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ANALYSIS OF FREIGHT DERIVATIVES AS TOOL FOR HEDGING RISK IN SHIPPING SECTOR

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Declaration of Authenticity

I, the undersigned, Ioannis Petropoulos, declare that this dissertation is my original work, gathered and utilized especially to fulfill the purposes and objectives of this study, and has not been previously submitted to any other university. I also declare that I bear the full responsibility for determining the fair use of the material.

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This master thesis was approved unanimously by the three-member Committee of inquiry, according to the regulations of the Master Science Studies Program in Shipping.

The members of the Committee were:

- Polemis Dionysios (Supervisor)

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ABSTRACT

The derivatives are quite recent in the shipping market. For this reason, even up to now a small part of shipping companies are using them as tool for hedging the risk, coming from the freight market itself. With this thesis, we will try to answer some basic questions, like if FFAs can eventually decrease this kind of risk. Through the statistical analysis, we will try to find out if there is a co-movement between the FFA and the respective index. Since we know that in order to decrease the risk of a time-series, you only have to predict it, we will use the VECM (Vector Error Correction Models) in order to forecast the BCI 180 index through the FFA-Cape 180 5TC. At the same time, it is declared from the very beginning that the data are limited – concerning the time – and that we use only one index (which is related with specific routes) and only one vessel size. As a result, taking under consideration all above restrictions we can ensure that the research is not reflecting the whole market, but can also trigger further and bigger analysis.

Keywords: FFA, freight rates, IMAREX, time series, VECM

ΠΕΡΙΛΗΨΗ

Τα παράγωγα εμφανίσθηκαν αρκετά πρόσφατα στην ναυτιλιακή αγορά, συνεπώς χρησιμοποιούνται από μικρό - ακόμη - μερίδιο των ναυτιλιακών εταιρειών ως μέσο αντιστάθμισης του κινδύνου που ενέχει η αγορά των ναύλων από την φύση της. Στην παρούσα εργασία θα επιχειρήσουμε να απαντήσουμε σε βασικά ερωτήματα, όπως το αν τα ναυτιλιακά παράγωγα (FFA) μπορούν εντέλει να μειώσουν αυτόν τον κίνδυνο. Μέσω στατιστικής ανάλυσης θα προσπαθήσουμε να ελέγξουμε αν τα FFA "ακολουθούν" τους ναυτιλιακούς δείκτες για τις αντίστοιχες διαδρομές πλοίων. Γνωρίζοντας λοιπόν ότι για να μειωθεί ο κίνδυνος μιας χρονοσειράς θα πρέπει να προβλεφθεί, θα επιχειρήσουμε να προβλέψουμε τον δείκτη BCI 180, μέσω του μοντέλου VECM (Vector Error Correction Models), χρησιμοποιώντας τις αντίστοιχες τιμές FFA (Cape 180 5TC). Όλα τα παραπάνω θα πραγματοποιηθούν λαμβάνοντας υπόψη ότι έχουμε περιορισμένο αριθμό

παρατηρήσεων όσον αφορά τον χρόνο, ότι εξετάζουμε μόνο έναν δείκτη, άρα όχι όλες τις διαδρομές των πλοίων, αλλά και ότι παίρνουμε μόνο ένα μέγεθος πλοίων. Συμπερασματικά, με όλους αυτούς τους περιορισμούς, μπορούμε να δηλώσουμε με βεβαιότητα ότι η έρευνα δεν αντικατοπτρίζει όλη την αγορά, αλλά μπορεί να αποτελέσει έναυσμα για μια μεγαλύτερης κλίμακας έρευνα.

Λέξεις – κλειδιά: ναυτιλιακά παράγωγα, ναυλαγορά. IMAREX, χρονοσειρά, VECM

CHAPTER 1 INTRODUCTION

The global economy depends on many different factors. Of great importance to the economy are commodities, such as grain, crude oil, iron ore and chemicals. These form the basis for almost all products in the world. So, in this globalised world, efficient goods transport from continent to continent is an increasingly indispensable economic growth factor. More than 95% of world trade (in volume) is carried by marine vessels. Transport volume has risen worldwide from 2800 million tons in 1986 to 4700 in 2005 (Kavussanos, M. and Visvikis, I., 2006).

The market for freight rates is complex. Market participants include shipowners, operators and charterers, all of whom are exposed to significant price risk. Reasons for changes in freight rates are manifold. From a long-term perspective, vessel supply determines the supply curve of shipping services. Thus, information on vessel availability, production and scrapping has a direct influence on equilibrium price levels. Demand for shipping services is closely linked to the demand for the commodities that require transportation. The more goods used in industrial production, the greater the demand for delivery services. Thus, the equilibrium freight rate level responds to changes in industry-specific demand and economic growth in general.

From a financial perspective, freight rates are typically considered part of the commodity market. However, freight rates exhibit some characteristics that distinguish them from most other markets. In contrast to all major traded commodities freight rates can be considered costs of services, not products. Therefore, they are essentially not storable, a property that makes simple cost-of-carry valuations of futures contracts for freight rates impossible. Further, the freight rate spot market shows a high degree of volatility, which causes significant risks for shipowners and charterers alike, creating a substantial hedging demand.

For a shipping company these risks can be associated with change in company value due to fluctuations in freight rates, operating costs, interest rates or asset prices (ships). The vessels running costs like manning and repairs are virtually constant, and may be controlled in the same way as in any other business. However, the vessels earnings may vary substantially from year to year, and month to month. For a shipping company, freight rate risk is arguably the most significant of all risks. Freight rate fluctuations affect the shipping companies' cash flow and ship values. From 2003 to mid-2008 bulk shipping freight rates increased by 300 per cent, and then dropped 95% in the last quarter of 2008. The fluctuations have made investors like Fredriksen, Niarchos and Onassis extremely wealthy, but also forced giant companies like OSG, Genmar and Sanko to file for chapter 11. Hedging tools like time-charter contracts and contracts of affreightment (COA) have long been recognized as risk management tools by shipowners and charterers.

In the early 1980s they realized that risk management techniques applied on commodities -and financial markets could be developed for risk management in the shipping industry. This led to BIFFEX, the first exchange-traded freight futures contract in May 1985, and development of the over-the-counter market for Forward Freight Agreements (FFA) in the mid-1990s. Shipowners and charterers could now hedge their freight rate risk through future positions in time -and voyage charter contracts. This also gave them the opportunity to include the market's expectations for the future path of the freight rates in the decision process. The BIFFEX contract was de-listed due to low liquidity in 2001. Forward freight agreements (FFA) grew almost exponentially from 1992 to 2008 and are still traded.

As a result, the availability of futures in the market creates the need for appropriate valuation models. Previous research focuses mainly on econometric aspects of the forward freight market such as Kavussanos and Nomikos (1999), Haigh (2000), Kavussanos and Nomikos (2003), Kavussanos and Visvikis (2004), and Batchelor et al. (2007).

In the present paper, we study the Baltic Exchange index BCI 180 (Baltic Capesize Index) and the FFA-Cape 180 5TC (Freight Forward Agreement-Cape 180 for five years time-charter) in order to answer the following questions:

• Can hedging in FFA reduce freight revenue variability?

