-Cont-Med within Skaw-Passero range, duration to be adjusted to 65 days	180,000 mt	T/C	12.5%

Source: (Hoogwerf, 2014)

3.2.2 Baltic Panamax Index (BPI)

The BPI index consists of four time charter route equally weighted and it concerns Panamax type vessels. The unit of measurement of the time charter route is US$/day and the BPI in index points is shown table 3.5

Table 3.5: Composition of BPI

Route	Route Description	Vessel Size	Weighting
P1A_03	Transatlantic (including ECSA) round of 45–60 days on the basis of delivery and redelivery Skaw Passero range	74,000 mt	25%
P2A_03	Basis delivery Skaw Passero range, for a trip via Gulf to the Far East, redelivery Taiwan–Japan range, duration 50–60 days	74,000 mt	25%
P3A_03	Transpacific round of 35–50 days either via Australia or Pacific (but not including short rounds such as Vostochy/Japan), delivery and redelivery Japan/South Korea ran	74,000 mt	25%
P4A_03	Delivery Japan-South Korea range for a trip via US West Coast-British Columbia range or Australia, redelivery Skaw-Passero range with a duration of 50-60 days	74,000 mt	25%

Source: (Exchange, 2011)

3.2.3 Baltic Supramax Index (BSI)

For the freight market of the supramax dry bulk vessels of a maximum of 10 years of age, the BSI gives a clear view of the market. The BSI contains two voyage routes and four time charter routes. The unit of measurement of the time charter route is US$/day, of the voyage route is US$/ton and of the BSI in index points table 3.6

Table 3.6: Composition of BSI

Route	Route Description	Vessel Size	Weighting
1A	Delivery Antwerp-Skaw range for a trip of 60-65 days redelivery to Singapore-Japan range including China. 5 per cent total commission. Laycan (Laydays cancelling) 5-10 days in advance.	52,454 mt	12.5%
1B	Delivery passing Canakkale for a trip with a duration 50-55 days redelivery to Singapore-Japan range including China. 5% total commission. Laycan 5/10 days in advance.	52,454 mt	12.5%
2	Delivery South Korea-Japan range for 1 Australian or trans Pacific round voyage, for a 35-40 day trip, redelivery South Korea-Japan range 5% total commission. Laycan 5/10 days in advance	52,454 mt	25%
3	Delivery South Korea/Japan range for a trip of 60/65 days redelivery Gibraltar/Skaw range 5 per cent total commission. Laycan 5/10 days in advance.	52,454 mt	25%
4A	Delivery US Gulf for a trip about 30 days, redelivery to Skaw – Passero range, 5 per cent total commission. Laycan 5/10 days in advance.	52,454 mt	12.5%
4B	Delivery Skaw – Passero range for a trip about 30 days, redelivery to US Gulf, 5 per cent total commission. Laycan 5/10 days in advance.	52,454 mt	12.5%

Source: (Exchange, 2011)

3.2.4 Baltic Handysize Index (BHSI)

The BHSI index has six time charter routes with different weighting and it concerns the Handysize type vessels. The unit of measurement of the time charter route is US$/day and of the BHSI in index points as table 3.7 shows.

Table 3.7: Composition of BHSI

Route	Route Description	Vessel Size	Weighting
1	Delivery Skaw – Passero for a trip about 35-45 days, redelivery to Recalada – Rio de Janeiro range. 5 per cent total commission. Laycan 5/10 days in advance.	45,500 mt	12.5%
2	Delivery Skaw - Passero range for a trip about 35-45 days, redelivery Boston – Galveston range. 5 per cent total commission. Laycan 5/10 days in advance	45,500 mt	12.5%
3	Delivery Recalada – Rio de Janeiro for a trip about 35/45 days, redelivery to Skaw – Passero range. 5 per cent total commission. Laycan 5/10 days in advance.	45,500 mt	12.5%
4	Delivery US Gulf for a trip about 35/45 days, via US Gulf or NC South America, redelivery to Skaw – Passero range. 5 per cent total commission. Laycan 5/10 days in advance.	45,500 mt	12.5%
5	Delivery SE Asia for a trip via Australia, about 25/30 days, redelivery Singapore – Japan range including China. 5 per cent total commission. Laycan 5/10 days in advance.	45,500 mt	12.5%
6	Delivery S Korea – Japan range for a trip via Nopac of about 40/45 days, redelivery Singapore-Japan range including China. 5 per cent total commission. Laycan 5/10 days in advance.	45,500 mt	12.5%

Source: (Exchange, 2011)

3.3 Shipping Freight Contracts

A shipping freight contract is a transportation agreement between the ship owner and the charterer for a certain amount of dollars per day or per cargo ton, commonly known as hire or freight rate. A formal contract between a ship owner and the charterer, is called a “charter party”. The name is derived from the Latin, 'Charta Partita', (literally 'divided document'). The charter party is a document which includes specific contractual agreements. There are several types of charter contracts and which can be classified into five different categories.

- Voyage charter contracts
- Time-charter contracts
- Trip-charter contracts
- Contracts of affreightment (CoA)
- Bareboat charter contracts.

3.3.1 Voyage Charter

A voyage charter is a contract, where the ship owner/ship operator signs to transport a cargo from port A (loading port) to port B (discharge port) and as a reward the ship-owner receives an amount of money expressed in US dollar per ton. This kind of contract is also known as spot contract. Under this kind of contract the ship owner is liable for all the expenses that will arise during the voyage. In particular these costs are the operating costs, the voyage cost, the capital cost and the cargo handling costs. (Alizadeh & Nomikos, 2009) In order to be able to compare a voyage charter and a time charter in financial terms the transformation of the freight from $/ton to $/day is suggested. This can be accomplished with the use of the Time Charter Equivalent of spot rates (TCE). The TCE is calculated by dividing the total earnings of a voyage by the days of the voyage. The earnings derive difference between the product of the spot rate and the amount deducted by the total voyage costs.

3.3.2 Time Charter

In this agreement the vessels are hired for a specific time period. This period can vary from 6 months to 10 years. Under a time charter the crew is employed by the owner, who is also responsible for the nautical operation and maintenance of the vessel and the supervision of the cargo and the charterer is liable for costs directly connected with the use of the vessel, for example, bunker costs and port charges, and pays for the loading and discharge. Therefore, the ship owner benefits from a permanent fixed income during the time charter period. The time charter contract on the other hand gives to the charterer the resilience to use the ship for several voyages, this means that the charterer has the commercial control of the ship.

3.3.3 Trip Charter

Under a trip charter agreement the charterer hires the vessel for a specific trip hence, the charterer is responsible from the loading port to the discharge port. The charterer pays the voyage costs and the ship owner the non-operational costs covering the ship owner against any fluctuations in the bunker fuel price as the charterer pays all the bunker costs. When a ship owner agrees on a trip charter contract is paid on a dollar per day basis ($/day), securing him in that way if any delay will occur. Contrary to a voyage contract where the charterer is charged on a $/ton basis and the ship owner cannot recompense for any delays.

3.3.4 Contracts of affreightment (CoA)

Under a contract of affreightment an agreement between the ship owner and the charterer is signed to transport an exact amount of cargo over a longer period for a fixed price per ton. This kind of contract is commonly used when the charterer needs to transport a large amount of cargo which cannot be handled on a single voyage. This gives to the ship owner the flexibility to arrange the series of voyage to use his vessels in the most efficient way. For instance, the ship owners can also transport cargo on the ballast trips to increase his revenues. This type of contract mainly facilitates the transport of iron ore and coal to the steel mills in Europe and Far East (Stopford, 1997)

3.3.5 Bareboat Charter

Finally when a charterer wants to have the total control of a vessel without owning it, the bareboat charter is the most suitable choice. Under this contract the charterer is responsible to run the vessel and also pay all costs except the capital costs. This scheme is suitable for investors who buy a ship and do not have any experience on shipping. Freight rates are normally paid on a $/day basis monthly. However bareboat contracts are only financial agreements and have no impact on the freight market.

3.4 Shipping derivatives

The shipping derivatives are financial derivatives whose value depends on or derives from the value of freight indexes and routes which are daily published. The shipping derivatives are financial contracts between two parties, for the transportation of a cargo by sea for a predetermined price. These contracts do not include the actual transportation of the underlying cargo and they are cash settled contracts. The settlement is different for each contract and it depends on the maturity which varies from a month to a year, the type of the contract (i.e. time charter, voyage charter etc.) and the market for instance dry bulk, wet bulk or container.

The main types of shipping derivatives are the following:

- Freight Futures
- Forward Freight Agreements (FFAs)
- Freight Options
- Containers Freight Swap Agreements

3.4.1 Participants in freight derivatives market:

The significant changes in the freight rates made imperative the use of financial tools in order to have a more efficient risk management for the parties that are involved in the shipping sector. In particular the ship owners/operators and the charterers use those financial products targeting to cover their position against the freight volatility and including the brokers they represent the three main participants in the freight derivative market. The increase of the volume and the value of the international trade, led to the increase of interest in the shipping derivatives because the majority of the goods are transported by sea (Chatman, et al., 2013).

Ship owners/operators

The ship owners/operators use the shipping derivatives in order to cover themselves against a decline to the freight rates. In particular by using shipping derivatives, they can balance their cash flows by choosing a freight rate at the moment, in order to be covered against future fluctuations in the freight rates. For instance a ship owner/operator who is active in the route Richards Bay to Rotterdam (route C4 of BCI) suspects that in June the Capesize freight rates will fall due to the seasonality that the dry bulk markets face in the summer (Grammenos, 2010, p. 332). Therefore, by selling a July Forward Freight Agreement for the C4 route, he is protected from the decrease on the anticipated freight rates (short position).

Shipping companies with a large fleet, also use these derivatives in a speculative way, hoping future changes in the freight rates. Especially by using the market power they have. A ship owner/operator who owns only one Capesize vessel does not have the same power as a ship owner/operator who owns or operates a fleet of 50 Capes. Moreover a ship owner/operator can take advantage of the period until the delivery of a new ship by using effectively the shipping derivatives. For instance if a company had ordered a VLOC of 300.000 dwt which is due to be delivered in June, the company should have already arranged a time charter contract for a year. Thus in April the ship owner/operator can buy a future contract for the remaining months.

Charterers

A charterer of a whole ship or of part of it, who might be the owner of the cargo or a third party carrier, takes the opposite position from the ship owner/operator in a transaction of shipping derivatives. The charterer aims to get covered against possible increases, to minimize his costs. Therefore the charterer will buy an FFA and he will have a long position. A charterer by issuing a time charter contract or a Contract of Affreightment for an extended period of time wants to be protected against the variability of freight rates and especially against decreases of the freight rates. To mitigate the risk from a possible decrease in the freight rates, he can buy a put option or he can sell a call option offsetting in that way losses that he might have in the physical market. Finally it is worth mentioning that both the ship owners/operators and the charterers can gain profits by taking advantage of freight rate differences of ship types that are substitutes and compete for the same cargoes.(arbitrage), for example Panamax and Supramax

Brokers

The role of a broker is to function as an intermediate, bringing together the buyer and the seller. The broker accomplishes his task by having a clear knowledge of the situation of the market. In particular brokers should have insight concerning the cargoes, their quality, limitations and their owners and the ship's specifications and the market trends, fluctuations and developments. Moreover a broker should have exceptional negotiating skills. (Lafranca, 2012). Brokers like Clarkson's Securities Ltd, Simpson Spence and Young Ltd and Freight Investor Services Ltd do not have a position in the market but they simply facilitate the transactions benefiting their clients. Their target is to find the best possible offer of the market for the client with a brokerage fee as a return.

The role of an FFA broker includes also the analysis of the of the freight market. The FFABA forward curves assess the FFAs contract prices and offer an estimation of the futures prices. These estimations are conducted by the members of FFABA and are submitted at a daily basis at 17.30 GMT to the Baltic Exchange for both the dry and the wet bulk market. (Exchange, 2014). The Baltic Exchange then publishes the forward curve for the dry and wet bulk market. In particular for the Capesize vessels for six different routes and for the average 4TC of the BCI(see table 3.4), for Panamax vessels for the routes 4TC, P2A and P3A (see table 3.5), for the Supramax class for the BSI T/C average and for the Handysize also for the BHSI T/C average(see table 3.6 and 3.7). In the wet bulk market, we have an estimation for a number of clean and dirty market routes. (Exchange, 2014)

The need for faster transactions in combination with the use of electronic screen platforms (i.e. Baltex), terminated the telephone communication between the brokers and the traders, which had a lot of drawbacks like delays in transaction and also was communication errors.

Clearing Houses

Due to the fact that more and more contracts are not now cleared in the stock exchange the existence of the clearing house is of paramount importance. The clearing houses are the central counterparty, whose function is to act as buyers for each seller and as sellers for each buyer. The clearing houses have the following advantages.

- Eliminate the credit risk, securing that the transaction will be completed even if one of the parties defaults. In that case the Clearing house will take over the obligations of the defaulted party, by closing or transferring open position. It is worth mentioning that none of the members is influenced. As far as the closing of open positions is concerned the clearing house uses the initial margin contribution of the defaulted party.
- Increase the liquidity in the market due to the fact that decreasing risks attract more investors.

- A central counterparty provides anonymity and eliminates the need for credit evaluations of the various counterparties.
- Transparency and consistency of pricing for margin and funds settlements as the price is same for all the contracts. (Culp, 2010)

The clearing of the shipping derivatives was a “demand” of the market and especially of the Forward Freight Agreements, which are not exchanged in the stock market, in order to diminish the credit risk from these contracts. These new types of contracts are called hybrid FFAs and they combine the advantages of the futures and of the forward positions by eliminating the counter-party credit risk, the multi-lateral transaction netting and by improving operational and capital efficiency across multimarket positions. (Kavussanos & Visvikis, 2006) The clearing houses that are available are:

- London Clearing House (LCH)
- The Norwegian Futures and Options Clearing House (NOS)
- Singapore Exchange (SGX)
- Chicago Mercantile Exchange (CME)

3.4.2 Forward Freight Agreement (FFA)

Forward freight agreement is “an agreement to buy or sell a freight rate (contract price) today for a future date whereby the payment (settlement price) is based upon an agreed route or an index prevailing at the time of shipping” (Lafranca, 2014) and the underlying assets are the freight rates. With the FFA’s it is possible to cover and minimize the market risk. According to Baltic Exchange “*An FFA is a swap agreement between two principals where agreement is struck for the value of the contract on an agreed future date*.” (Exchange, 2014). The settlement price is not calculated in the same way but it depends on the contract that is adopted so that FFAs can facilitate short and long term contracts, for instance for a voyage charter the average of the last week of a month of the Baltic Capesize Index or the Baltic Panamax Index represents the settlement price. In the case of the Time charter the monthly average of the BCI, BPI, BHMI and BSI denotes the settlement price. (SGX, 2014). According to the Alizadeh and Nomikos for some routes it is more favorable to use these derivatives due to the fact that the freight rates of these routes are more volatile than others, for example in the Panamax market these route are BPI 4TC, BPI P2A and BPI P3A. (Alizadeh & Nomikos, 2009)

The first type of FFA’s is commonly known as over the counter derivatives (OTC) or swaps and are tailor made derivatives. The other type consists of derivatives known as futures or cleared contracts. (Milburn, 2006). Through the OTC the agreement is conducted based on trust between the counterparts, while with the cleared derivatives the two parties are relying on the clearing houses taking out some of the risk leading to a 95% of the agreements to be cleared. (Lafranca, 2014). There are two ways the forward freight agreements can be traded over the counter or with an exchange such as the International Maritime Exchange (IMAREX). The OTC trade is facilitated by the mediation of a specialized broker, on a basis of a principal to principal contract or with the use of a standardized contract like FFABA or through a clearing house. On the other hand trading with exchange gives the possibility to trade with a screen which provides standard contracts, cleared immediately. (Grammenos, 2010)

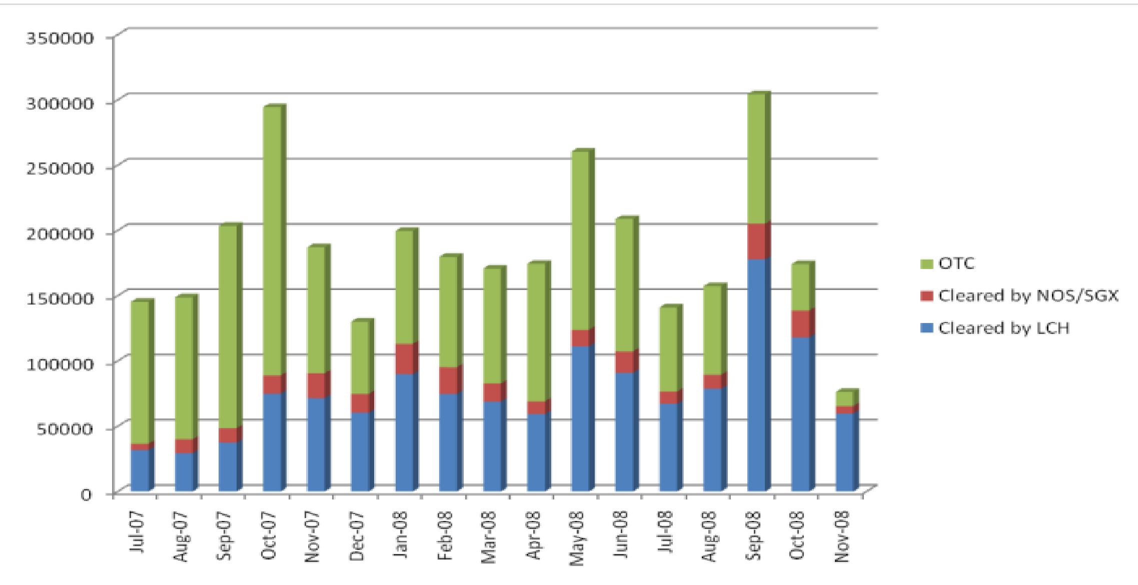
The Forward Freight Agreement Brokers Association (FFABA) formed in 1997 is an independent association of FFA broking Baltic Exchange members aiming to promote the FFA trading and connect all the parties. The main goals of the FFABA according to Baltic Exchange are to:

- Promote the trading of Forward Freight Agreements (FFAs)
- Promote high standards of conduct among market participants
- Liaise with the Baltic Exchange to ensure the production of high quality indices for use by the freight futures industry
- Provide a forum for brokers and principals to resolve problems as they arise
- Develop and promote the use of standard contracts
- Develop the use of other 'over the counter' and exchange traded derivative products for freight risk management (Exchange, 2014)

3.4.3 Credit Risk and the Emergence of Cleared FFAs'

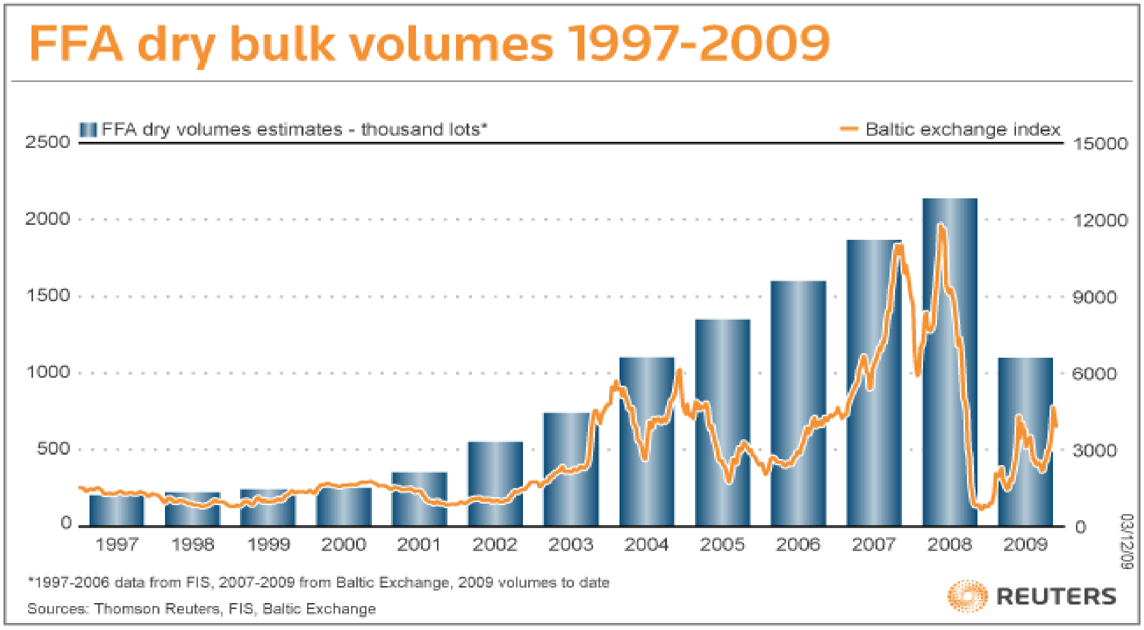
In 1992 the Clarkson started to use the FFAs contracts as a more sophisticated derivative than the BIFFEX. The FFAs have as an underlying asset individual routes of the Baltic Freight Index and consequently are a more efficient tool to decrease the freight rate risk exposure compared to the BIFFEX contracts whose underlying asset was the BFI. The increasing volume of FFAs' compared to the freight futures in the stock market IMAREX and NUMEX and the financial crisis of 2008 made clear that the OTC contracts have a significant disadvantage the credit risk. This decreased the volume of OTC FFAs' and led to a drastic shift towards the cleared or hybrid FFAs which are cleared through a clearing house diminishing the default risk. In the following figures the monthly variance of the Forward Freight Agreements of the dry bulk market is presented for the period July 2007 to November 2008

Figure 3.1: FFA Cleared Contracts Volume



Source: (Kurek-Smith, 2008)

Figure 3.2: FFA Contracts volume



Reuters graphic/Scott Barber

Source: (Manley , 2009)

4 Methodology

The methodology is the most crucial parts of this thesis. The aim is to use the data in such a way that they produce reliable results. The target is to answer in the simplest and most efficient way the main research questions and the sub questions posed on chapter 1. This is accomplished with a quantitative approach through statistical analysis and econometrical models chosen based on the literature review. First of all a statistical analysis will be done concerning the indexes and following that and econometrical approach

The statistical analysis, gives us the ability to summarize and report in single numbers called descriptive statistics, information about the distributional properties of a variable or an asset. Through the descriptive statistics in particular, we can assess the dispersion, location and shape of the distribution. Examples of such measurements are the mean, the median, the mode, the variance, the coefficient of skewness and the coefficient of kurtosis. (Statistics, 2014)

4.1 Central tendency measurements (location)

The central tendency measurements are the indications and the information concerning which value, the variable will probably take or where the variable is most likely to be located. The central tendency of a variable can be measured in different ways with the average (mean) and the median being the most.

4.1.1 The arithmetic mean

The average value of a variable is reflected through the arithmetic mean of all the observations of a population or a sample. Although the average is the most used measurement, it is a biased index as it is influenced by extreme values due to the fact that the observation is equally weighted in the calculation of the average. The arithmetic mean is calculated in a different way for a population (μ) and for a sample ($\bar{\chi}$). (Leech, et al., 2007)

Table 4.1: Arithmetic Mean Equations

Population Mean	Sample Mean
$\mu = \frac{\sum_{i=1}^{n} x_i}{n}$	$\bar{\chi} = \frac{\sum_{i=1}^{N} x_i}{N}$

4.1.2 The median

The median of a number of observations sorted in an ascending order, is the arithmetic mean of the two middle values when we have an even number of data or of the value in the middle, in case we have an odd number of observations. The median is a relatively good location measurement for skewed data as it is not affected by extreme values. It give us a number close to the value of the sample or the population that is most frequent. However, the median is not taking into account all the values of the database as for its calculation only the middle values are used. Therefore, it is suitable for analyzing non numerical qualitative data. (Hempel, 2007)

4.1.3 The Mode

The value which appears most frequently in a database, a sample or a population is called the mode. Similarly to the median, the mode is a relatively good location measurement for skewed data as it is not affected by extreme values. It gives us a number close to the value of the sample or the population that is most frequent. However, the mode is not capable of taking into account all the values of the database and it might be difficult to interpret since there may be more than one mode in a data set. (Statistics, 2014)

4.2 Variability Measurements

Although it is useful to understand and have the information on the most probable values of a data set, sample or population, it is crucial to have a clear image of the degree of the dispersion or the variability of a value. There are several methods used to calculate the variability, for instance the variance, the standard deviation, the range, the interquartile range and the percentile range. From the abovementioned the most commonly used measurement for calculating and demonstrating the volatility and the dispersion of a sample or a data set is the standard deviation. (Education, 2014)

4.2.1 Variance and standard deviation

The variance is the average of the squared deviations of the observations from their arithmetic mean. Mathematically we can calculate the variance of a sample and a population, using the following formulae. An important factor is that the sum of the squared deviation in the sample variance is divided by the number of observation subtracted by one (n-1) and in the case of the population we divide by the total number of the observations (N). The reason is that a small sample may lead to statistical errors. Therefore, large samples tend to be more accurate and give results close to the population variance.

Table 4.2: Variance Equations

Population Variance	Sample Variance
$\sigma^2 = \frac{\sum_{i=1}^{N}(\chi_\iota - \mu)^2}{N}$	$S^2 = \frac{\sum_{i=1}^{n}(\chi_\iota - \bar{\chi})^2}{n-1}$

The main scope of the variance is to calculate the dispersion of the data around the arithmetic mean. A major setback of the variance is its unit of measurement due to the fact that the deviation from the mean is being squared. (Chatzinikolaou , 2002)

4.2.2 Standard Deviation

This setback can be avoided by the use of the standard deviation, which is the square root of the variance. This is the reason why the standard deviation is the most commonly used measurement as mentioned above because it has the same unit of measurement as the data set.

Table 4.3: Standard Deviation Equations

Population Standard Deviation	Sample Standard Deviation
$\sigma = \sqrt{\sigma^2}$	$s = \sqrt{s^2}$

Finally for the variability measurements two aspects should be taken into account. Firstly, for the calculation of the variance and the standard deviation it is more accurate to use the percentage changes (returns) of an index rather than the index itself. There are two ways (periodic returns and logarithmic returns) to estimate the returns and there are depicted in the table below. (Salkind & Rasmussen, 2007)

Table 4.4: Equation of Returns

Periodic returns	Logarithmic Returns
$r_t = \frac{P_t - P_{t-1}}{\lvert P_{t-1} \rvert} = \frac{P_t}{\lvert P_{t-1} \rvert} - 1$	$r_t = LN\left(\frac{P_t}{P_{t-1}}\right) = LN(P_t) - LN(P_{t-1})$

Secondly a common mistake that most of the researchers do is that they omit the period the data are published (i.e. daily, weekly, monthly, etc) and they report the dispersion measurement in a different period for instance annually. This mistake can be avoided by converting the data from one reporting period to another. For instance if we calculated the returns of the data for a specific period and we are aiming to analyze the annual data the following transformation can be followed.

Table 4.5: Transformation table

Period	Returns	Variance	Standard Deviation
Daily	$r_{yearly} = r_{daily} * 356$	${\sigma^2}_{yearly} = r_{daily} * 356$	$\sigma_{yearly} = r_{daily} * 356$
Weekly	$r_{yearly} = r_{weekly} * 52$	${\sigma^2}_{yearly} = r_{weekly} * 52$	$\sigma_{yearly} = r_{weekly} * 52$
Monthly	$r_{yearly} = r_{montlhy} * 12$	${\sigma^2}_{yearly} = r_{montlhy} * 12$	$\sigma_{yearly} = r_{montlhy} * 12$

Quarterly	$r_{yearly} = r_{quarter} * 4$	${\sigma^2}_{yearly} = r_{quarter} * 4$	$\sigma_{yearly} = r_{quarter} * 4$

4.2.3 Coefficient of skewness

The Fisher-Pearson standardized third moment or the coefficient of skewness is a statistic that provides us with information about the shape of the distribution. The coefficient of skewness is an indicator of how symmetrical is the variable around the mean. Therefore, a variable can be symmetrical and left or right skewed.

Figure 4.1: Left Skewed Distribution

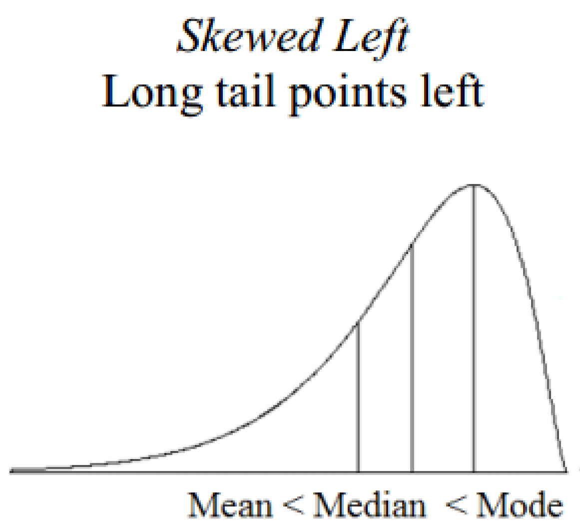


Figure 4.2: Symmetric Skewed Distribution

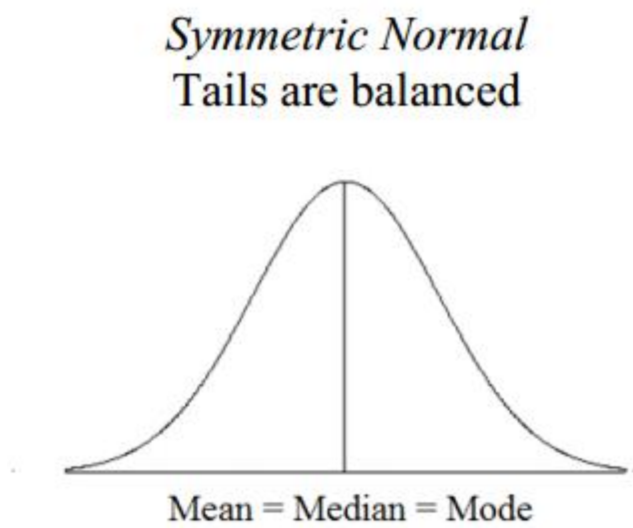
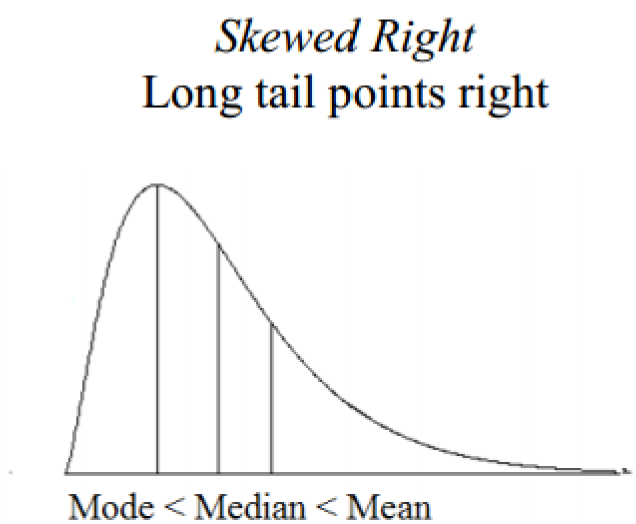


Figure 4.3: Right Skewed Distribution



Source: (Doane & Seward, 2011)

The coefficient of skewness can be estimated with the following equation.

$$\gamma = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^3}{\left(\sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2}\right)^3}$$

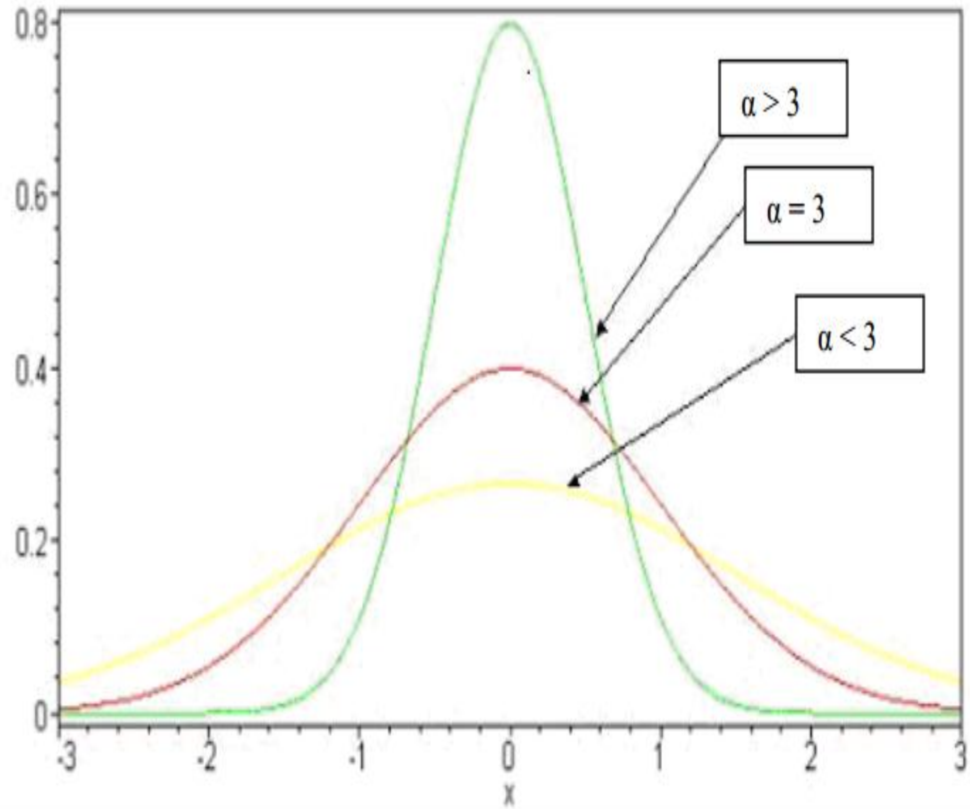
As already mentioned the estimated coefficient of skewness shows how symmetric is the distribution of a variable. In particular, if the estimated sample skewness is negative γ<0, then the distribution is positively skewed which means that the left tail of the distribution is longer and fatter compared to the right tail and the mean is greater than the median and the mode (Figure 4.2) Furthermore, in case the population skewness is zero, γ=0, the distribution is symmetrical around its mean. Consequently the left and the right tails of the distribution are exactly the same and the mean, median and mode are equal (Figure 4.2). On the other hand, if γ >0, the distribution is negatively skewed, therefore, the right tail of the distribution is longer and fatter compared to the left tail and the mean is greater than the median and the mode (Figure 4.3). (Diamantopoulos, 2012)

4.2.4 Coefficient of Kurtosis

The coefficient of kurtosis refers to the peakness of a distribution. In particular a distribution that has a relatively high maximum frequency and therefore a high concentration of variables around the arithmetic mean is named as leptokurtic a>3. On the other hand when the maximum frequency is low the distribution is called platykurtic a<3. Finally mesokurtic a=3 distribution is a distribution that is relatively similar with the normal distribution. The coefficient of kurtosis can be calculated from the following equation: (Fouskakis, n.d.)

$$\alpha = \frac{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^4}{(\sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \bar{x})^2})^4}$$

Figure 4.4: Distribution with different coefficient of kurtosis



Source: (Fouskakis, n.d.).