• Does econometric based hedging strategies outperform naive strategies?

• Are econometric based hedging strategies robust out of sample?

• Are FFA prices good predictors of subsequent index prices?

We expect FFA hedging to generate a substantial reduction in freight rate variability and to be robust out of sample, but are uncertain on the magnitude of this risk reduction. Based on talks with market participants, we do not anticipate econometric based hedging strategies to significantly outperform naive strategies. We expect to find that the forecasting performance varies across vessel types and forecasting horizons.

The remainder of the paper is structured as follows.

Chapter one provide an introduction to the most important supply and demand drivers for seaborne transport, how ships are employed, investigated vessel types, Baltic Exchange, Forward Freight Agreements (FFA) and Freight futures.

Chapter two presents the trading of freight, through the exchanges, advising also the internal and external factors which affecting the freight rates.

Chapter three provide introduction to derivatives

Chapter four gives an overview of the freight derivatives (future contracts, FFA, options etc)

Chapter five presents statistical analysis for the BCI 180 index and the FFA-Cape 180 5TC, using the Vector Error Correction Model (VECM)

Chapter six summarizes the key findings and presents the conclusions of this thesis.

1.1. Supply and demand for seaborne transport

Seaborne transport is for many commodities the only, or by far the most economical mode of transport. Imports and exports of raw materials and semi-finished products are the single most important shipping demand driver. The main cargoes transported are crude oil, iron ore, coal and grains. The economic centers of North America, Europe and Asia dominate the maritime trade. Brazil and Australia are the largest exporters of iron ore and coal, while China is the largest importer. Shipments with crude oil from the Middle East Gulf to Asia and North America dominate the seaborne transport of wet cargoes. The shipping industry can be characterized as capital intensive, cyclical, volatile, and seasonal (Kavussanos & Visvikis, 2006).

The supply side of maritime transport responds slowly to changes, while demand may change rapidly and on an irregular basis, which in turn causes volatile freight rates. The single most important demand factor is the world economy. Fluctuations in the growth rate affect demand for raw and semi-finished materials, which in turn affect the demand for sea transport. Time lags, stock building, mass psychology and multiplier effects enhance the freight rates fluctuations. The share of traded goods transported by sea, and average distance from exporter to importer is crucial. Random shocks in climate, resources, political frameworks and commodity prices may cause large shifts in demand. Finally, transport from distant locations will only take place if the total price (or quality) included transport cost is lower compared to the alternative. Inelastic short-term demand cause peaks in the freight rate, and rates tend to become volatile when they move above the vessels operating costs Stopford (2009).

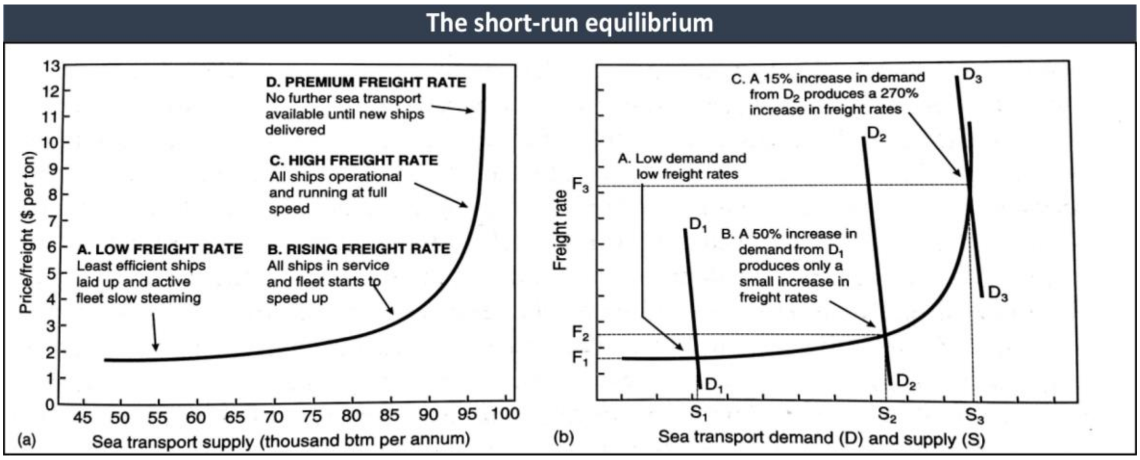
Table 1. 1 Ten important factors affecting demand and supply for seaborne transport.

Supply and demand	
Supply	**Demand**
The world economy	World fleet
Seaborn commodity trade	Fleet productivity
Average haul	Shipbuilding
Random Shocks	Scrapping
Transport costs	Freght revenue

Compiled from Stopford 2009

Supply starts with the size of the merchant fleet, and is influenced by shipowners, bankers, charterers and regulatory authorities. The number of ships built or scrapped determines fleet rate growth. It takes around a year to build a merchant vessel, 2-3 years if the shipyards are busy. Average economic life of a ship is around 25 years, which results in a low number of vessels scrapped each year. This means that it takes years, not months before the fleet size adjust after a large shift in demand. Fleet productivity is determined by the vessels speed, port time and deadweight utilization. When supply is low, rates rise and give incentive for owners to order more vessels. In period of high supply of vessels and low freight rates, vessels utilize low steaming to minimize operating expenses. If the latter is infective measure, then vessels are either laid-up or sold for scrap.

Figure 1 Short-run equilibrium: (a) short-run supply function; (b) short run adjustment.



Compiled from Stopford 2009.

The short-run supply curve is shown in figure 1.1a. It illustrates the ton-miles of transport available at various levels of freight rates, for a given size of fleet. When freight rate is low, inefficient ships are laid up. As the freight rate increases, laid up ships enters the market in operational status, which in turn causes the supply to increase. Further on, we note that the short-run supply curve become more inelastic when freight rate increases. When the market reaches premium freight rate, the elasticity is almost perfect and no further supply is obtained by increasing freight rate. In a market situation with high and premium freight rates, all ships will be operational and running at full speed. Further supply will only be available when newbuildings enter the market. Turning to the short-run adjustment with demand curves, we can elaborate how freight rates are determined. Freight rates are settled were supply equals demand. Figure 1.1b shows three equilibrium points, all with different supply/demand levels. When demand is low, freight rates are settled at point $F1$. Because the supply curve is elastic in periods with low freight rates, an increase in demand to point B will only result in a slight increase in freight rates. At point C, the supply curve become inelastic and the shift in demand is sufficient to treble the level of freight rates to point $F3$.

Short-run supply and demand are also influenced by seasonal cycles, both short and long. Examples of seasonal cycles are the high volumes of grain transported from August and the end of the year, and high demand for shipments with oil to the Northern Hemisphere in the winter. Short cycles, also called business cycles, may have duration between 3 to 12 years. Long cycles are related to regional, economic or technological change (Stopford, 2009).

Table 1. 2 The market tone from 150 years of shipping cycles.