4.2.5 Coefficient of Variation

The coefficient of variation is a measure of the dispersion for a data set, a sample or a population, independent of the unit of measurement used for these. The main advantage of the coefficient of variation is that it gives the flexibility to compare distributions with different units of measurement. This elimination is accomplished by dividing the standard deviation by the mean. The higher the coefficient of variation the more dispersed the data is around the mean. (Herve, 2010)

Table 4.6: Coefficient of Variation Equations

Population Coefficient of Variation	Sample Coefficient of Variation
$CV = \frac{\sigma}{\mu}$	$CV = \frac{s}{\bar{x}}$

Usually we can express the coefficient of variation as a percentage as follows:

Table 4.7: Percentage CV

Population Coefficient of Variation	Sample Coefficient of Variation
$CV = \frac{\sigma}{\mu} * 100$	$CV = \frac{s}{\bar{x}} * 100$

For the above measurements the Microsoft Windows Excel software will be used based on the returns of each index.

4.3 Exponential Generalized Autoregressive Heteroscedastic Model (EGARCH)

For the econometric approach as already mentioned in chapter 2 the EGARCH (1, 1) model will be used to estimate the function of the volatility. The EGARCH is an asymmetric GARCH model that specifies not the conditional variance but the logarithm of the conditional volatility. The main advantage of the EGARCH model it is that allows the variance to respond differently to negative and positive shocks. In particular if a_j is negative then negative shocks tend to increase and vice versa. (Alizadeh & Nomikos, 2009). According to (Nelson, 1991) and (Malmsten, 2004) the EGARCH (p,q) is defined as a combination of the following equations.

$$ln\sigma^2{}_t = a_0 + \sum_{j=1}^{q} g_j(z_{t-j}) + \sum_{j=1}^{p} \beta_j ln\,\sigma^2{}_{t-j}$$

$$\varepsilon_t = z_t h_t{}^{1/2}$$

$$g_j(z_{t-j}) = a_j z_{t-j} + \psi_j(|z_{t-j}| - E|z_t|)$$

Combining these three equations:

$$ln\sigma^2{}_t = a_0 + \sum_{j=1}^{q}[a_j \frac{\varepsilon_{t-j}}{\sigma^2{}_{t-j}{}^{1/2}} + \psi_j(\left|\frac{\varepsilon_{t-j}}{\sigma^2{}_{t-j}{}^{\frac{1}{2}}}\right| - E\left|\frac{\varepsilon_t}{\sigma^2{}_t{}^{\frac{1}{2}}}\right|)] + \sum_{j=1}^{p} \beta_j ln\,\sigma^2{}_{t-j}$$

$$\Leftrightarrow \sigma^2{}_t = \exp(a_0 + \sum_{j=1}^{q} a_j \frac{\varepsilon_{t-j}}{\sigma_{t-j}} + \sum_{j=1}^{q} \psi_j(\left|\frac{\varepsilon_{t-j}}{\sigma_{t-j}}\right| - E\left|\frac{\varepsilon_t}{\sigma_t}\right| + \sum_{j=1}^{p} \beta_j ln\,\sigma^2{}_{t-j})$$

While $\sigma^2{}_t$is known as the conditional variance since it is a one period ahead estimate for the variance calculated on any past information the relevant z_t is a sequence of independent identically distributed random variables with zero mean and using as unit variance the parameters (a_0,a_j, ψ_j, β_j) $\in \mathbb{R}$. The magnitude effect or the symmetric effect of the model is represented by the ψj parameter which is also known as the "GARCH" effect. β_j determines the persistence in conditional volatility regardless of what is happening in the market. For instance the larger the β_j is the longer it takes for the volatility to decline. The leverage effect or the asymmetry is measured by the parameter α_j. In particular when α_j>0 negative shocks cause less volatility than positive shocks. On the other hand, when α_j<0 positive shocks are more influential to the volatility. Finally when α_j=0 the model is symmetric. (Lu Jing, 2008) . For the purposes of this thesis the EGARCH(1,1) model will be used. The EGARCH (1,1) model is the most commonly used model according to (Malmsten, 2004) The equation of the EGARCH(1,1) is the following:

$$\sigma^2{}_t = \exp(a_0 + a_j \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \psi_j (\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| - E \left|\frac{\varepsilon_t}{\sigma_t}\right|) + \beta_j ln\sigma^2{}_{t-1})$$

However the Eviews software uses a different specification of the EGARCH model. In particular the equation is the following:

$$\sigma^2{}_t = \exp(a_0 + a_j \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \psi_j \left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \beta_j ln\sigma^2{}_{t-1})$$

The Eviews specification differs from the Nelson's model. Eviews gives the availability to choose between normal, Student's t-distribution and the Generalized Error Distribution (GED) while Nelson assumes only GED. The two different estimations give identical estimates except from the a_0 coefficient

In this chapter a detailed description, of the methods that they will be used, was given. All the calculations will be based on the periodic returns of the daily and monthly earnings, as well as on the returns of the average contracts prices. Firstly we described all the basic descriptive statistics that they will give a briefly overview of the characteristics of the returns. However from the central tendency measurements due to the nature of the data, the mode measurement will probably not give a result as the data are continuous and it is not likely to repeat the same return value. Secondly and finally a thorough analysis of the EGARCH model including a presentation of the equations and the explanation of the coefficients. Also in combination with the literature review we can understand the advantages of this model, compared to other ARCH family models.

5 Data Description and Preliminary Analysis

The data set comprises daily observations of the spot freight rates for four Panamax routes, routes P1A (time-charter), P2A (time-charter), P3A (time charter) and P4A (time charter) and the average of the four time charter routes (4TC) (see table 3.5) It covers the periods from 01 November 2002 to 27 June 2014. As far as the monthly settlement is concerned, monthly freight rates of the same routes and the average of these route will be analyzed for the period between November 2002 and June 2014. These data have been provided by the Clarkson Shipping Intelligence Database. For the FFA contracts the average of the daily prices of all the possible maturities will be used for the period from 1 August 2007 to 2 December 2013. The contracts prices have as an underlying asset the 4TC index. This thesis focuses on that specific index as it represents the 98% of the dry market. (Polemis, 2014) These prices have been provided by Freight Investor Services. The data set has been compiled after the percentage returns have been extracted and Augmented Dickey- Fuller (ADF) test has been conducted to check whether the data are stationary.

5.1 Panamax Daily Prices

The first index that will presented is the daily average of the 4 time charter routes. In the figure 5.1 we present the prices of the observation, in the figure 5.2 the periodical returns are presented for the same index.

Figure 5.1: Panamax 4 T/C

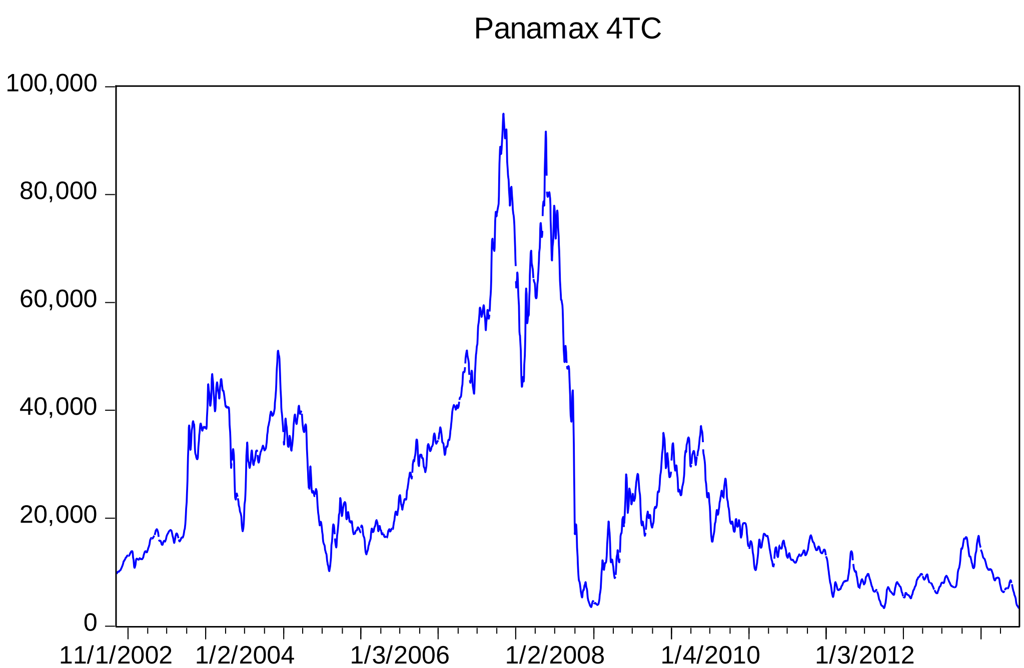
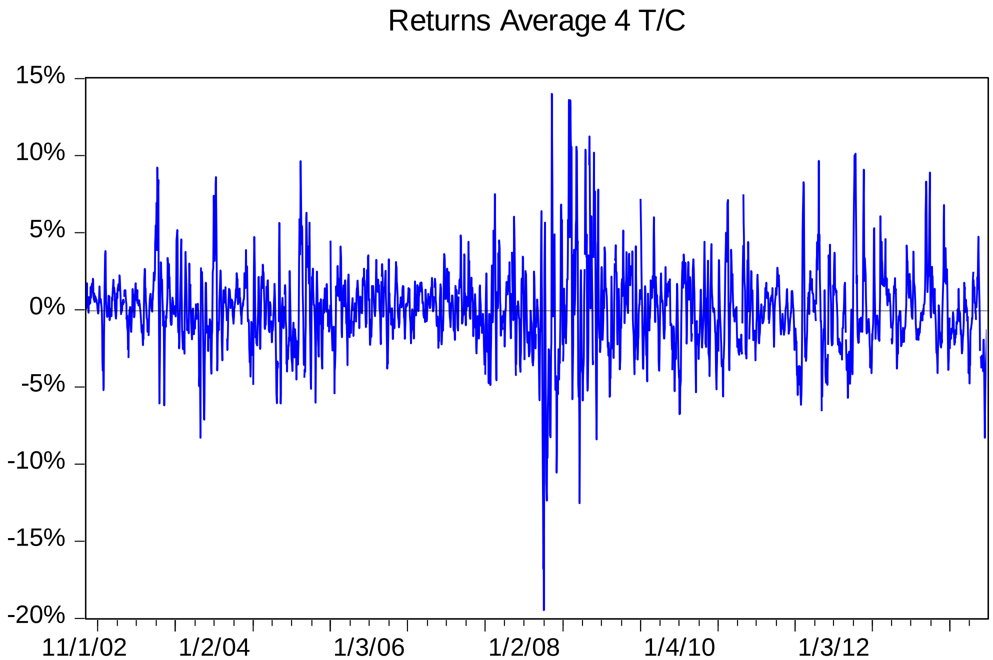


Figure 5.2: Returns Average 4 T/C



For the daily returns we run the ADF unit root test and the absolute value is of the t-statistics is greater (16.88) than every test critical value, therefore we reject the null hypothesis so the data are stationary. Secondly we can analyze the daily prices of P1A route. In particular in figure 5.3 and figure 5.4 we visualize the daily prices and the periodical returns respectively for the route P1A.

Figure 5.3: Panamax P1A

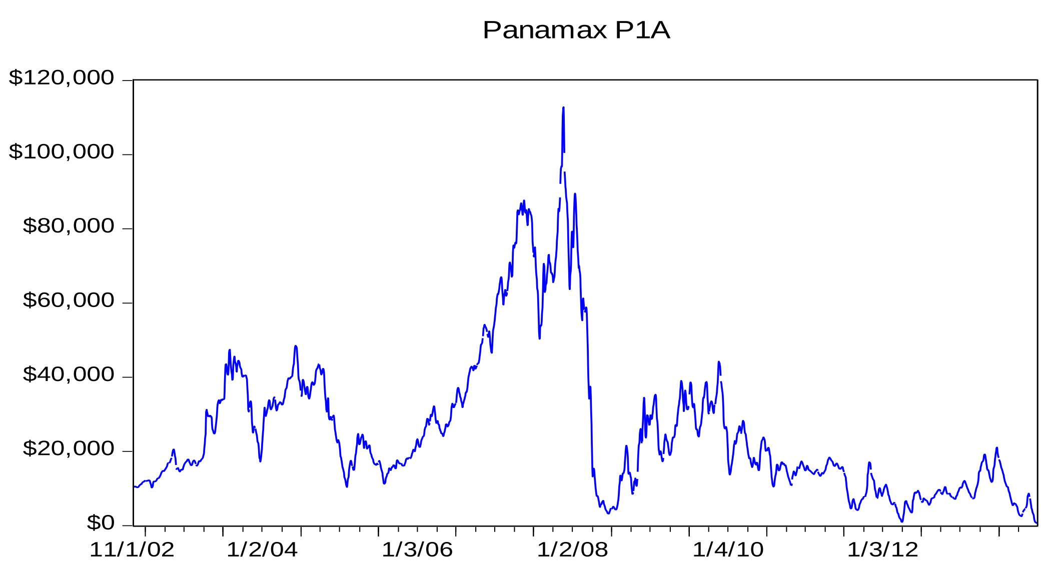
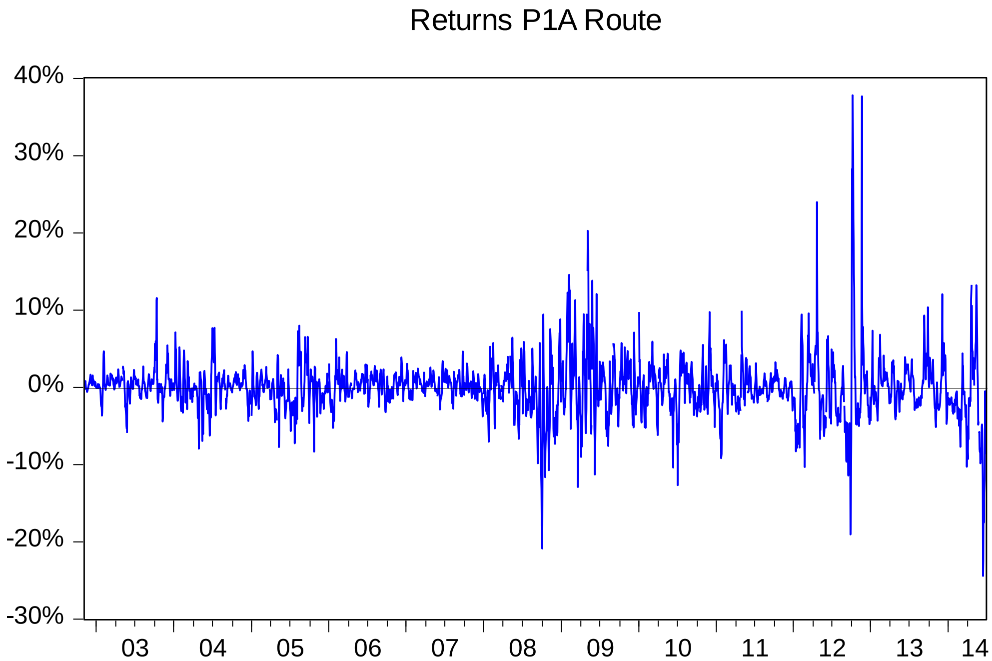


Figure 5.4: Returns Panamax P2A



Running the ADF test for the P1A route the absolute value of t-statistics is 19.09 greater than the critical values so the data are stationary.

Another route that this thesis will analyze is the Skaw Passero range to the Far East via the U.S. Gulf (P2A route). Following the same procedure as above, figure 55 represents the prices of the P2A route and figure 5.6 is a visualization of the periodical returns which are again stationary as the t-statistics absolute value (20.4) is greater than the critical values.

Figure 5.5: Panamax P2A

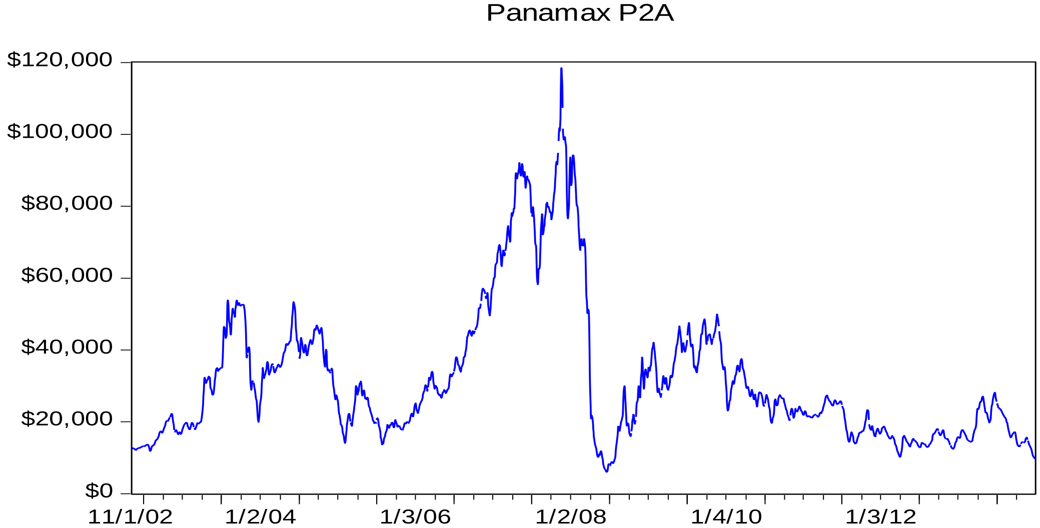
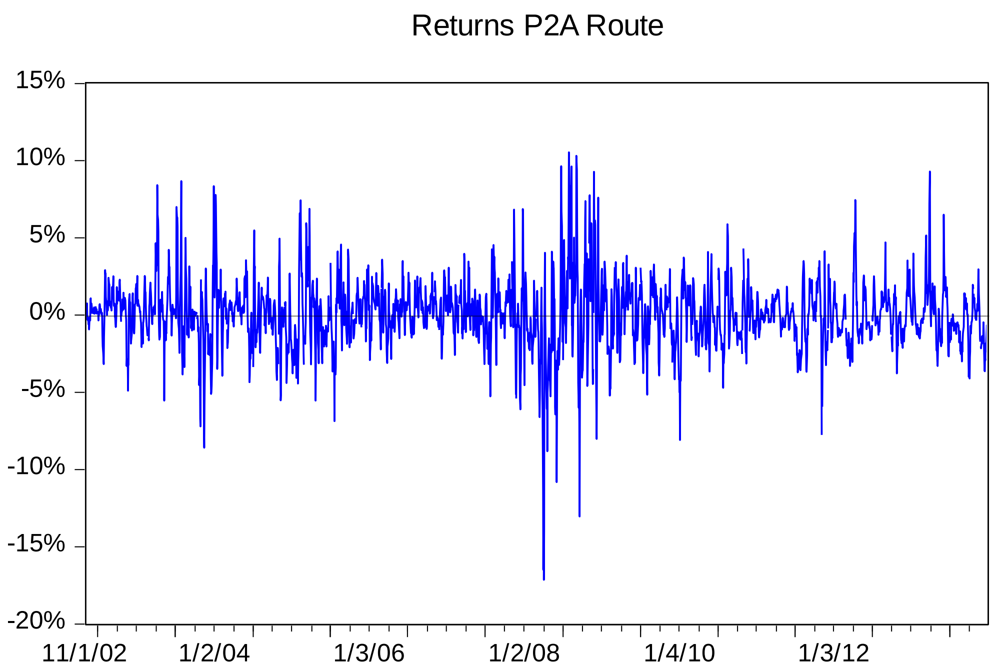


Figure 5.6: Returns P2A



The next index that this thesis deals with is the Panamax P3A route and the historical prices and the periodical returns are presented in the figures 5.7 and 5.8

Figure 5.7: Panamax P3A

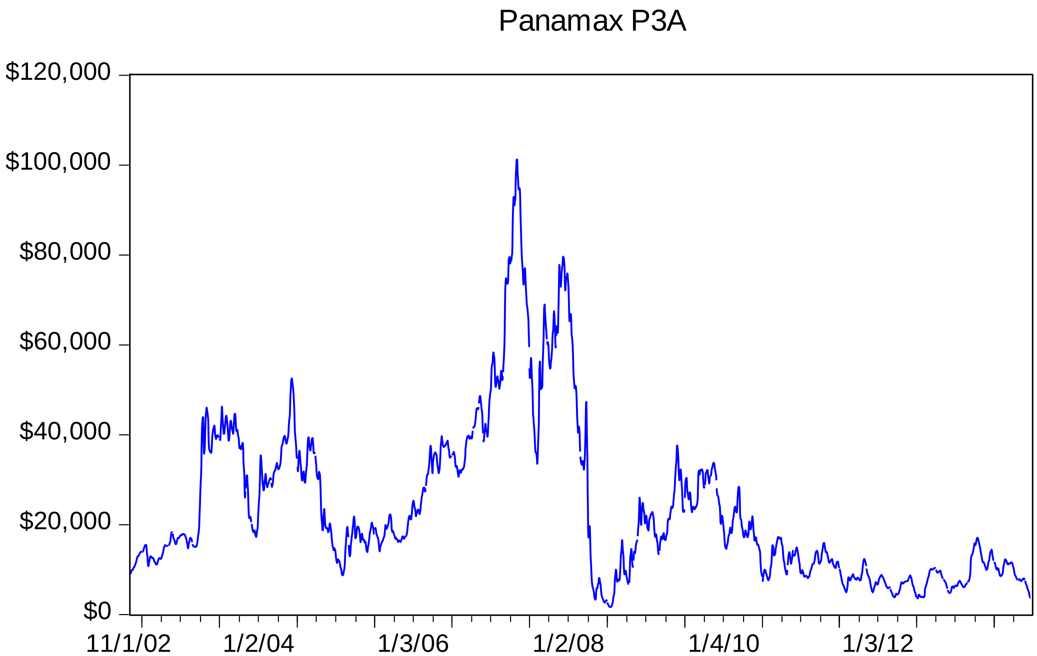
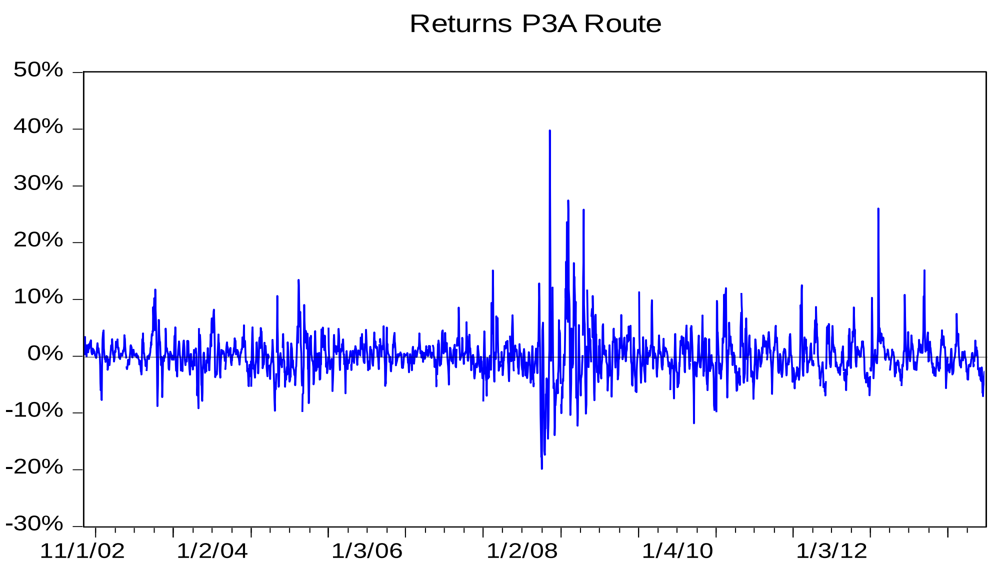


Figure 5.8: Returns P3A



Running the ADF test for the periodical returns we are able to say that the data are stationary so they are not obscured, as the absolute value of the t-statistic is 14.77 which is higher than the critical test values.

Finally the last Panamax route that will be evaluated is the P4A route and represented in figures 5.9 and 5.10.

Figure 5.9: Panamax P4A

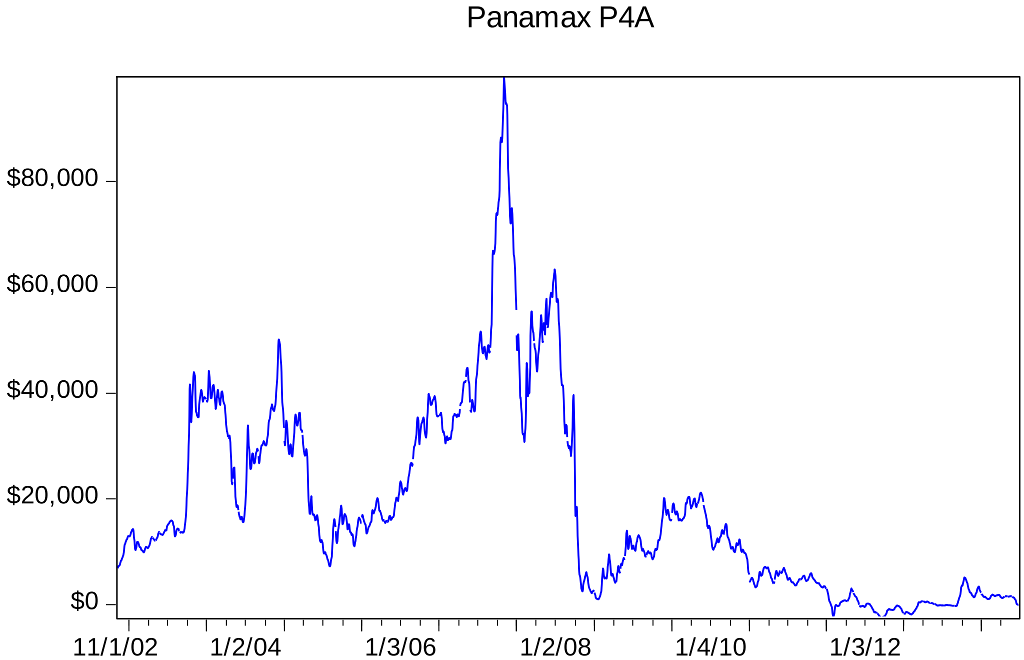
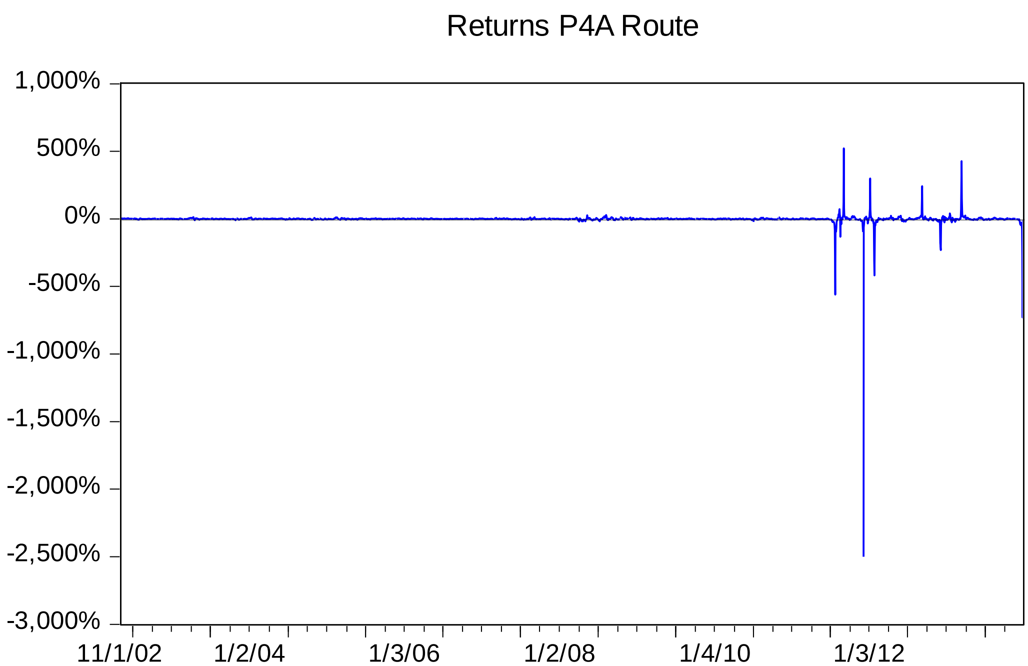
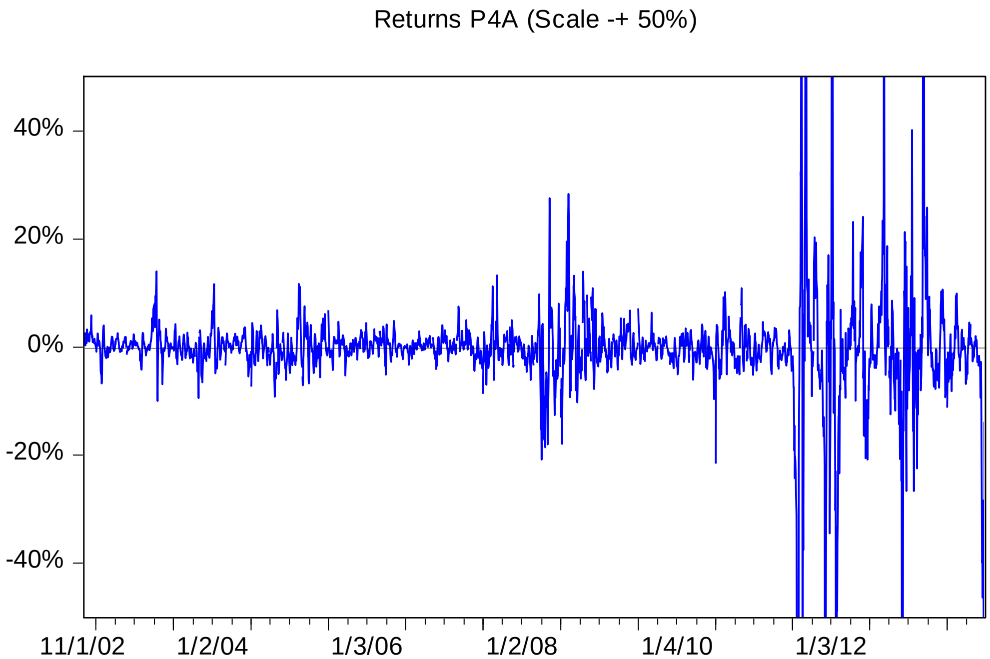


Figure 5.10: Returns P4A



For this route the returns are seems relative clustered around zero until 2011, if we “zoom in”, it is observable that there is also variation in the periodical returns.

Figure 5.11: Returns P4A (Scale -+ 50%)



As far as the obscurity of the periodical returns concerns the ADF test shows that the data are stationary.

5.2 Panamax Monthly Prices

In this section of the thesis a presentation and a preliminary analysis of the monthly Panamax historical data is introduced for the same route as before (P1A, P2A, P3A, P4A and 4 T/C). In figure 5.12 we can observe that the prices of the five routes are relative similar, with two peaks in the last quarter of 2007 and second quarter of 2008. Moreover in January of 2009 the prices decreased to historically low levels. Figure 5.13 presents the returns of the routes in percentages. Although the P4A route graph is scaled between -80% and 160 % to illustrate the volatility, there are some data that distract a lot the graph. These are the returns of the following months, February 2009 with an increase of 246% but especially the returns of August 2012 when the earnings fell from -4$ per day to -1318 $/day. Furthermore conducting the ADF test for checking whether the data are stationary or not all the data series (routes P1A, P2A, P3A, P4A and 4 T/C) are stationary. The graph set is concentrated and presented in Appendix 1 section of this thesis

Figure 5.12: Panamax P1A (Monthly)

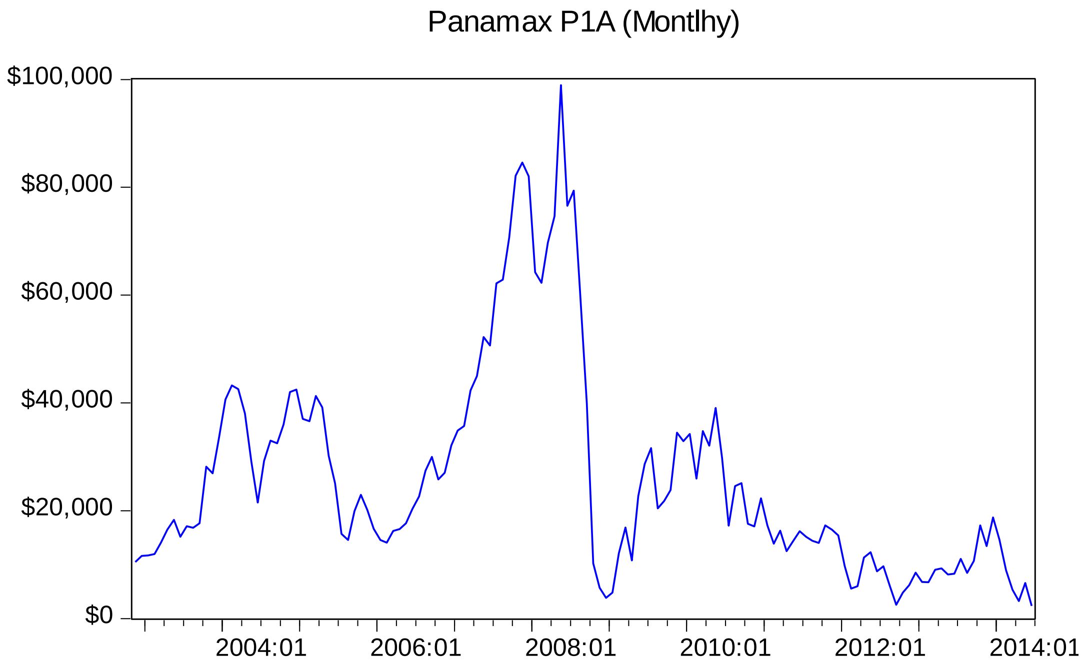
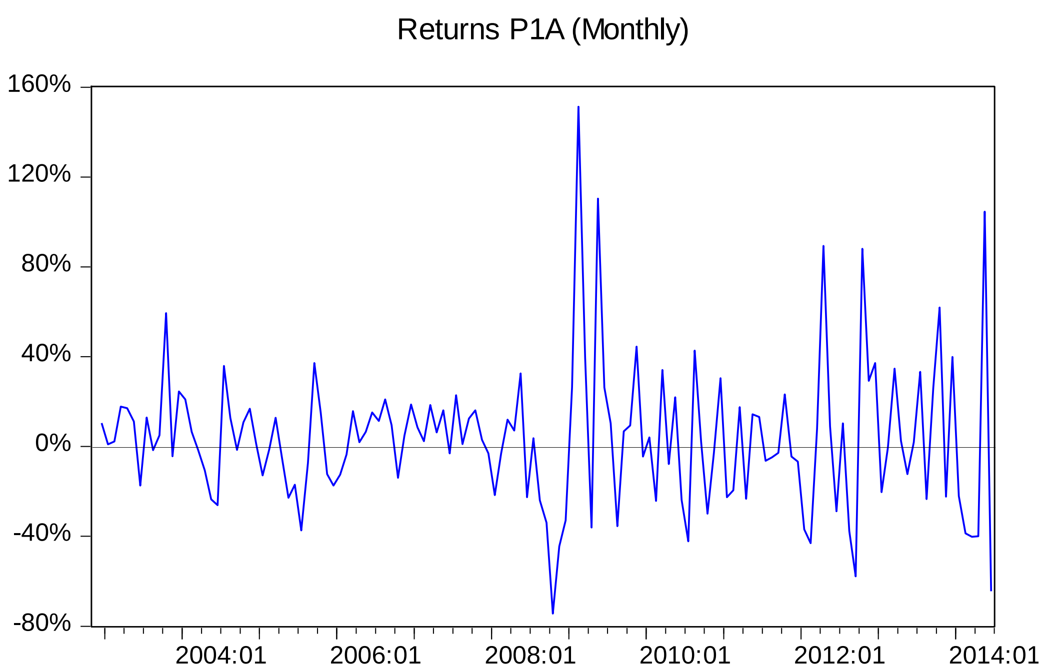