Two centuries of cycles			
Period	**Demand Growt**	**Supply tendency**	**Market tone**
1869-1914	Fast	Expanding	Competitive
1920-1930	Fast	Overcapasity	Weak
1930-1939	Falling	Overcapasity	Depressed
1945-1956	Very fast	Shortage	Prosperous
1956-1973	Very fast	Expanding	Competitive
1973-1988	Falling	Overcapasity	Depressed
1988-1997	Slow	Expanding	Competitive
1998-2007	Very fast	Shortage	Prosperous
2007-2013	Slow	Overcapasity	Depressed

Compiled from Stopford 2009 and various sources.

Shipping cycles the past 150 years are summarized in table 1.2. There have been two periods of prosperity, the 1950s and the period from 1998 to 2007. Both can be explained by growing demand for seaborne freight services and shortage of shipbuilding capacity. Three of the periods have been characterized by unusual competitiveness, with growth in trade and increased shipbuilding capacity. The weak shipping markets of the 1920s, was followed by a decrease in trade, and shipbuilding overcapacity in 1930s. The last years shipping market are characterized by first of all overcapacity of ships. The growth has been positive, much due to large Chinese imports of raw materials.

1.2. Deployment of ships

The main participants in the freight market are the shipowners and the charterers. Shipowners have vessels for hire, while charterers have cargo to transport. It is common practice that parties enter into a contractual agreement called a charter party. Most common charter parties are voyage charter, time charter, bareboat charter and contract of affreightment (COA). Costs and responsibilities are distributed differently under each contract. If the shipowner and charterer enters into a:

- *Voyage charter*, the shipowner agrees to transport a specific cargo between two ports. Freight is paid at a fixed price per ton, e.g. 15$/mt for transport of 150.000mt of coal from Richards bay to Rotterdam. Contract of affreightment (COA) is an agreement on performing a series of cargo parcels at a fixed price per ton.
- *Time charter*, the charterer decides which ports to call, and which cargo the vessel shall carry. In return, he pays a fixed rate per day in addition to port and fuel costs. If the vessel is fixed on a voyage charter or COA the shipowner pays for port costs and bunkers.
- *Bareboat charter*, the charterer manages the vessel and pays for operating and voyage costs.

The shipowner (or charterer) can secure the revenue (cost) for a period of time equal to the length of the contract. Either the shipowner or the charterer loses money when the spot freight rate or hire deviates from the agreed price. The shipowners gain is the charters loss and vice versa (Stopford, 2009).

1.3. Vessel types

Approximately 90% of all traded volume is transported by sea. Large installments, like drilling rigs and long pipes have no other alternative of transportation and are transported by purpose built vessels. Other goods like coal, grain, ore, petroleum products and consumer goods (containers) utilize the economies of scale in shipping to reduce transport costs. Tankers, bulkers and container vessels are built to carry these goods. It can therefore be more economical to import goods from thousands of miles away by sea, than to obtain the goods from some domestic location. Vessels that transport dry cargo in bulk are generally called bulk carriers. These vessels are the work horses of the fleet and transport coal, iron ore, grains, bauxite, paper rolls, fertilizer and cement. Hatches raised above deck level to cover the large cargo holds characterize bulk carriers. Vessels transporting crude oil, petroleum products and chemicals are called tankers. Tankers are similar to bulk carriers, but can be distinguished by the pipelines and vents on deck. This thesis investigates freight rates and Forward Freight Agreements (FFA) associated with these two segments, which again can be divided into subcategories of vessel types and sizes:

- **Capesize** bulk carriers typically transports coal or iron ore and has a displacement of 100,000 to 180,000 dwt. In general it serves deep-water terminals and can access 19% of the world ports. This vessel is too big for the Suez- and Panama Canal, and have to go round the Cape of Good Hope and Cape Horn.
- **Panamax** bulk carriers are primarily used for transporting grain or iron ore. Typical displacement is between 60,000 to 70,000 dwt. These vessels can enter approximately 27% of the ports in the world. It is the largest that can pass thru the Panama Canal.
- **Very large crude carriers** (VLCC) are large tankers with 120,000 - 200,000 dwt displacement. They are primarily used for large shipments of crude oil between the Arabian Gulf to U.S, Western Europe and Japan. These vessels are too large to transit the Suez laden, but can be ballasted through on the return voyage.
- **Suezmax** are midsized tankers with 120,000 - 200,000 dwt displacement primarily used to transport crude oil. This is the largest ship that can transit the Suez Canal fully loaded. A typical trading route for a Suezmax is between West Africa and the U.S. Atlantic coast.
- **Aframax** tankers mainly transport crude oil and have a displacement of 0,000 - 120,000 dwt. They typically trade in routes with short distances and areas with limited port resources. These vessels are recognized as the work horses of the tanker fleet. Their size allows them to operate in areas where crude production is relatively low, or where restrictions on draft or size prevent the use of Suezmax or VLCCs.
- **Long range 1** (LR 1) are coated product tankers with displacement from 55,000 to 90,000 dwt. By products one usually mean light distillates of crude oil like kerosene, gasoline and naptha. Due to an expansion of refinery capacity in the

Middle East, India and China this is a vessel category that is increasing in popularity

1.4. Baltic exchange and investigated trading routes

Reliable price information is crucial to obtain a well-functioning market. The leading provider of freight market information is the Baltic Exchange. Freight rate information is calculated on a daily basis using data from an independent panel of shipbrokers. Information is based on shipbrokers assessments of the market level for each trading route. These assessments are based on recent fixtures, current negotiations and the balance between supply of ships and demand for transport (Alizadeh & Nomikos, 2009). Freight information is reported to the market 13:00 London time, and is the aritmetric average of all received assessments that day. The Baltic Exchange provides daily assessments on over 50 of the largest shipping routes. In addition they report weekly sale & purchase and demolition assessments as well as daily forward prices. The first Baltic index was published in 1985. It consisted of 13 voyage routes covering bulk vessels from 14,000mt to 120,000mt. Today, the Baltic Exchange produces indices covering a wide range of vessel and cargo types. Examples of Baltic indices are Baltic Capesize Index, Baltic Panamax Index, Baltic Clean Tanker Index, and Baltic Dirty Tanker Index. The most important trading routes in each segments makes up each index. In the Capsize segment we investigate route C3, C4, C5 and C7. These are voyage charter routes quoted in US dollars per metric tons of transported cargo. The most important iron ore routes, C4 and C5, reflect transport from Brazil to China and Australia to China, respectively. C4 and C7 are the most important coal routes and mirrors transportation from South Africa and Colombia to The Netherlands, respectively. In the Panamax segment we have investigated route P2A_03 and P3A_03. These are trip-charter routes quoted in dollars per day. P2A_03 is based on delivery in Skaw-Gibraltar, with redelivery in the Taiwan-Japan region Duration of this voyage range between 60-65 days. P3A_03 is based on delivery in Japan-South Korea, with redelivery in the same region. This voyage has duration of 35-50 days. (Simpson Spense & Young).

Table 1. 3 Overview of investigated trading routes.

Overview of selected routes from Baltic Exchange				
Segment/Route	**Vessel size**	**Cargo basis**	**Route description**	**Index**
Capesize				
C3	150 000mt	Iron Ore	Tubarao/Qingdao	Baltic Ex. Capesize Index
C4	150 000mt	Coal	Richards Bay/Rotterdam	Baltic Ex. Capesize Index
C5	150 000mt	Iron Ore	W Australia/Qingdao	Baltic Ex. Capesize Index
C7	150 000mt	Coal	Bolivar/Rotterdam	Baltic Ex. Capesize Index
Panamax				
P2A_03	74 000mt dwt	Grain	Skaw/Gibraltar	Baltic Ex. Panamax Index
P3A_03	74 000mt dwt	Grain	Japan/South Korea	Baltic Ex. Panamax Index
Clean Tanker				
TC5	55 000mt	Clean Products	Ras Tanura to Yokohama	Baltic Ex. Clean Tanker Index
Dirty Tankers				
TD3	265 000mt	Crude Oil	Middle East Gulf/Japan	Baltic Ex. Dirty Tanker Index
TD5	130 000mt	Crude Oil	West Africa/USAC	Baltic Ex. Dirty Tanker Index
TD7	80 000mt	Crude Oil	North Sea/Continent	Baltic Ex. Dirty Tanker Index

Compiled from various sources.

Routes in the tanker segment are quoted inWorldscale1 points. We examine the TC5 route, which along with TC2 is the most important routes for clean tankers. The TC5 reflects transportation from Saudi Arabia to Japan by a LR1 tanker loaded with naphtha condensate. Within the dirty tanker segment we investigate route TD3, TD5 and TD7. These are the most important dirty routes in terms of physical trade. Route TD3 is operated by a VLCC, and reflects transportation of crude oil from the Middle East to the Far East. TD5 is operated by a Suezmax vessel for transportation of crude oil from West Africa to US. Finally, TD7 is operated by an Aframax tanker and mirrors shipments with crude oil from the North Sea to the Continent (Alizadeh & Nomikos, 2009). Used as basis for calculation of tanker spot rates. Worldscale points show the cost of transporting a tonne of cargo using the standard vessel on a round voyage, also known as Worldscale 100 (Stopford, 2009).

CHAPTER 2 TRADING FREIGHT

Until recently freight was mentioned as the contracted price paid for the actual service of transporting goods. . Today though, there are other ways that provides you the opportunity to trade freight, . Also organizations that are not directly interested in the service of transporting goods can still have a great interest in the freight market. This is because financial products related to freight are provided by the freight market. Different kinds of financial contracts exist, in which agreements are made about paying and receiving a certain amount of money, which is related to the freight rates. To give a very simple example, one could trade a contract which states that three days from now one will pay the seller of that contract the value which the freight rate of a certain route and charter-type had two days ago and one will receive the value it will have two days from now.

This example gives a good insight in how freight can be traded by not actually trading the service itself, but by 'trading the freight rates'. There are many financial contracts like this circling in the freight market. In fact, these contracts form a much larger freight market share than the actual trading of the freight service. In section 4 some of these contracts and reasons why the market provides them are discussed.

2.1 Exchanges

Organizations, traders and analysts who are interested in freight are keen on data and information regarding the freight market. Transparency is important in the process of price discovery. There are exchanges and trading platforms for freight, just as there are exchanges for commodities and stocks. An exchange is a highly organized, regulated market where (financial) contracts can be bought and sold. An exchange supports the process of price discovery by providing information for everyone with interest in the contracts being traded.

2.1.1 The Baltic Exchange

The most well-known freight exchange is the Baltic Exchange in London, which is an independent source of maritime market information. It was founded in 1744. The organization provides independent daily shipping market information, maintains professional ship-broking standards and resolves disputes. Parties with interest in trading freight contracts4 can become a member of this foundation. A lot of the information about freight in this document has been found in paper [5] about the Baltic Exchange.

Just like the S&P500 shows the development of the stock rates from the 500 largest companies on the U.S. stock exchange, the Baltic Exchange developed an index for freight. This Baltic Freight Index BFI shows the development of freight rates for sea routes that are most used. At the beginning, in 1985, the Baltic Freight Index was based on 13 different routes. In time, more routes were added and after a while, the Baltic Freight Index got split into subcategories. There are now indices which reflect freight rates for dry bulk only (Baltic Dry Index, or BDI), for Capesize vessels (Baltic Capesize Index, or BCI), for Panamax vessels (Baltic Panamax Index, or BPI), and so on. The Baltic Dry Index is most used in the freight market, because of the large market share of dry bulk commodities. (www.balticexchange.com)

2.1.2 IMAREX

Another well-known freight trading facility is offered by the International Maritime Exchange (IMAREX) in Oslo. It was founded in 2000 and began as a small association, but nowadays it handles financial freight products worth over USD 200 billion per year (http://www.newsweb.no).

Figure 2 Baltic Dry Index and S&P500 during 2012-2013

As found on www.bloomberg.com.

In figure 3 a relative chart with the Baltic Dry Index and the S&P500 over 1 year are presented. The graphs show the percentage changes from, respectively, the Baltic Dry Index and the S&P500, compared to the values of these two indices at the beginning of June 2013. The absolute percentage changes of the Baltic Dry Index are much higher than those of the S&P500. In other words, the Baltic Dry Index varies much more than the S&P500. This is in line with the statement in subsection 1, that freight rates are very volatile.

2.2 Factors which effect freight rates

In the beginning of this chapter the high volatility of freight rates was mentioned. There are many different events, which can have an effect on the cost of sea transport. A distinction can be made between internal and external factors. Internal factors cover factors directly related to freight, like fleet supply and commodity demand, while external factors, such as seasonal pressures, do not influence freight directly. When looking at some examples of this second type of factor more closely, it can be seen that they can have an enormous influence on the freight rates. This makes external factors at least as important as internal drivers.

2.2.1 Internal factors

The first internal factor that drives freight rates is fleet supply. When few ships are available for chartering, while at the same time on a relative basis many parties wish to charter a vessel, freight rates will rise. When, on the other hand, many ships are available, freight rates will decrease. As with all products and markets it is a matter of supply and demand. For the reason described above, it is important for both ship owners and ship charterers to spend sufficient time on fleet analysis. Awareness of the global and regional number of vessels per type or class is crucial, as much as the age of those ships. When, for example, globally 50 Capesize vessels are available, out of which 40 are over 20 years old (whereas the expected lifetime of a Capesize vessel is only 25 years), it is reasonable to expect that soon there will be a shortage of those ships.

Therewith, tension in the market is expected. This will then most likely put upward pressure on the freight rates for Capesize vessels. This way, ship owners, charterers and financial institution try to forecast freight rates (at least that part which depends on fleet supply). A logical continuation of freight rate evaluation, after looking at the fleet supply, is to look at the demand-side, the commodity demand. When commodities have to be transported, but the availability of ships is relatively low, freight rates will increase. Conversely, when the demand is relatively low, freight rates will decrease. So, when, for example, the grain harvest has been very successful, a lot of grain has to be shipped, which results in high freight rates (of course under the condition of ceteris paribus). Market participants with interest in the freight market usually try to forecast commodity demand in some way, because they want to make an accurate estimation of how the freight rates will behave in the future. The fleet supply is the internal factor having the biggest influence on the freight rates.