Figure 5.13: Returns P1A (Monthly)



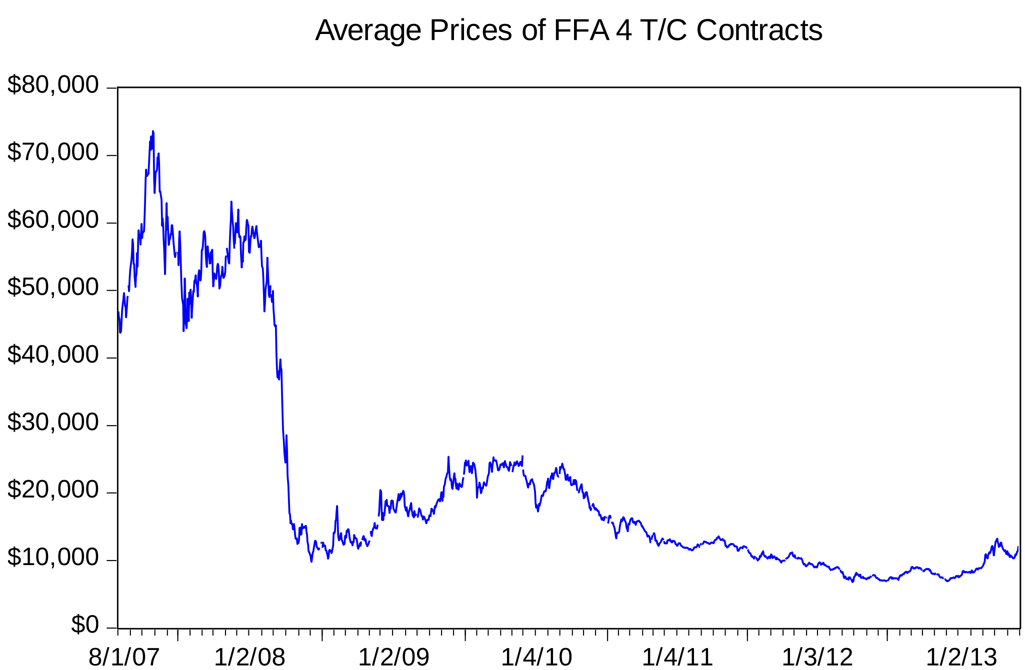
5.3 *Forward Freight Agreement- Panamax 4 T/C*

The dataset includes the daily prices of the contracts which have as underlying asset the Baltic Panamax Index T/C average. There are various contract series which in particular for the average 4 T/C start from one month to 4 years. For the purpose of this thesis the average price of the daily contracts has been estimated as depicted in the table 5.1

Table 5.1: Average FFA contract price

Date	July	+Q1	+Q2	+Q3	+Q4	+1 Year	+2 Years	+3 Years	+4 Years	Average
01/07/2008	71500	65000	61500	70500	71000	60250	43000	32500	26500	55750

Figure 5.14: Average Prices of FFA 4 T/C Contracts



In figure 5.14 the prices of the FFA contracts from 1 August 2007 until 2 December 2013 are illustrated. It is worth mentioning that the reporting periods are different between the spot prices and the FFA prices, and this is the reason why they seem to have different patterns. This can be resolved by combining the FFA price with the underlying asset, which in our case is the average panama time charter price.

Figure 5.15: Comparison FFA and Average T/C Prices

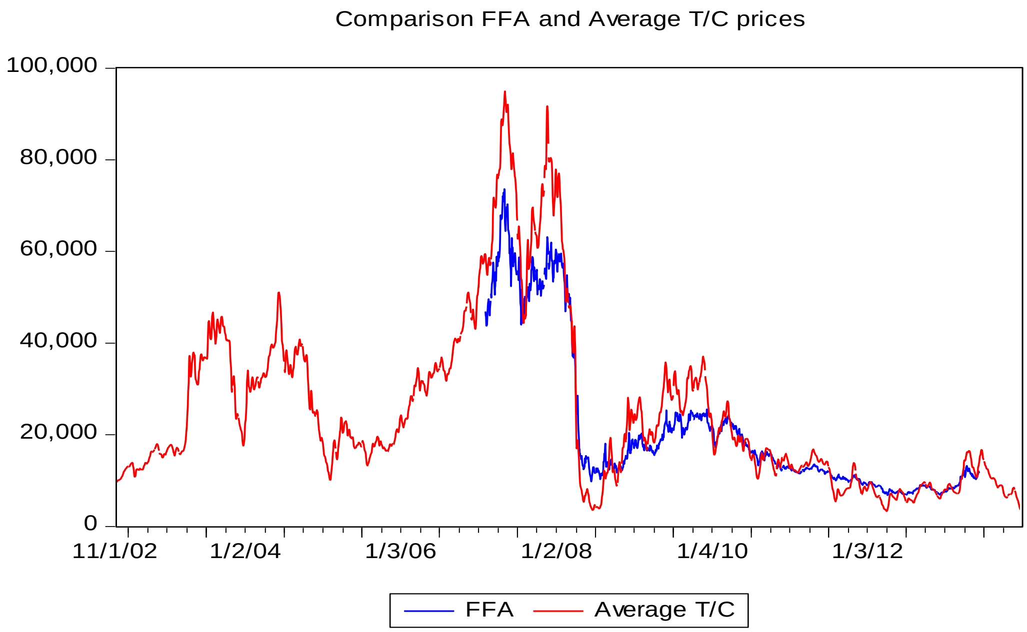
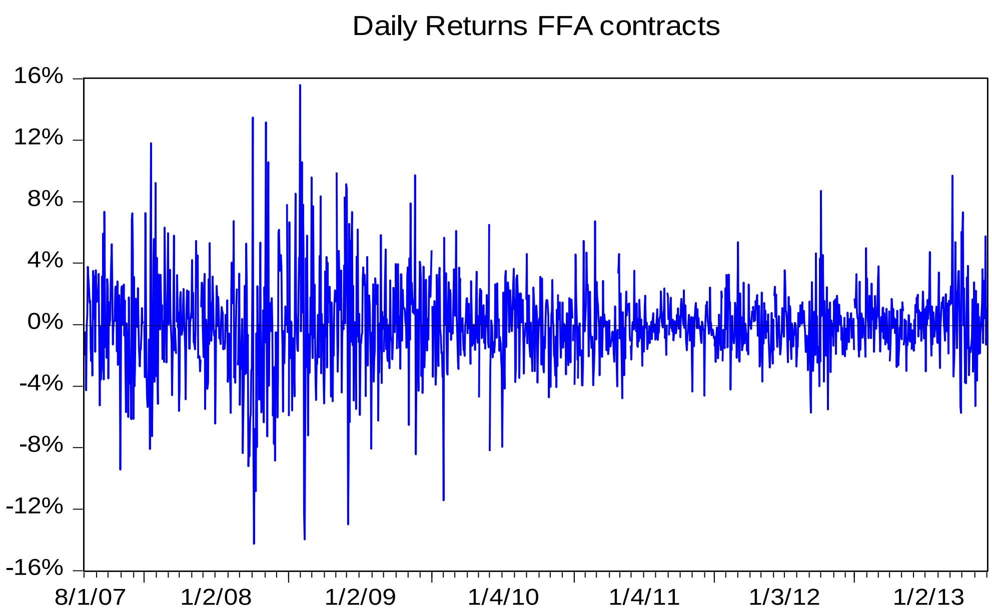


Figure 5.16: Daily Returns FFA Contracts



The daily returns of the FFA contracts are presented in the graph above and based on the unit root test the data are stationary.

6 Results

6.1 Descriptive Statistics

6.1.1 Daily Prices

The results of the descriptive statistics of the daily returns including the returns of the FFA contracts are concentrated in the table 6.1. In particular the largest mean in absolute value is observed in the P4A route (-1.58842%) and P2A route has the highest mean of 0.015808%. From all the indexes only the returns of the P2A and P3A have a positive mean, meaning that in the perpetual the returns are positive. Analyzing the coefficient of skewness, most of the returns have a symmetric distribution as the coefficient of skewness is close to zero with the exception of the P4A route with a coefficient of skewness equal to -35.58. As far as the kurtosis is concerned the returns of the P1A, P2A P3A and P4A are leptokurtic, while the returns of the average 4 T/C and of the FFA's are close to three charactering them as mesokurtic. Using the descriptive statistics we are able to have a first impression of the volatility of the returns of the routes. In particular the volatility varies between 2.17% and 3.66% excluding the returns of the P4A route which fluctuates at 53.72%.

Figure 6.1: Distribution of Daily Returns

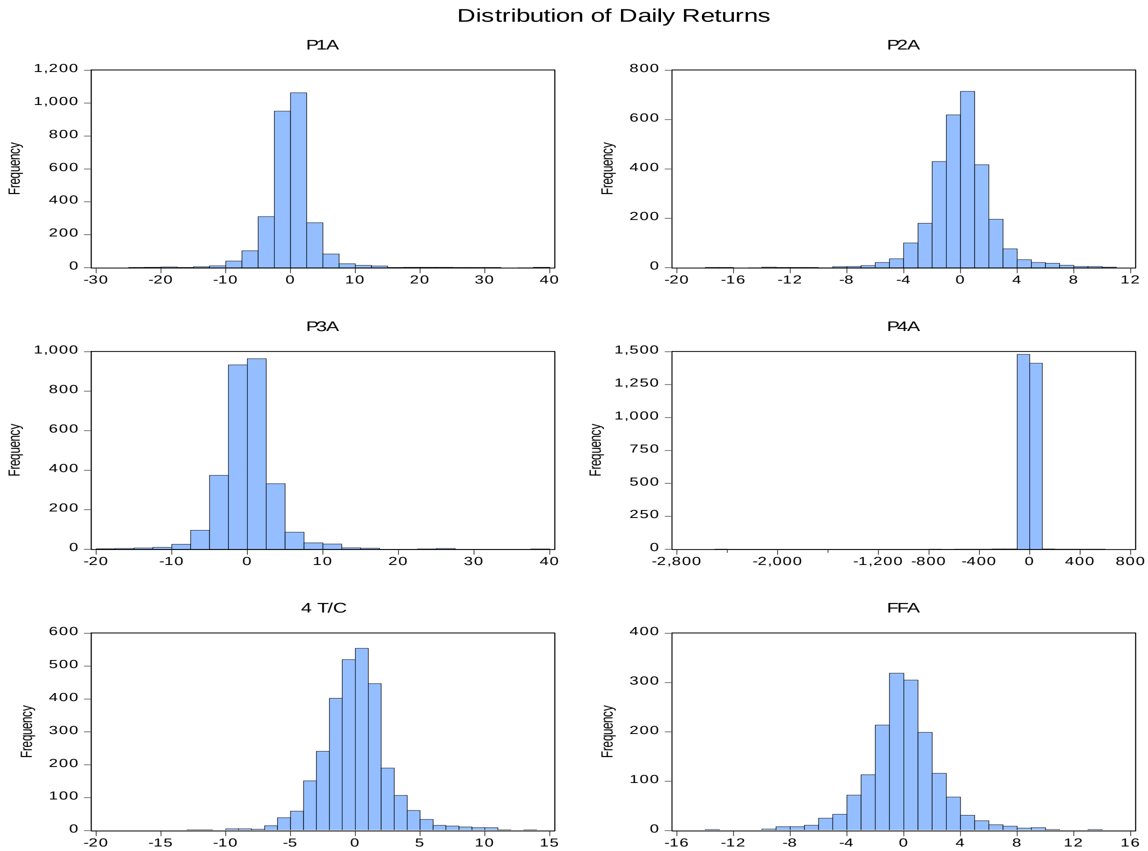


Table 6.1: Results of Descriptive Statistics-Daily

	P1A	P2A	P3A	P4A	4 T/C	FFA
Mean	-0.0273%	0.01508%	0.02791%	-1.58842%	-0.00058%	-0.04720%
Median	0.0386%	0.08492%	0.00000%	-0.09253%	0.00000%	-0.07710%
Minimum	-24.4372%	-17.15%	-19.87%	-2500.00%	-19.48%	-14.25%
Maximum	37.8202%	10.54%	39.82%	521.43%	14.01%	15.59%
Variance	0.1344%	0.04730%	0.12976%	28.869%	0.07179%	0.07819%
Standard Deviation	3.6651%	2.174373 %	3.601556%	53.720914%	2.678926%	2.795411%
Coefficient of Skewness	1.25	-0.29	1.18	-35.58	0.11	0.07
Coefficient of Kurtosis	16.58	6.08	11.97	1631.80	4.59	3.88
Coefficient of Variance	-134.41	144.17	129.04	-33.82	-4613.25	-59.23

6.1.2 Monthly Prices

In this section the descriptive statistics of the monthly returns are presented. All the routes have a positive mean with the P3A having the highest of 3.86% and the P4A route is characterized by the lowest mean -227.18%. Concerning the skewness of distribution all the returns are skewed to the right. However, the returns of the P2A route are symmetric and those of the P4A route are skewed to the left. Furthermore all the distributions are leptokurtic as the coefficients of kurtosis are higher than three. The distributions of the P1A and P2A routes can be characterized more as mesokurtic than leptokurtic. Finally, the most volatile index is the P4A route, followed by the rest with a volatility around 19.24% and 34.21%.

Figure 6.2: Distribution of Monthly Returns

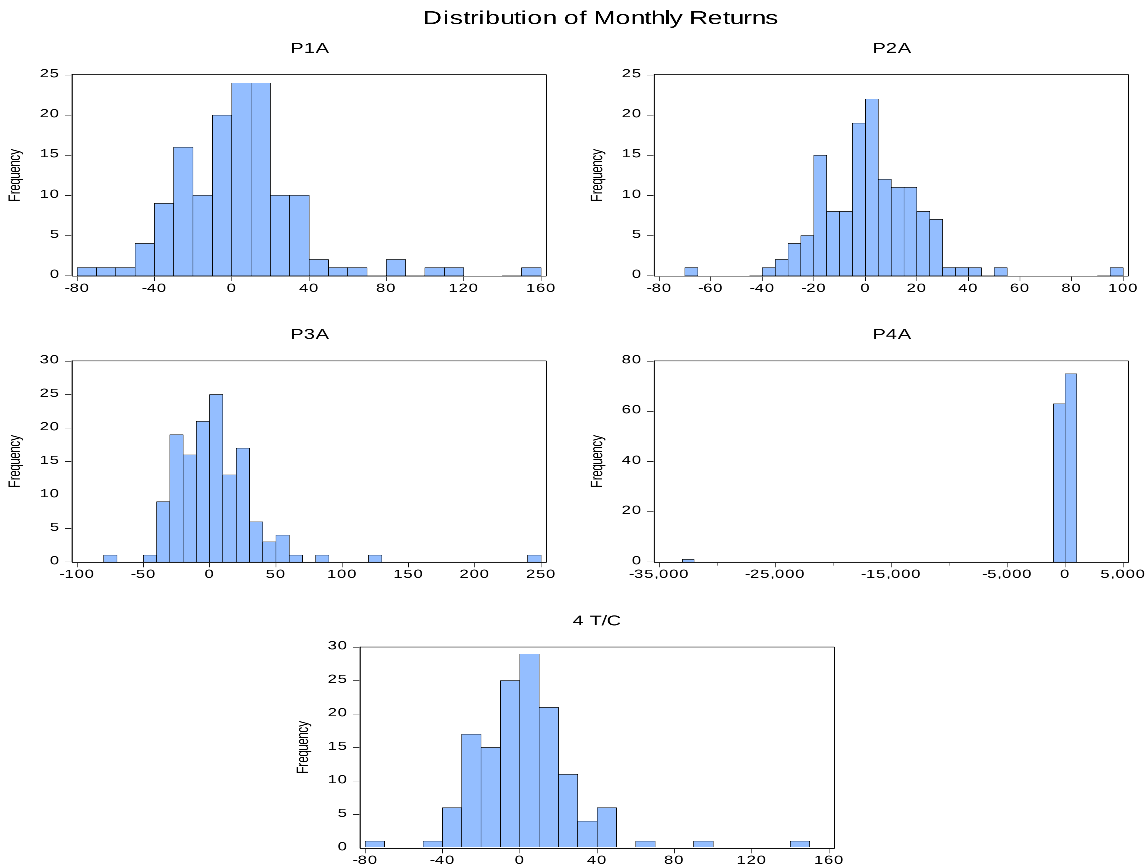


Table 6.2: Results Descriptive Statistics-Monthly

	4 T/C	P1A	P2A	P3A	P4A
Mean	2.37322%	3.62420%	1.85247%	3.86381%	-227.18888%
Median	1.12953%	2.36893%	1.66177%	1.33211%	3.09772%
Minimum	-71.31%	-74.37%	-69.75%	-71.70%	-32850.00%
Maximum	142.48%	151.36%	96.05%	245.83%	880.81%
Variance	6.37372%	10.10561%	3.73204%	11.78922%	77762.01147%
Standard Deviation	25.155254%	31.674766%	19.248869%	34.211703%	2778.535091%
Coefficient of Skewness	1.46	1.20	0.57	2.97	-11.77
Coefficient of Kurtosis	7.09	4.19	4.26	18.00	138.69
Coefficient of Variance	10.60	8.74	10.39	8.85	-12.23

6.2 EGARCH Estimations

In this part of the thesis the results of the EGARCH regressions are presented and it is divided in two parts the results of daily volatility and those of the monthly volatility.

6.2.1 Daily Volatility

Running the EGARCH model for the daily returns based on the equation that follows, the equations of the variance have been estimated.

$$\sigma^2{}_t = \exp(a_0 + a_j \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \psi_j(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + \beta_j ln\sigma^2{}_{t-1})$$

<u>P1A Route</u>

$$\sigma^2{}_t = \exp(0.065996 - 0.019564 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 1.299537(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.754905 ln\sigma^2{}_{t-1})$$

<u>P2A Route</u>

$$\sigma^2{}_t = \exp(0.001130 - 0.061819 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 1.222144(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.679732 ln\sigma^2{}_{t-1})$$

<u>P3A Route</u>

$$\sigma^2{}_t = \exp(-3.109132 + 0.049115 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 1.253857(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.714437 ln\sigma^2{}_{t-1})$$

<u>P4A Route</u>

$$\sigma^2{}_t = \exp(-1.299164 - 0.197173 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - 1.411037(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.948017 ln\sigma^2{}_{t-1})$$

<u>Average 4 T/C</u>

$$\sigma^2{}_t = \exp(-3.807050 - 0.003536 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - 1.433610(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.672270 ln\sigma^2{}_{t-1})$$

<u>Forward Freight Agreements</u>

$$\sigma^2{}_t = \exp(-0.126658 - 0.005109 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 0.200803(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.985614 ln\sigma^2{}_{t-1})$$

All the above coefficients are accumulated in the following table 6.3.

Table 6.3: Daily Returns EGARCH Coefficients

Daily Returns EGARCH Coefficients						
	P1A	P2A	P3A	P4A	4 T/C	FFA
α_0	0.065996	0.001130	-3.109132	-1.299164	-3.807050	-0.126658
α_j	-0.019564	-0.061819	0.049115	-0.197173	-0.003536	-0.005109
ψ_j	1.299537	1.22144	1.253857	-1.411037	-1.433610	0.200803
β_j	0.754905	0.679732	0.714437	0.948017	0.672270	0.985614

6.2.2 Monthly Volatility

$$\sigma^2{}_t = \exp(0.5125 - 0.444929\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 0.422049(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.970681 ln\sigma^2{}_{t-1})$$

$$\sigma^2{}_t = \exp(0.977205 - 0.25467\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 0.292953(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.789637 ln\sigma^2{}_{t-1})$$

$$\sigma^2{}_t = \exp(0.797431 - 0.423431\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 0.094599(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|) + 0.873681 ln\sigma^2{}_{t-1})$$

$$\sigma^2{}_t = \exp(14.61289 + 1.557461\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 1.062076\left(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|\right) - 0.473602 ln\sigma^2{}_{t-1})$$

$$\sigma^2{}_t = \exp(0.966559 - 0.391286\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 0.194824\left(\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|\right) + 0.821916 ln\sigma^2{}_{t-1})$$

Table 6.4: Monthly Returns EGARCH Coefficients

Monthly Returns EGARCH Coefficients					
	P1A	P2A	P3A	P4A	4 T/C
α_0	0.5125	0.977205	0.797431	14.61289	0.966559
α_j	-0.444929	-0.25467	-0.423431	1.557461	-0.391286
ψ_j	0.422049	0.292953	0.094599	1.062076	0.194824
β_j	0.970681	0.789637	0.873681	-0.473602	0.821916

7 Conclusions

The global dry bulk shipping is a divided market. It consists of the Capesize, Panamax, Supramax and Handysize market. These segments are becoming more and more complex throughout the years. In this thesis a focused analysis of Panamax daily and monthly returns, as well as the returns of Forward Freight Agreements contracts. Initially in the first chapter an introduction in the topic, including a small historical analysis of the market and also the research question was formulated. Following that chapter two provides a theoretical and methodological background derived from previous studies. In particular the topics of pricing in seaborne trade, the risks the counterparties face and the various models used to quantify the volatility in shipping were tackled. In order for the reader to better understand basic notions of the dry bulk market as well as terms used in this thesis, such as the different freight contracts and the market of freight derivatives, chapter 3 was formulated. Chapter four examines the procedures that will be followed to answer the research question. Following this chapter 5 introduced the data and conducts a preliminary analysis to them, in order to check if these data are eligible to be analyzed we test whether the data are stationary or not. Finally the sixth chapter presents the results of the descriptive statistics and the EGARCH model. Based on the descriptive statistics results, it is observable that the volatility of the daily returns is lower than the one of the monthly returns. In particular assuming that business days are annually 252, the volatility is significant higher for the monthly returns. Although it seems bizarre as many researches show that as the maturity increases the volatility decreases. In particular this happens in a comparison between different time charter contracts of different maturities, where the volatility becomes lower as the maturity increases. For instance a six months' time charter contract is more volatile than a three years' time charter contract.

Table 7.1: Annualized Volatility

	Annualized Volatility				
Route	P1A	P2A	P3A	P4A	4 T/C
Daily Returns	58%	35%	57%	853%	43%
Monthly Returns	110%	67%	119%	9625%	87%

Moreover from table 6.1 we can observe that the Forward Freight Agreements Contracts returns and the underlying asset (average 4 T/C) have quite similar results verifying that there is a close relationship between this freight derivative and the spot index. Furthermore by analyzing the coefficients derived from the EGARCH model, it is feasible to understand how the volatility reacts to shocks of the market. In particular, by evaluating the α_j firstly for the daily returns, negative shocks tend to increase volatility for the P2A and P4A and also the volatility of returns shocks is asymmetric (the coefficients for P1A, P3A, 4 T/C and FFA are not statistically significant and symmetrical). With the exception of the P4A and average 4 T/C, shocks larger than average increase the volatility more than shocks smaller than average. Finally analyzing the β_j coefficient the volatility of FFA's takes longer to decline and the volatility of 4 T/C reacts faster than the other routes. Additionally for the monthly returns, the volatility increases to negative shocks except from the P4A route returns. The ψ_j coefficient is only statistical significant for the P1A and P4A routes and as the coefficients are positive, shocks larger than average tend to increase the volatility than shocks smaller than average. Moreover the higher the ψj the more powerful the linkage between the current volatility and past shocks. The P3A route β_j coefficient has the closest value to one which means that the shocks have the greatest persistence to volatility. A notable fact is that from the analysis of the daily returns of the average 4 T/C and of the Forward Freight Agreement, it is observable that these two indexes react differently to shocks, proving that the Forward Freight Agreements are a sufficient hedging tool for this specific route. Concluding this thesis provides valuable information concerning the drivers that influence the volatility of the returns of the aforementioned indexes and therefore they are able to efficiently manage their portfolio and of course take less risky decisions. Firstly it is helpful for Panamax ship owners/managers who usually operate their ships on a time charter base and also for users of the Forward Freight Agreements who buy these contracts to mitigate their risk or they use them as a speculative tool.

7.1 Limitations and Further Research

Although the results of the EGARCH models seem to be relatively significant from a statistical aspect, it is not appropriate to expand the results for other parts of the sector. Additionally this thesis focused only on one segment (Dry Bulk) and one vessel class (Panamax) and the result is perhaps not immediately applicable to other segments of the market or other ship types. For a more detailed research, it is suggested to expand the investigation to more segments and ship types. Moreover although forecasting is not an appropriate tool to predict the market, using the formulas derived from this thesis makes it feasible to forecast the volatility. Finally an analysis of the relationship between realized volatility on FFA contracts, volatility of the index and implied volatility of FFA options will also provide the opportunity to examine another perspective of the market.

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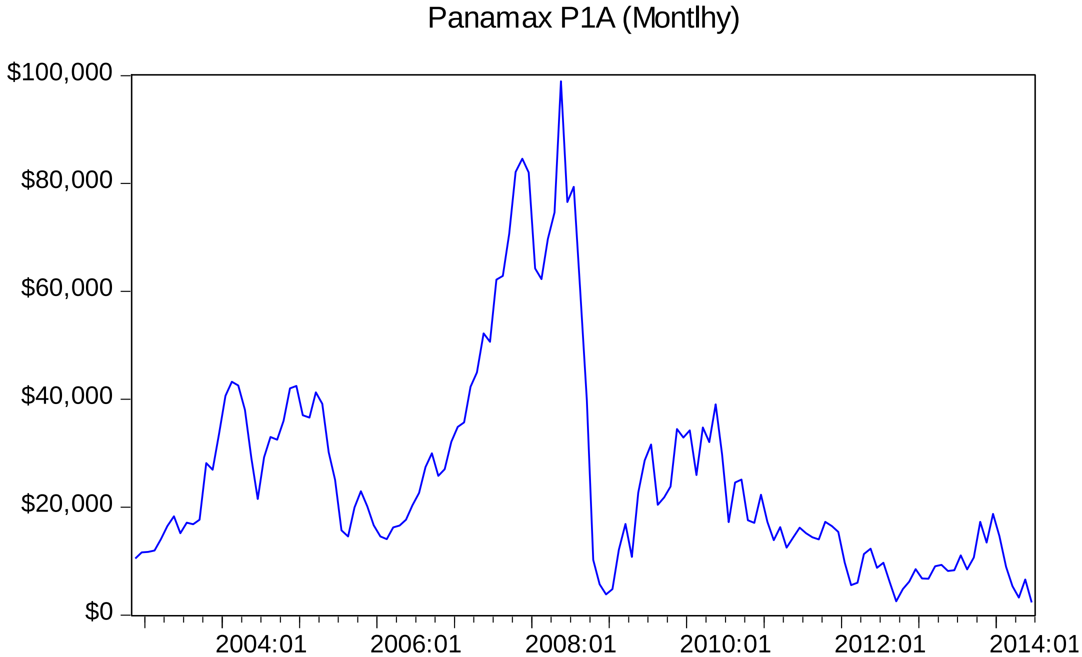
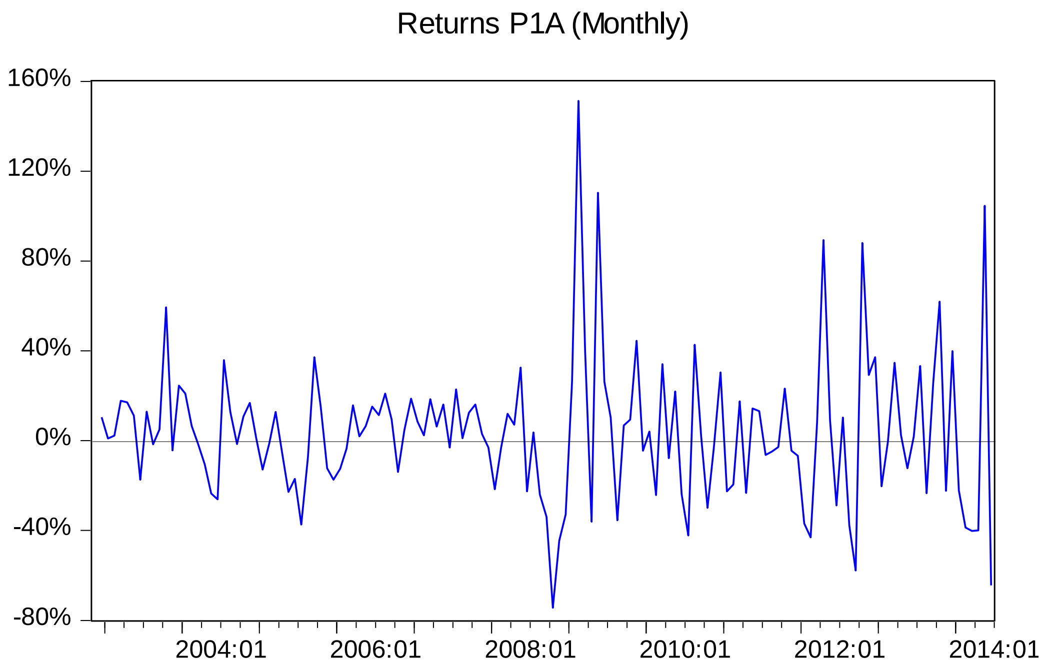
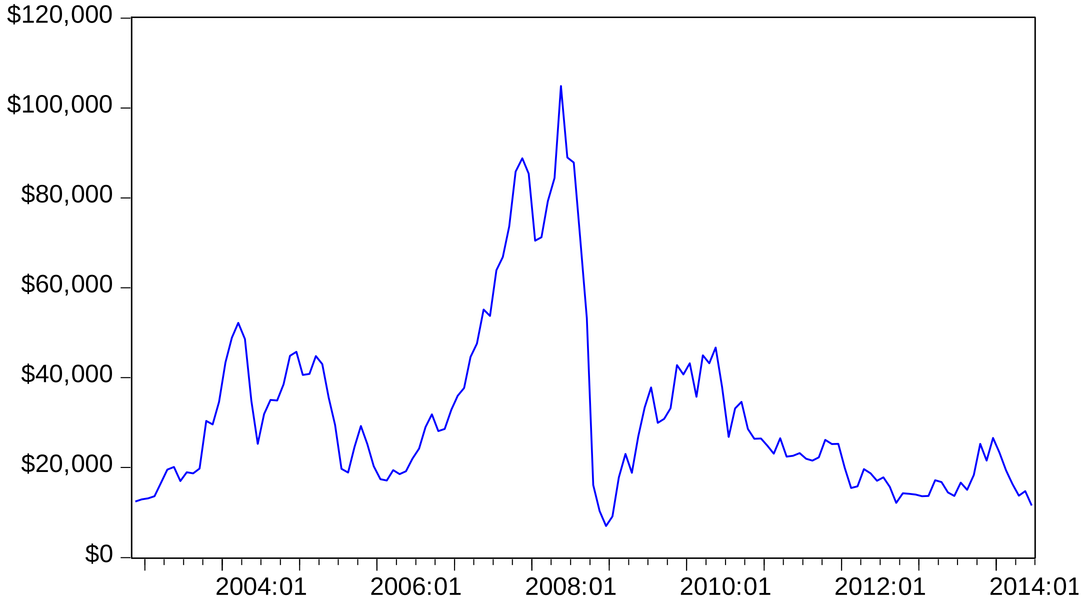
Appendices

Appendix 1- Panamax Monthly Prices Graphs

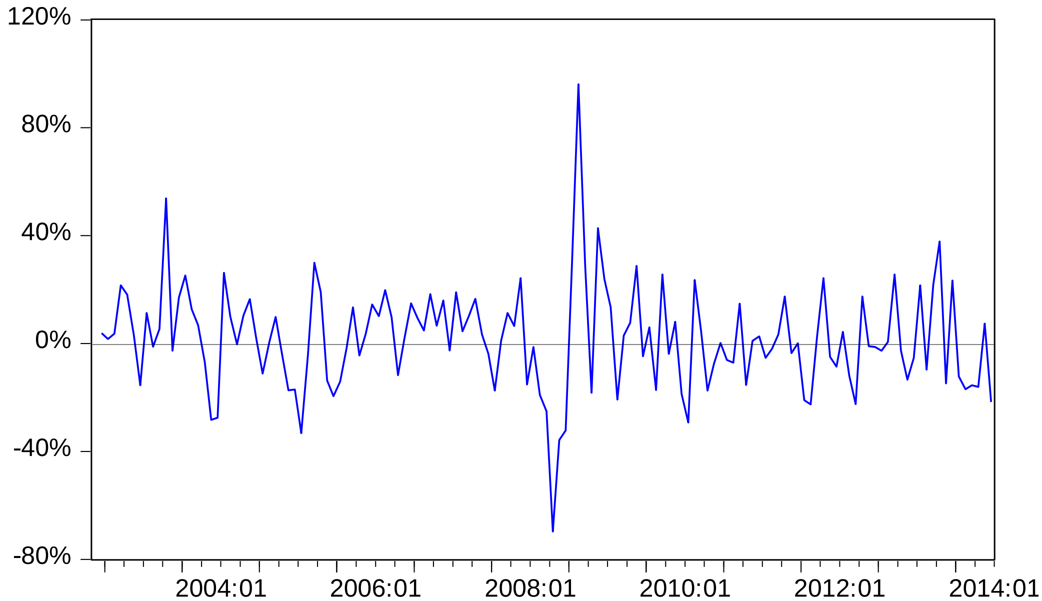




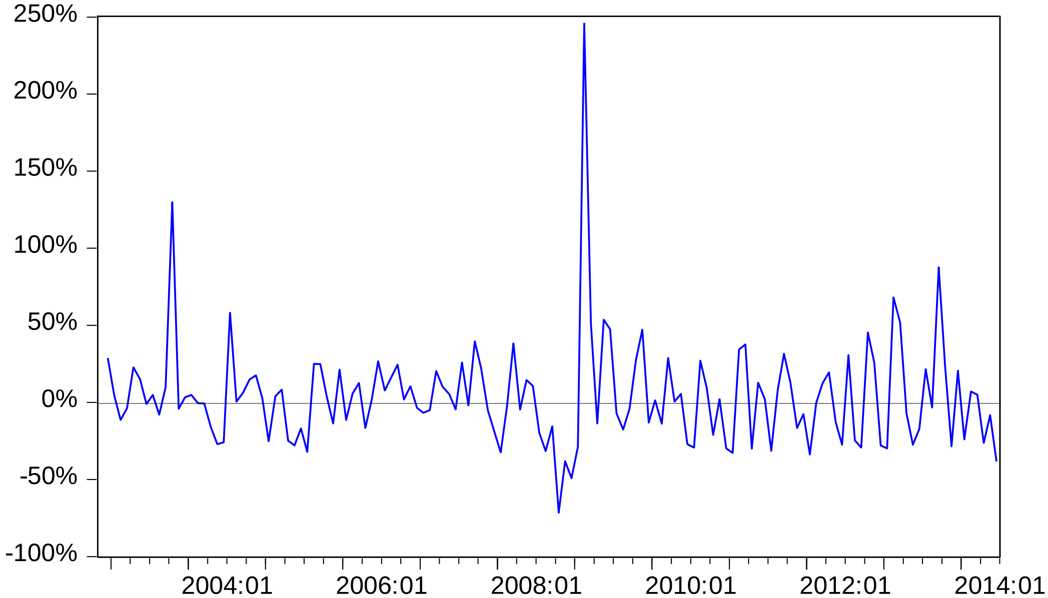
Panamax P2A (Monthly)