As mentioned already in chapter 1, the shipbuilding has direct influence on the freight market. Newbuilding prices are determined by supply and demand. The shipping companies are the buyers and the shipyards are the sellers. Key factors on the demand side are freight rates, the price level of modern second-hand vessels, financial resources available to the shipping companies, access to credit and, most importantly, expectations for the future. Shipyard supply is governed by production costs, the slipway and the size of the orderbook. In times of economic expansion, the shipyards most often have a large order backlog, pushing up newbuilding prices. The opposite happens during a recession – due to excess capacity the shipyards lower their newbuilding prices to tempt the shipping companies.

We explained how the freight rates affect the shipbuilding prices. However we observe counter effect into the same case. The shipbuilding in general affects the freight rates. If we have big orderbook for new vessels, then the force for decreasing the freight will be bigger. In other words, it's the oversupply of vessels since 2010 which keeps the freight rates in low levels.

Another reason affecting the freight rate is the opposite of shipbuilding, the scrapping of the ships. Is very easy to understand that the scrapping of the vessels leads to low ship supply and eventually to increasing of freight rates.

2.2.2 External factors

Next to internal factors there are external factors, which affect freight rates. First of all, seasonal pressures can have a great effect on the rates. In winter time, low temperatures (frost) can cause ice, which affects the routes ships can take. When detours have to be taken, not only the total freight costs rise, due to longer travel time, but also the freight rates will rise, because longer traveling time results in less availability of ships. Season or weather can also influence the harvest. When the weather is optimal, harvest will be successful, which results in a large demand of transport, and therefore high freight rates. Another factor, which affects freight rates, is the price of bunker fuel. When the price of bunker fuel rises, the costs for transport will increase as well. Therefore, high fuel prices result in high freight rates.

Currency exchange rates are also of influence on freight rates. Consider an Australian ship charterer who wants to transport its goods from the U.S. to Australia. The Australian company wants to charter a ship from a U.S. charterer. Doing so, he will first need to exchange Australian dollars for U.S. dollars. When the exchange rate between Australian and U.S. dollars is favorable for the Australian company, freight rates that the U.S. company will charge the Australian company for, will be relatively low. Low freight costs will support high demand, which then in time results in higher freight rates. That means that foreign exchange rates cause freight rates to fluctuate (volatility).

Political factors have direct influence on freight rate as well. These factors include the government's intervention in trade and shipping matters, as well as the use of trade policies to protect home-made products against foreign goods. Considerations by government bodies on whether to intervene include whether the government is democratically elected by citizens and has predetermined fiscal policies, and whether the country is a member of any economic/ trading bloc and its attitudes towards maintaining membership of international conventions.

Other political factors refer to occurrences such as wars, revolutions, national crises, or even strikes. Examples of political events include the Korean War in the 1950s, which led to commodity stockpiling in Western countries, the invasion of Kuwait by Iraq in 1990, which created an increase of tanker freights because speculators used tankers for oil storage (UNCTAD 2002 report).

Above, only a few of the widespread factors that influence freight rates have been mentioned. It is not difficult to conclude that freight rates fluctuate a lot, i.e. are very volatile. They depend on so many factors, that it is impossible for the rates to stay constant. This high volatility causes some concern. Ship-owners and charterers are not able to precisely forecast the freight rates, so they carry a lot of price risk. When a charterer wants to transport goods next month, little can be said about the price the organization will have to pay the ship-owner at that time. Also the ship-owner is exposed to a lot of price risk; this market participant cannot forecast what the future spot rates will be, so he cannot say anything about the amount of his future profit or loss. To this extent, freight derivatives have been provided.

CHAPTER 3 INTRODUCTION TO DERIVATIVES

Having introduced the different risks a shipping company faces in its day to day operation, I will now give insights to the different derivative contracts and their application, because they are also used to manage price risk. In basic, derivatives are contracts on a transaction "whose value depends or derives from the values of other […] underlying variables" (Alizadeh et al, 2009). Underlying variables can be commodities or financial assets and virtual performance is presented in indices. The contract is usually concerned with "the terms of a transaction that will take place in the future" (Alizadeh et al, 2009).

Forwards, futures, swaps and options are therefore all derivative instruments and may be traded through an exchange or over-the-counter (OTC). The former features standardized versions with pre-defined characteristics termed by the exchange. It really all started with the Chicago Board of Trade in 1848, where fixed quantities and qualities of grain could be traded between farmers and merchants, but soon also developed a so call to-arrive contract allowing agreements for the future delivery of grain. Risk management is what derivatives were originally intended for. We know that already in the 1860s farmers were able to hedge their physical positions with derivative contracts. Essentially hedging describes taking a position opposite of those in the physical market, diminishing any losses, but also gains made there.

"Hedgers are either short or long" (Amir H. Alizadeh & Nikos K. Nomikos, 2009). A farmer would naturally be long on grain, because he produces it and aims to sell it for profit. Then farmers could enter into future contracts, selling (paper-) grain they did not yet harvest at the prevailing price; i.e. go short on the paper trade. If later the market softened and they would be forced to sell at a loss (grain is perishable), they would make a profit on the future position, buying the contract back at a price lower than originally shorted.

This circumstance has the benefit that now we can take a much riskier position on the physical trade than otherwise feasible (Amir H. Alizadeh & Nikos K. Nomikos, 2009) and may therefore also lead to a more efficient allocation of resources not possible with an entirely physical risk management strategy. In the grain case that could mean that the farmer can grow more crops on the land owned with less risk of bankruptcy when not being able to sell it at harvest.

Hedging with derivatives implies transferring the risk to someone else that is willing to take it in return for a possible profit. Essentially the basis for derivatives trading then becomes speculation, because either one party has different expectations of future market developments. In fact, it appears that many more derivative contracts are traded for speculative reasons rather than risk management purposes. Alizadeh & Nomikos (2009) point out a number of characteristics that facilitate this speculation:

1. Very high liquidity,
2. Low transaction costs and
3. The possibility to forward (short) sell.

This ensures that almost all sellers will find a buyer (liquidity), at a very low cost and even without having a position in the real market (shorting). With the use of put options and forward contracts as explained earlier, participants may much easier speculate on a falling market than otherwise possible in a physical market. In addition, selling future contracts on a cleared exchange (BIFFEX / IMAREX) only costs a fee, which is a mere proportion of what the position is actually worth. Over the counter agreements are personalized and may only cost brokerage or nothing at all. Both ways, low transaction costs also allow the application of leverage. Leverage is multiplying the initial investment without the necessary cash backing, but essentially borrowed money supplied through a broker or exchange. That way it increases the returns on investment, creating the possibility of very high profits (and of course losses).

High speculation may lead to the false conclusion that future prices lose their connection to the underlying asset. But if there were serious price discrepancies, it would allow traders to enter into multiple agreements and secure virtually risk- free profits, merely by capitalizing on these differences rather than real development.

This process is known as arbitrage and the fact that enough people seeking it (called arbitrageurs) exist, brings the asset and contract back in line (however then leaving it to the composition of the index). Through arbitration and in general, “derivatives markets provide a mechanism through which the supply and demand for an asset are brought into alignment" (Alizadeh et al, 2009). By sharing both, present and future (expected) spot prices, the derivatives markets have a price discovery role that adds to the overall transparency. As already mentioned this helps towards a better allocation of resources facilitated by reduced search and transaction costs as well as additional guidance for production and consumption decisions.