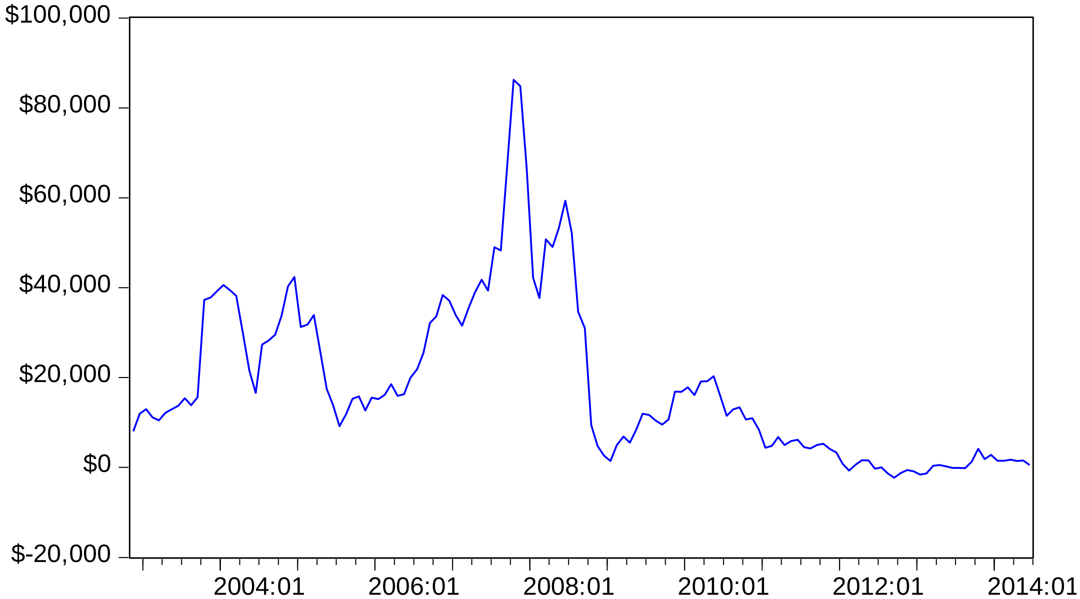
Returns P2A (Monthly)



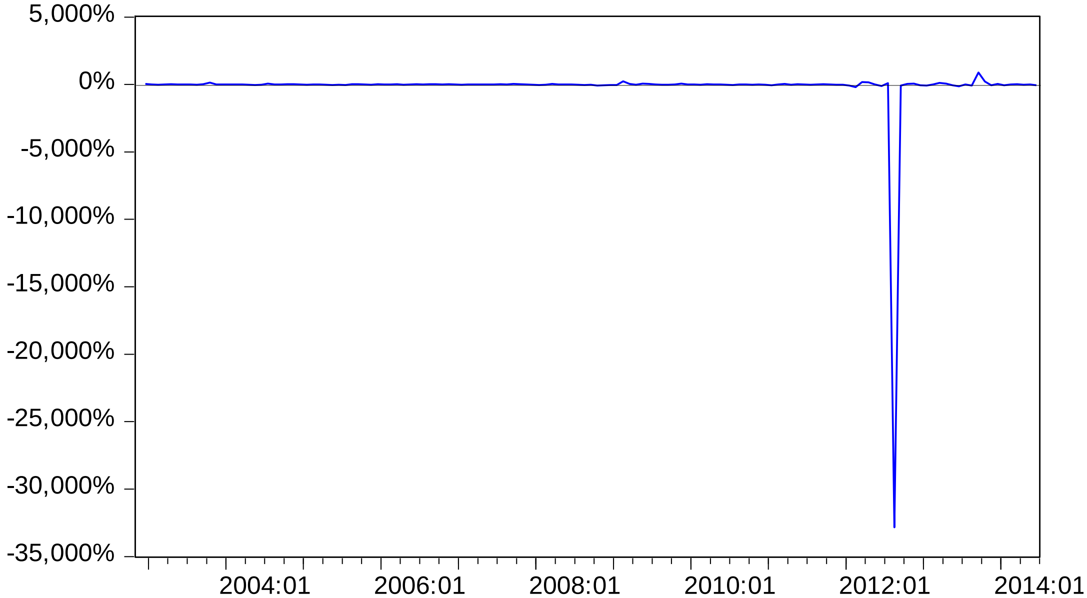
Returns P3A (Monthly)



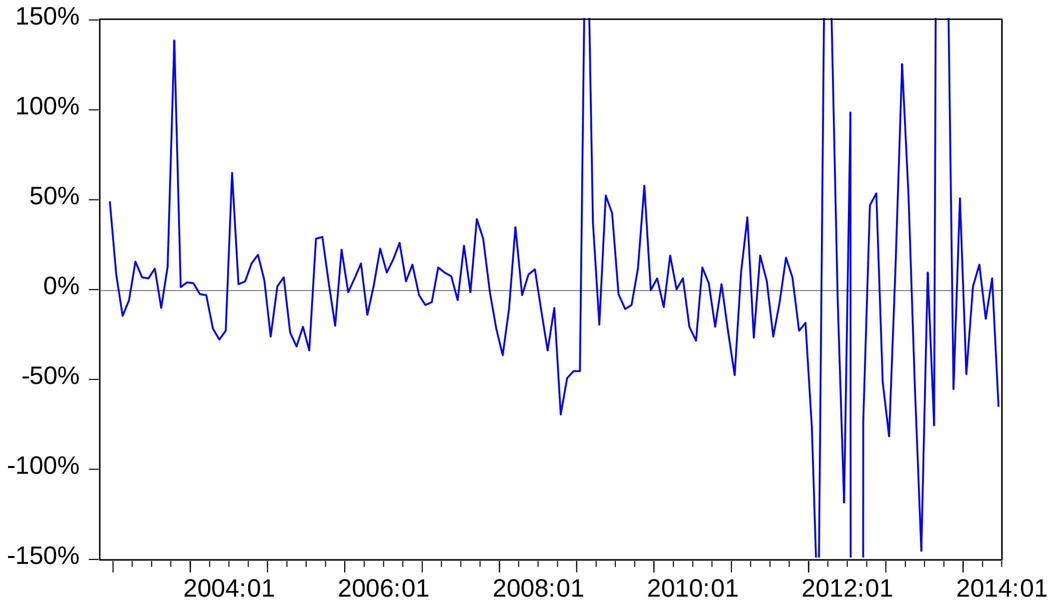
Panamax P4A (Monthly)



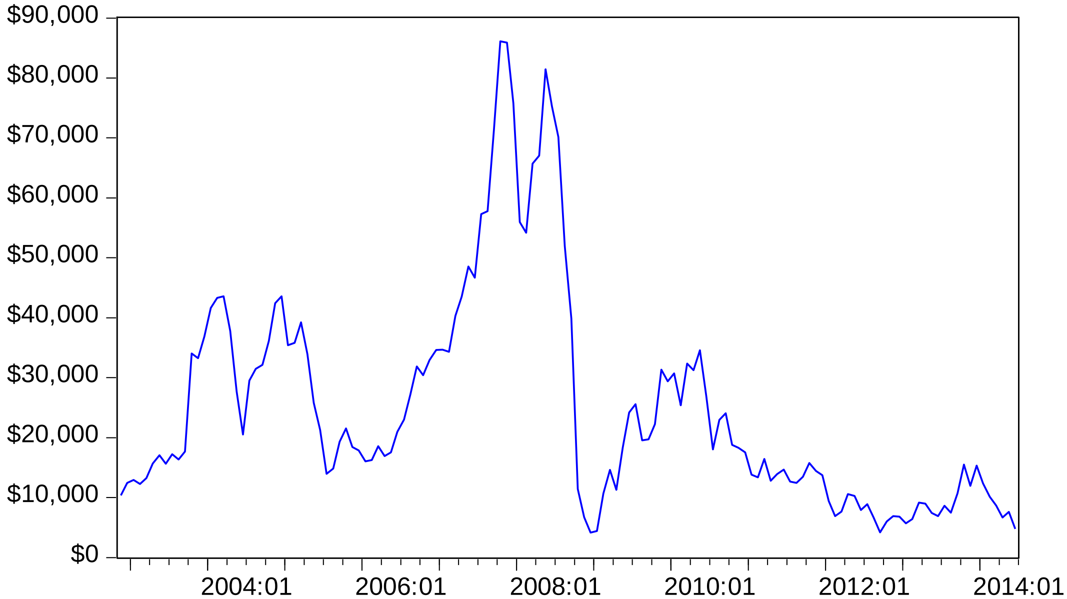
Returns P4A (Monthly)



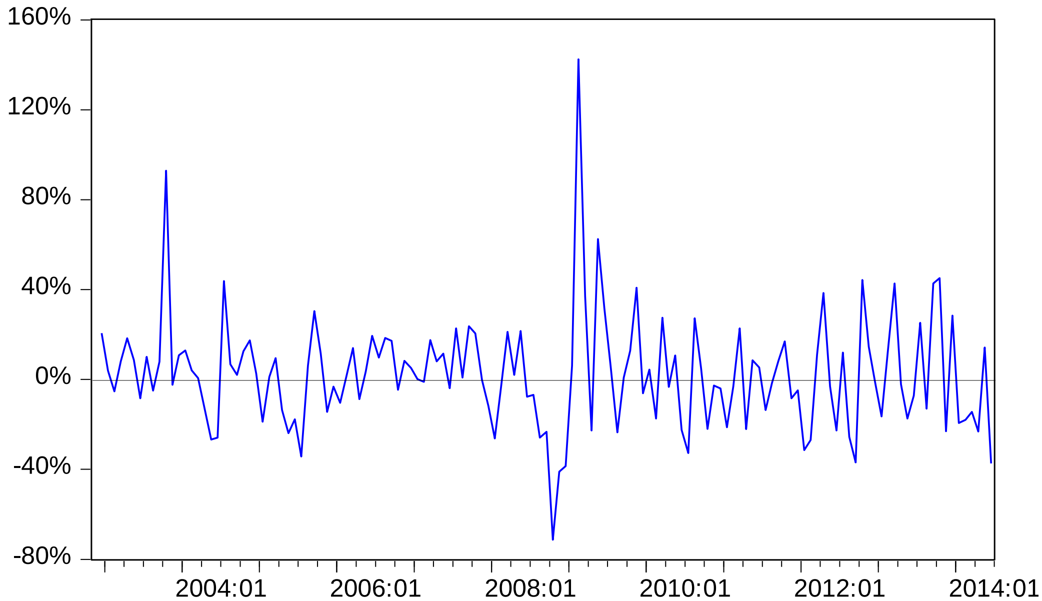
Returns P4A (Monthly) (Scale:-+ 150%)



Panamax 4TC (Monthly)



Returns 4TC (Monthly)



Appendix 2-Augmented Dick-Fuller Tests.

P1A Route-Daily

Null Hypothesis: P1A RETURNS has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=27)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-19.07536	0.0000
Test critical values:	1% level		-3.432410	
	5% level		-2.862336	
	10% level		-2.567238	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(P1ARETURNS)				
Method: Least Squares				
Date: 08/10/14 Time: 17:36				
Sample (adjusted): 11/06/2002 6/27/2014				
Included observations: 2905 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
P1A RETURNS(-1)	-0.193835	0.010162	-19.07536	0.0000
D(P1A RETURNS(-1))	0.227610	0.018124	12.55846	0.0000
C	-4.99E-05	0.000357	-0.139473	0.8891
R-squared	0.126396	Mean dependent var		-4.47E-06
Adjusted R-squared	0.125794	S.D. dependent var		0.020605
S.E. of regression	0.019265	Akaike info criterion		-5.060013
Sum squared resid	1.077058	Schwarz criterion		-5.053843
Log likelihood	7352.669	Hannan-Quinn criter.		-5.057790
F-statistic	209.9354	Durbin-Watson stat		2.005947
Prob(F-statistic)	0.000000			

P2A Route-Daily

Null Hypothesis: P1ARETURNS has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=27)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-19.07536	0.0000
Test critical values:	1% level		-3.432410	
	5% level		-2.862336	
	10% level		-2.567238	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(P1ARETURNS)				
Method: Least Squares				
Date: 08/10/14 Time: 17:36				
Sample (adjusted): 11/06/2002 6/27/2014				
Included observations: 2905 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
P1ARETURNS(-1)	-0.193835	0.010162	-19.07536	0.0000
D(P1ARETURNS(-1))	0.227610	0.018124	12.55846	0.0000
C	-4.99E-05	0.000357	-0.139473	0.8891
R-squared	0.126396	Mean dependent var		-4.47E-06
Adjusted R-squared	0.125794	S.D. dependent var		0.020605
S.E. of regression	0.019265	Akaike info criterion		-5.060013
Sum squared resid	1.077058	Schwarz criterion		-5.053843
Log likelihood	7352.669	Hannan-Quinn criter.		-5.057790
F-statistic	209.9354	Durbin-Watson stat		2.005947
Prob(F-statistic)	0.000000			

P3A Route-Daily

Null Hypothesis: RETURNSP3A has a unit root				
Exogenous: Constant				
Lag Length: 4 (Automatic - based on SIC, maxlag=27)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-20.07486	0.0000
Test critical values:	1% level		-3.432413	
	5% level		-2.862337	
	10% level		-2.567239	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RETURNSP3A)				
Method: Least Squares				
Date: 08/10/14 Time: 19:02				
Sample (adjusted): 11/11/2002 6/27/2014				
Included observations: 2902 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RETURNSP3A(-1)	-0.276018	0.013749	-20.07486	0.0000
D(RETURNSP3A(-1))	0.265247	0.018910	14.02648	0.0000
D(RETURNSP3A(-2))	0.022283	0.019082	1.167727	0.2430
D(RETURNSP3A(-3))	0.050029	0.018493	2.705385	0.0069
D(RETURNSP3A(-4))	0.084814	0.018515	4.580809	0.0000
C	7.31E-05	0.000385	0.189681	0.8496
R-squared	0.156401	Mean dependent var		-4.46E-06
Adjusted R-squared	0.154944	S.D. dependent var		0.022572
S.E. of regression	0.020750	Akaike info criterion		-4.910461
Sum squared resid	1.246927	Schwarz criterion		-4.898111
Log likelihood	7131.079	Hannan-Quinn criter.		-4.906012

F-statistic	107.3818	Durbin-Watson stat		2.000084
Prob(F-statistic)	0.000000			

P4A Route-Daily

Null Hypothesis: RETURNSP4A has a unit root					
Exogenous: Constant					
Lag Length: 0 (Automatic - based on SIC, maxlag=27)					
			t-Statistic	Prob.*	
Augmented Dickey-Fuller test statistic			-46.26006	0.0001	
Test critical values:	1% level		-3.432410		
	5% level		-2.862336		
	10% level		-2.567238		
*MacKinnon (1996) one-sided p-values.					
Augmented Dickey-Fuller Test Equation					
Dependent Variable: D(RETURNSP4A)					
Method: Least Squares					
Date: 08/06/14 Time: 13:52					
Sample (adjusted): 11/05/2002 6/27/2014					
Included observations: 2906 after adjustments					
Variable	Coefficient	Std. Error	t-Statistic	Prob.	
RETURNSP4A(-1)	-0.848712	0.018347	-46.26006	0.0000	
C	-0.002879	0.005527	-0.520861	0.6025	
R-squared	0.424266	Mean dependent var		0.000102	
Adjusted R-squared	0.424067	S.D. dependent var		0.392580	
S.E. of regression	0.297930	Akaike info criterion		0.416772	
Sum squared resid	257.7657	Schwarz criterion		0.420884	
Log likelihood	-603.5696	Hannan-Quinn criter.		0.418253	
F-statistic	2139.993	Durbin-Watson stat		1.999207	
Prob(F-statistic)	0.000000				