From then futures exchanges have been created all around the world, beginning as open-entry trade floors and developing into electronic platforms automatically performing transactions though high-tech computer systems.

Over the counter contracts (OTC) on the other hand are traded in a network of agents and brokers, usually arranging via telephone or email. The main difference to the exchange platform based system is that agreements are not set by the standards of the exchange, but are tailor-made for the individual client. That way, terms such as expiry date and underlying commodity can be chosen freely. On the other hand they also lack the security provided be an exchange and therefore are subject to credit risk, as explained earlier.

3.1 Futures and Forwards

Now to the different derivative contracts that can be used to manage the above risks: As mentioned earlier there are forward contracts, futures contracts, swaps and options. The former two are virtually identical concerning their definition and functioning; for minor details see Table 1. A very straight forward definition of a forward contract is a forward contract is an agreement entered into today between two parties, A and B, according to which, Party B has the obligation of delivering at some fixed future date a given quantity of a clearly specified underlying asset, and Party B the obligation of paying at that date a fixed amount that is agreed today (at date zero), and that is called the forward price at date zero of the asset at date T, denotes as F(0,T)" (Alizadeh et al, 2009).

Table 3 Differences between Futures and Forwards

	Futures	Forwards
Trading	Exchange-traded	OTC
Credit Risk	Guaranteed by clearing house	Counter-party risk (OTC clearing also possible)
Deposit/Collateral	Initial margin deposit	Usually not required
P&L	P&L realised daily through marking-to-market	P&L realised at the settlement of the contract
Contract Trerms	Highly standardised	Tailor-made
Closing Position	Usually by closing contracts on the exchange; offset or reversing trade	Negotiated between the counter-parties or via offsetting trades

Source: Alizadeh et al., 2009, p.11

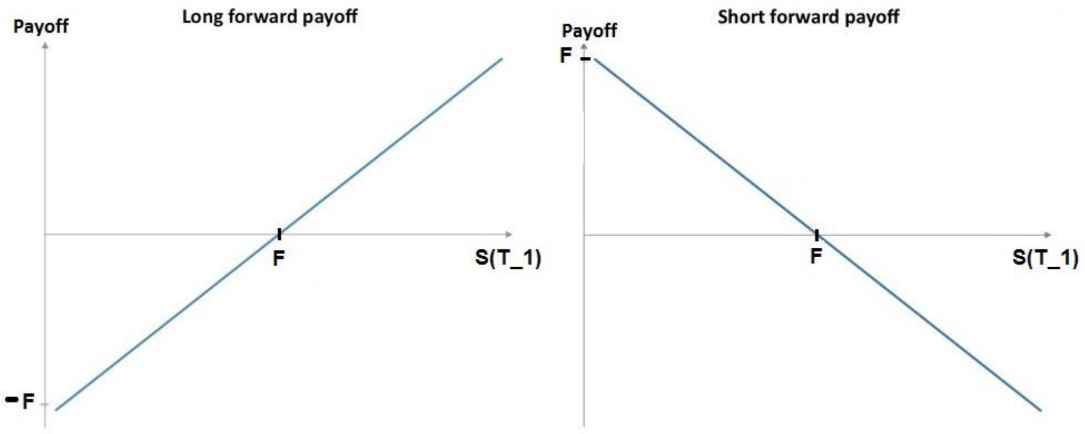
Again, the underlying asset may be anything really, such as a financial asset, a commodity or of course freight. But settlement does not have to be made physically otherwise intangible assets such as freight would not be feasible for derivative trade.

"Only in 1982 when cash settlement procedures were introduced for stock futures a valid alternative to physical delivery was created" (Grammenos, 2010).

Definition 1. A forward is a financial contract in which the holder and the writer agree to exchange the underlying asset at the settlement date for the contract price.

Using a forward contract, a trader can lock in the price (s)he will pay/receive for a certain asset in the future and (s)he does not have to worry about the risk that the price of the asset will increase/decrease. However, once the future contract starts, the two parties are obliged to exchange the underlying asset, even if it will not be profitable for (one of) them. In figure 4 the payoff of a forward for both the buyer and the seller of the contract are shown, where the variables F and S(T) have the same meaning as mentioned in the terminology ($S(T_1)$ is the settlement price at the trade date).

Figure 4. 1 Payoffs from a forward contract for both the buyer and the seller.



A future is basically the same as a forward; however, there are two main differences:

1. A future is exchange-traded, while a forward is traded over the counter (OTC). This means that a forward is a private contract between two parties, which implies there is a relatively high credit risk, also a probability of default. A future, on the other hand, is a more formal contract, whereby the clearing house takes over the counterparty risk (and therewith assures there is no credit risk for a party when the counterpart defaults).

2. Exchange-traded contracts (futures) require the two parties to settle price changes daily, so that no party ever has a large obligation to the other. Otherwise, when one party defaults while having a large obligation to the other party, the clearing house has to pay a large amount to cover this obligation. By applying this so-called marking-to-market principle, the clearing house only has small amounts of money it might has to cover. With a forward, no daily settlement is required. Note that the marking-to-market principle does not change the amount the contract pays off, it only spreads the payoff over more points in time (Alizadeh et al., 2009, p.11)

3.2. Swaps

"A swap is an agreement between two or more parties to exchange a sequence of cash flows over a period of time, at specified intervals" (Alizadeh et al, 2009).

Such arrangements are very popular with interest rates, for instance in form of "fixed-for-floating" interest swaps, where Party A agrees on paying a fixed rate on a certain principle to Party B, each year until the contract matures (e.g. 5 years). Party B in turn pays a floating rate to Party A and the difference is then settled. The same can of course be done with currencies, where one interest rate is denominated in each and another currency. In general, all assets or indices thereof are suitable for swap arrangements, but will not be discussed in depth here.

3.3. Options

"Options are financial contracts, which give their holder flexibility; that is the right - but not the obligation – to either buy or sell an asset at a specific price if market conditions are favorable" (Alizadeh, et al, 2009).

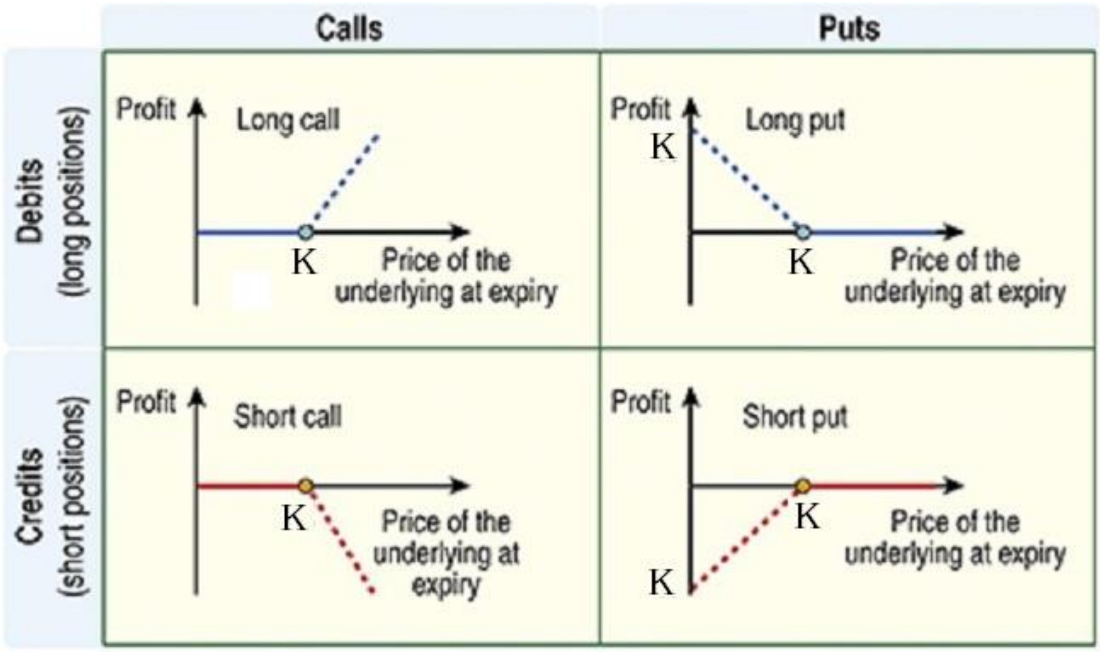
Options are usually divided into "call" and "put" options, allowing buying or selling at an agreed price until a certain time in future. This right however, has to be purchased at a price, called a premium.

Definition 2. An option is a financial contract in which the holder has the right, but not the obligation, to buy or sell the underlying asset at the strike price on or before the expiration date.

So, the main difference between an option and a future/forward is the fact that a future gives the holder (and its counterpart) an obligation, while an option gives the holder a right (but the writer also a potential obligation).

Figure 4.2 shows the payoffs for both a put and a call option with strike price K, when both long and short.

Figure 4. 2 Payoffs from a put and call option for both the buyer and the seller.



CHAPTER 4 FREIGHT DERIVATIVES

Now that standard knowledge about derivatives is set out, focus is put on freight derivatives in particular. The first thing to notice, is that with freight derivatives the underlying asset can be, for example, the Baltic Freight Index or another index which represents the spot freight rates. Furthermore, freight derivatives are cash settled. In other words, instead of actually receiving the underlying asset at delivery time, the owner of a freight derivative receives cash. When, for example, an equity future (a future with a stock as underlying asset) is cash settled, the owner of the future receives the difference between the values of the stock at settlement minus the agreed price at the conclusion of the deal. When the same future is physically settled, the owner receives the actual stock at expiration and pays the price, which was fixed at the expiration date. So, in the case of freight derivatives, the owner of the derivative receives at expiration the value of the Baltic Freight Index/freight rate (settlement price) minus the price, which was fixed at the conclusion of the deal.

Furthermore, in practice, all freight derivatives consist of more than one settlement period. In theory, first a single settlement period is considered and then a few of these single contracts are summed up to form a contract with more settlement periods, as will be seen later when pricing a freight option.

4.1 Freight futures or Forward Freight Agreements

The first freight futures to be traded were introduced on the Baltic International Freight Futures Exchange (BIFFEX) in May 1985. This shows that the financial freight market is, with an age of around 30 years, indeed rather new, as was stated in the beginning of this document. Freight futures are mostly referred to as Forward Freight Agreements (FFA). This might be a bit misleading, since the word 'forward' is involved in this, but nowadays most of the time these FFA's are traded as futures, so through a clearing house.

Definition 3. A freight future is a financial contract, which states that at a certain time in the future one party will pay the contract price and receive the value of the Baltic Freight Index at that time from the other party.

A freight future is settled against the average of the spot freight rates9 (also, the average values of the Baltic Freight Index) during the settlement period. This averaging is done for two reasons:

1. First of all, settling against the average values of the Baltic Freight Index limits the chance of price manipulation by large participants. When the FFA's would be settled against one single freight rate, participants may try to increase or decrease the freight rate in the future by trading a lot or very little in freight rates just before the time at which they want the freight rate to have a certain value. When the FFA's are settled, against an average of the freight rates, the chance of this happening, decreases significantly.

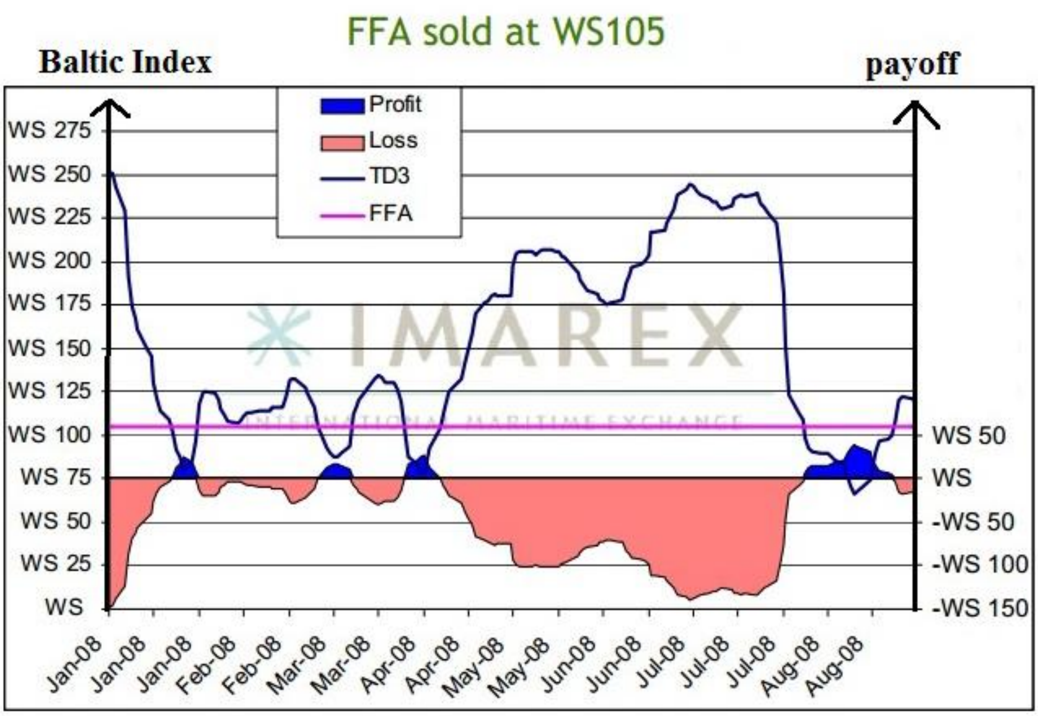
2. Secondly, the transportation of goods generally takes more than just one day, so charterers are exposed to freight rates for some period of time. When settling against the average of freight rates during this period, freight rates during the entire length of the transportation are considered, which seems fairer than just looking at a freight rate on one of the days during this period.

Moreover, FFA's can be based on a per day contract price or a per ton contract price. When the FFA is based on a time-charter, the contract price will be expressed by an amount per day, while with voyage charters, the contract price will be expressed by an amount per ton.