Average 4 T/C-Daily

Null Hypothesis: RETURNS4TC has a unit root				
Exogenous: Constant				
Lag Length: 5 (Automatic - based on SIC, maxlag=27)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-16.88679	0.0000
Test critical values:	1% level		-3.432413	
	5% level		-2.862337	
	10% level		-2.567239	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RETURNS4TC)				
Method: Least Squares				
Date: 08/06/14 Time: 12:04				
Sample (adjusted): 11/11/2002 6/27/2014				
Included observations: 2902 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RETURNS4TC(-1)	-0.198982	0.011783	-16.88679	0.0000
D(RETURNS4TC(-1))	0.398927	0.018273	21.83168	0.0000
D(RETURNS4TC(-2))	-0.034726	0.019512	-1.779707	0.0752
D(RETURNS4TC(-3))	0.056780	0.019341	2.935735	0.0034
D(RETURNS4TC(-4))	0.046347	0.018882	2.454626	0.0142
D(RETURNS4TC(-5))	-0.078718	0.018534	-4.247160	0.0000
C	-7.51E-05	0.000234	-0.321243	0.7480
R-squared	0.222799	Mean dependent var		-4.15E-06
Adjusted R-squared	0.221188	S.D. dependent var		0.014277
S.E. of regression	0.012599	Akaike info criterion		-5.907948
Sum squared resid	0.459556	Schwarz criterion		-

			5.893540
Log likelihood	8579.432	Hannan-Quinn criter.	-5.902757
F-statistic	138.3177	Durbin-Watson stat	2.006784
Prob(F-statistic)	0.000000		

P1A Route Monthly

Null Hypothesis: R1A has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-11.06653	0.0000
Test critical values:	1% level		-3.478189	
	5% level		-2.882433	
	10% level		-2.577990	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(R1A)				
Method: Least Squares				
Date: 08/07/14 Time: 20:24				
Sample (adjusted): 2003M01 2014M06				
Included observations: 138 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R1A(-1)	-0.964498	0.087155	-11.06653	0.0000
C	3.428410	2.747331	1.247906	0.2142
R-squared	0.473823	Mean dependent var		-0.543072
Adjusted R-squared	0.469954	S.D. dependent var		43.94976
S.E. of regression	31.99730	Akaike info criterion		9.783567
Sum squared resid	139240.5	Schwarz criterion		9.825991
Log likelihood	-673.0661	Hannan-Quinn criter.		9.800807
F-statistic	122.4681	Durbin-Watson stat		1.955345
Prob(F-statistic)	0.000000			

P2A Route-Monthly

Null Hypothesis: R2A has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-8.876700	0.0000
Test critical values:	1% level		-3.478189	
	5% level		-2.882433	
	10% level		-2.577990	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(R2A)				
Method: Least Squares				
Date: 08/07/14 Time: 20:24				
Sample (adjusted): 2003M01 2014M06				
Included observations: 138 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R2A(-1)	-0.739100	0.083263	-8.876700	0.0000
C	1.310319	1.608589	0.814577	0.4167
R-squared	0.366841	Mean dependent var		-0.185138
Adjusted R-squared	0.362185	S.D. dependent var		23.53111
S.E. of regression	18.79273	Akaike info criterion		8.719204
Sum squared resid	48030.65	Schwarz criterion		8.761627
Log likelihood	-599.6250	Hannan-Quinn criter.		8.736444
F-statistic	78.79580	Durbin-Watson stat		1.934690
Prob(F-statistic)	0.000000			

P3A-Monthly

Null Hypothesis: R3A has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*

Augmented Dickey-Fuller test statistic			-9.394191	0.0000
Test critical values:	1% level		-3.478547	
	5% level		-2.882590	
	10% level		-2.578074	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(R3A)				
Method: Least Squares				
Date: 08/07/14 Time: 20:25				
Sample (adjusted): 2003M02 2014M06				
Included observations: 137 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R3A(-1)	-1.069966	0.113897	-9.394191	0.0000
D(R3A(-1))	0.197710	0.085017	2.325541	0.0215
C	4.008551	2.934272	1.366114	0.1742
R-squared	0.465241	Mean dependent var		-0.313504
Adjusted R-squared	0.457260	S.D. dependent var		46.01703
S.E. of regression	33.90117	Akaike info criterion		9.906430
Sum squared resid	154004.7	Schwarz criterion		9.970372
Log likelihood	-675.5905	Hannan-Quinn criter.		9.932415
F-statistic	58.29011	Durbin-Watson stat		1.956953
Prob(F-statistic)	0.000000			

P4A Route-Monthly

Null Hypothesis: R4A has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-11.74835	0.0000
Test critical values:	1% level		-3.478189	
	5% level		-2.882433	
	10% level		-2.577990	
*MacKinnon (1996) one-sided p-values.				

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(R4A)				
Method: Least Squares				
Date: 08/07/14 Time: 20:25				
Sample (adjusted): 2003M01 2014M06				
Included observations: 138 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R4A(-1)	-1.007362	0.085745	-11.74835	0.0000
C	-230.8717	239.9045	-0.962348	0.3376
R-squared	0.503693	Mean dependent var		-0.828457
Adjusted R-squared	0.500043	S.D. dependent var		3972.467
S.E. of regression	2808.837	Akaike info criterion		18.73332
Sum squared resid	1.07E+09	Schwarz criterion		18.77574
Log likelihood	-1290.599	Hannan-Quinn criter.		18.75056
F-statistic	138.0237	Durbin-Watson stat		2.000116
Prob(F-statistic)	0.000000			

Average 4 T/C-Monthly

Null Hypothesis: RTCA has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=13)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-9.809445	0.0000
Test critical values:	1% level		-3.478189	
	5% level		-2.882433	
	10% level		-2.577990	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RTCA)				
Method: Least Squares				
Date: 08/10/14 Time: 20:02				
Sample (adjusted): 2003M01 2014M06				
Included observations: 138 after adjustments				

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RTCA(-1)	-0.835916	0.085215	-9.809445	0.0000
C	1.804790	2.143901	0.841825	0.4014
R-squared	0.414362	Mean dependent var		-0.419442
Adjusted R-squared	0.410055	S.D. dependent var		32.60589
S.E. of regression	25.04389	Akaike info criterion		9.293523
Sum squared resid	85298.69	Schwarz criterion		9.335947
Log likelihood	-639.2531	Hannan-Quinn criter.		9.310763
F-statistic	96.22520	Durbin-Watson stat		1.937838
Prob(F-statistic)	0.000000			

Forward Freight Agreements

Null Hypothesis: RFFA has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=23)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-33.44347	0.0000
Test critical values:	1% level		-3.434270	
	5% level		-2.863158	
	10% level		-2.567679	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(RFFA)				
Method: Least Squares				
Date: 08/10/14 Time: 20:05				
Sample (adjusted): 8/03/2007 12/02/2013				
Included observations: 1585 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RFFA(-1)	-0.827937	0.024756	-33.44347	0.0000
C	-0.037726	0.069233	-0.544920	0.5859
R-squared	0.414022	Mean dependent var		0.001914
Adjusted R-squared	0.413652	S.D. dependent var		3.599026
S.E. of regression	2.755896	Akaike info criterion		4.866623

Sum squared resid	12022.83	Schwarz criterion	4.873397
Log likelihood	-3854.799	Hannan-Quinn criter.	4.869140
F-statistic	1118.465	Durbin-Watson stat	1.995383
Prob(F-statistic)	0.000000		

Appendix 3- EGARCH Estimations

P1A Route-Daily

Dependent Variable: R1				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 15:46				
Sample (adjusted): 11/04/2002 6/27/2014				
Included observations: 2907 after adjustments				
Convergence achieved after 56 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.065996	0.020822	3.169494	0.0015
	Variance Equation			
C(2)	-0.661207	0.025278	-26.15765	0.0000
C(3)	1.299537	0.040690	31.93729	0.0000
C(4)	-0.019564	0.028257	-0.692371	0.4887
C(5)	0.754905	0.012461	60.58126	0.0000
R-squared	-0.000648	Mean dependent var		-0.027269
Adjusted R-squared	-0.000648	S.D. dependent var		3.665746
S.E. of regression	3.666932	Akaike info criterion		4.417662
Sum squared resid	39075.22	Schwarz criterion		4.427939
Log likelihood	-6416.072	Hannan-Quinn criter.		4.421365
Durbin-Watson stat	0.315523			

P2A Route-Daily

Dependent Variable: P2ARETURNS	
Method: ML - ARCH (Marquardt) - Normal distribution	
Date: 08/12/14 Time: 17:47	
Sample (adjusted): 11/04/2002 6/27/2014	
Included observations: 2907 after adjustments	

Convergence achieved after 28 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.001130	0.000169	6.691940	0.0000
	Variance Equation			
C(2)	-3.651827	0.120935	-30.19667	0.0000
C(3)	1.222144	0.042875	28.50468	0.0000
C(4)	-0.061819	0.030332	-2.038119	0.0415
C(5)	0.679732	0.013243	51.32808	0.0000
R-squared	-0.002029	Mean dependent var		0.000151
Adjusted R-squared	-0.002029	S.D. dependent var		0.021747
S.E. of regression	0.021770	Akaike info criterion		-5.467990
Sum squared resid	1.377188	Schwarz criterion		-5.457714
Log likelihood	7952.724	Hannan-Quinn criter.		-5.464288
Durbin-Watson stat	0.354149			

P3A Route- Daily

Dependent Variable: RETURNSP3A				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 17:53				
Sample (adjusted): 11/04/2002 6/27/2014				
Included observations: 2907 after adjustments				
Convergence achieved after 65 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	8.23E-06	0.000275	0.029989	0.9761
	Variance Equation			

C(2)	-3.109132	0.097651	-31.83926	0.0000
C(3)	1.253857	0.042402	29.57060	0.0000
C(4)	0.049115	0.028392	1.729881	0.0837
C(5)	0.714437	0.011983	59.62240	0.0000
R-squared	-0.000057	Mean dependent var		0.000279
Adjusted R-squared	-0.000057	S.D. dependent var		0.036022
S.E. of regression	0.036023	Akaike info criterion		-4.562796
Sum squared resid	3.770943	Schwarz criterion		-4.552519
Log likelihood	6637.024	Hannan-Quinn criter.		-4.559093
Durbin-Watson stat	0.392218			

<u>P4A Route-Daily</u>

Dependent Variable: RETURNSP4A				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 17:56				
Sample (adjusted): 11/04/2002 6/27/2014				
Included observations: 2907 after adjustments				
Convergence achieved after 310 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000814	0.000146	5.571609	0.0000
	Variance Equation			
C(2)	-1.299164	0.021052	-61.71333	0.0000
C(3)	1.411037	0.016750	84.23961	0.0000
C(4)	-0.197173	0.007851	-25.11382	0.0000
C(5)	0.948017	0.002031	466.6809	0.0000
R-squared	-0.000966	Mean dependent var		-0.015884
Adjusted R-squared	-0.000966	S.D. dependent var		0.537302
S.E. of regression	0.537561	Akaike info criterion		-3.644189

Sum squared resid	839.7523	Schwarz criterion	-3.633912
Log likelihood	5301.828	Hannan-Quinn criter.	-3.640486
Durbin-Watson stat	1.676499		

Average 4 T/C-Daily

Dependent Variable: RETURNS4TC				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 18:00				
Sample: 11/01/2002 6/27/2014				
Included observations: 2908				
Convergence achieved after 29 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000137	0.000206	0.666672	0.5050
	Variance Equation			
C(2)	-3.807050	0.170713	-22.30085	0.0000
C(3)	1.433610	0.056055	25.57527	0.0000
C(4)	-0.003536	0.035593	-0.099353	0.9209
C(5)	0.672270	0.019670	34.17658	0.0000
R-squared	-0.000029	Mean dependent var		-5.81E-06
Adjusted R-squared	-0.000029	S.D. dependent var		0.026789
S.E. of regression	0.026790	Akaike info criterion		-5.139376
Sum squared resid	2.086310	Schwarz criterion		-5.129102
Log likelihood	7477.652	Hannan-Quinn criter.		-5.135674
Durbin-Watson stat	0.285582			

Forward Freight Agreements

Dependent Variable: RFFA				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 18:27				
Sample (adjusted): 8/02/2007 12/02/2013				
Included observations: 1586 after adjustments				
Convergence achieved after 13 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.069053	0.051674	-1.336321	0.1814
	Variance Equation			
C(2)	-0.126658	0.012095	-10.47200	0.0000
C(3)	0.200803	0.017581	11.42137	0.0000
C(4)	-0.005109	0.008960	-0.570183	0.5686
C(5)	0.985614	0.003180	309.9730	0.0000
R-squared	-0.000061	Mean dependent var		-0.047196
Adjusted R-squared	-0.000061	S.D. dependent var		2.796293
S.E. of regression	2.796378	Akaike info criterion		4.559679
Sum squared resid	12394.28	Schwarz criterion		4.576605
Log likelihood	-3610.825	Hannan-Quinn criter.		4.565967
Durbin-Watson stat	1.655404			

P1A Route- Monthly

Dependent Variable: R1A		

Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 18:08				
Sample (adjusted): 2002M12 2014M06				
Included observations: 139 after adjustments				
Convergence achieved after 31 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	3.527076	1.831107	1.926199	0.0541
	Variance Equation			
C(2)	0.512500	0.273542	1.873566	0.0610
C(3)	0.422049	0.190294	2.217875	0.0266
C(4)	-0.444929	0.134207	-3.315250	0.0009
C(5)	0.870681	0.041155	21.15613	0.0000
R-squared	-0.000009	Mean dependent var		3.624201
Adjusted R-squared	-0.000009	S.D. dependent var		31.78934
S.E. of regression	31.78949	Akaike info criterion		9.325199
Sum squared resid	139458.9	Schwarz criterion		9.430755
Log likelihood	-643.1013	Hannan-Quinn criter.		9.368094
Durbin-Watson stat	1.897816			

P2A Route-Monthly

Dependent Variable: R2A				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 18:10				
Sample (adjusted): 2002M12 2014M06				
Included observations: 139 after adjustments				
Convergence achieved after 26 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.457908	1.507330	1.630637	0.1030
	Variance Equation			

C(2)	0.977205	0.317062	3.082058	0.0021
C(3)	0.292953	0.188930	1.550595	0.1210
C(4)	-0.254670	0.113670	-2.240428	0.0251
C(5)	0.789637	0.066140	11.93882	0.0000
R-squared	-0.000989	Mean dependent var		1.852468
Adjusted R-squared	-0.000989	S.D. dependent var		19.31848
S.E. of regression	19.32803	Akaike info criterion		8.604203
Sum squared resid	51553.05	Schwarz criterion		8.709760
Log likelihood	-592.9921	Hannan-Quinn criter.		8.647099
Durbin-Watson stat	1.471560			

P3A Route-Monthly

Dependent Variable: R3A				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 18:14				
Sample (adjusted): 2002M12 2014M06				
Included observations: 139 after adjustments				
Convergence achieved after 66 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	1.849582	2.701572	0.684632	0.4936
	Variance Equation			
C(2)	0.797431	0.355866	2.240815	0.0250
C(3)	0.094599	0.132498	0.713964	0.4752
C(4)	-0.423431	0.111347	-3.802804	0.0001
C(5)	0.873681	0.063197	13.82478	0.0000
R-squared	-0.003466	Mean dependent var		3.863799
Adjusted R-squared	-0.003466	S.D. dependent var		34.33539
S.E. of regression	34.39485	Akaike info criterion		9.584393
Sum squared resid	163254.8	Schwarz criterion		9.689950
Log likelihood	-661.1153	Hannan-Quinn criter.		9.627288
Durbin-Watson stat	1.767723			

Dependent Variable: R4A				
Method: ML - ARCH (Marquardt) - Normal distribution				
Date: 08/12/14 Time: 18:16				
Sample (adjusted): 2002M12 2014M06				
Included observations: 139 after adjustments				
Convergence achieved after 208 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-54.98971	0.671855	-81.84756	0.0000
	Variance Equation			
C(2)	14.61289	0.408917	35.73563	0.0000
C(3)	1.062076	0.114847	9.247728	0.0000
C(4)	1.557461	0.080153	19.43107	0.0000
C(5)	-0.473602	0.037256	-12.71211	0.0000
R-squared	-0.003841	Mean dependent var		-227.1889
Adjusted R-squared	-0.003841	S.D. dependent var		2788.584
S.E. of regression	2793.934	Akaike info criterion		13.54255
Sum squared resid	1.08E+09	Schwarz criterion		13.64811
Log likelihood	-936.2072	Hannan-Quinn criter.		13.58544
Durbin-Watson stat	2.006918			

Average 4 T/C-Monthly

Dependent Variable: RTCA		
Method: ML - ARCH (Marquardt) - Normal distribution		
Date: 08/12/14 Time: 18:34		
Sample (adjusted): 2002M12 2014M06		

Included observations: 139 after adjustments				
Convergence achieved after 45 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(2) + C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(4)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(5)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.692614	2.036943	1.321890	0.1862
	Variance Equation			
C(2)	0.966559	0.332250	2.909132	0.0036
C(3)	0.194824	0.175104	1.112620	0.2659
C(4)	-0.391286	0.158860	-2.463084	0.0138
C(5)	0.821916	0.066585	12.34381	0.0000
R-squared	-0.000161	Mean dependent var		2.373230
Adjusted R-squared	-0.000161	S.D. dependent var		25.24625
S.E. of regression	25.24829	Akaike info criterion		9.109666
Sum squared resid	87971.70	Schwarz criterion		9.215223
Log likelihood	-628.1218	Hannan-Quinn criter.		9.152562
Durbin-Watson stat	1.655931			