Example 1. Consider a ship-owner who is looking to protect the company against a possible decrease of the freight rates. To this extent, the company sells an FFA contract for its Panamax ship based on time chartering, with trade date T1 = 1 in years, contract price F = \$18.500 per day, 12 settlement periods, where every settlement period has the length of one month (assume there are 30 days in a month) and with the first settlement at 31 January 2014. If the average of the freight rates in January, also the settlement price, turns out to be $15.000, the ship-owner receives the difference of $18.500 x $15.000 = $3.500 per day during 30 days. This sums up to a total amount of $3.500 x 30 = $105.000. When the settlement price in February is $20.000, the ship-owner has to pay the difference $20.000 - $18.500 = $1.500 per day to the holder of the FFA, which sums up to a total amount of $1.500 x 30 = $45.000. After paying or receiving these differences every month, at the end of the year the ship-owner can check whether this FFA has been profitable for them.

In figure 4.3 an example of the payoff of an FFA sold at WS105[11] is shown, where the blue line indicates the realized average freight rates. The pink constant line is the contract price (so the price to be paid for the blue line). The blue and pink volumes respectively indicate the profits and losses made by the seller of the FFA contract. Note that two vertical scales are used.

Figure 4. 3 Profits and losses made by the seller of a FFA contract for tanker cargo sold at WS105

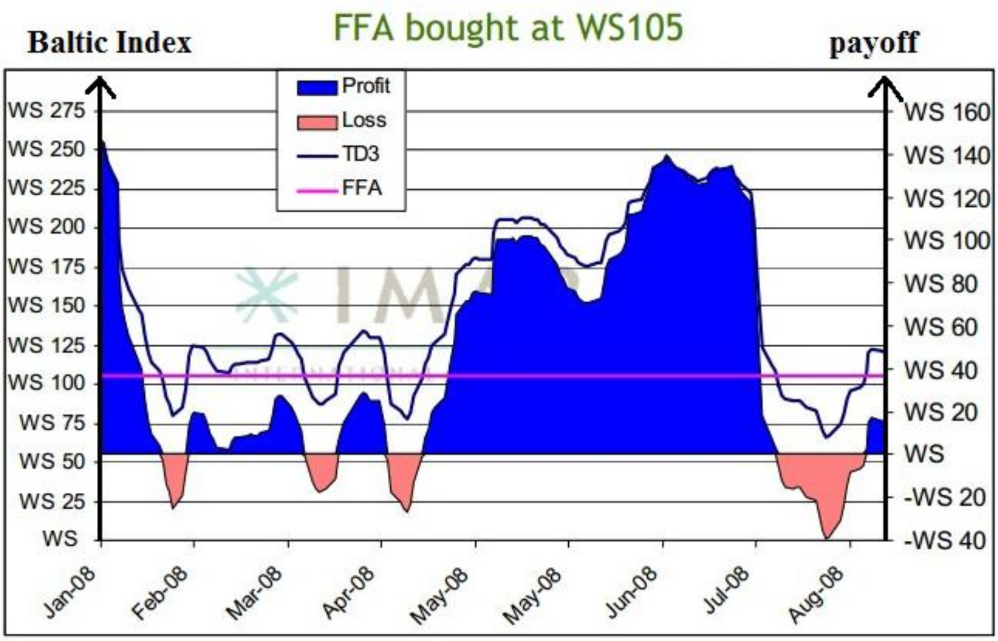


As found on www.balticexchange.com

It can be seen that when the blue line, also the average Baltic Index12, transcends the pink FFA contact price, the seller of the FFA loses money. This is because the seller now earns less than he could have when just selling his freight against the spot freight rate. On the other hand, when the blue line lies beneath the pink contract price, the seller makes a profit, for he can sell his freight against a higher price than he could have, when just selling it against the spot freight rate. Logically, when the Baltic Index line and the contract price line intersect, the seller makes neither a profit, nor a loss.

We can of course also look at the same FFA, but now focus on the viewpoint of the buyer. In this case, the buyer makes a profit when the seller makes a loss and conversely makes a loss when the seller makes a profit.

Figure 4. 4 Profits and losses made by the buyer of a FFA contract for tanker cargo bought at WS105



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4.2 Freight options

Apart from freight futures, the freight market also deals with freight options, which are insurances against freight rates moving beyond a specified price level. There are different kinds of options. In this document, only so-called European and Asian options are important.

Definition 4. A European option is a type of option which can only by exercised at the exercise date of the option. Its payoff is calculated by settling against the value of the underlying asset at exercise time. In other words, the payoff of a European (call) option with strike price K equals $\max\{S(T) - K, 0\}$.

Definition 5. An Asian option is a type of option from which the payoff is calculated by settling against the average values of the underlying asset during some period of time [t_1; t_N]. In other words, the payoff of an Asian (call) option with strike price K equals maxf(1) N PN i=1 S(ti)Kg.

A freight option is an Asian option with the spot freight rates/Baltic Freight Index as underlying asset.

Definition 6. A freight option is a financial contract which states that the holder has the right to pay/receive the average of the values of the freight rates during some period on or before the expiration date and receive/pay strike price. The writer then has the obligation to receive/pay this average and pay/receive the strike price when the holder decides to exercise.

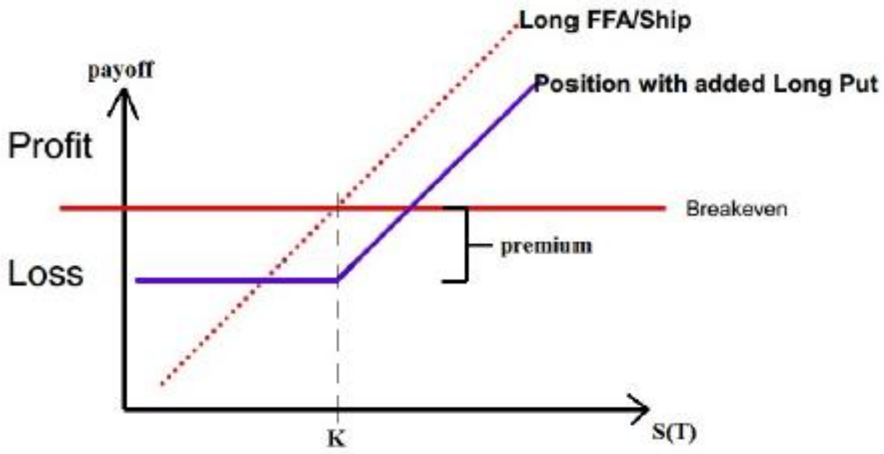
With an option in his portfolio, the holder has no risk of losing any money due to high or low prices of the underlying asset, because he always has the possibility not to exercise the option and thereby have zero payoffs. This way, the (expected) payoff from an option can never be negative. This differs from a future, where the holder has the obligation to exercise the contract, which can lead to a negative payoff for the holder. However, with an option, the holder has to pay an upfront premium to the seller. This is the only way the seller of the option can earn money, because the holder can never have a negative payoff. In other words, the seller can never have a positive payoff (if this premium would not be taken into account).

Example 2. Consider a ship-owner who is looking to protect the company against possible decreases in the freight rates. To this extent, the company buys a freight put option for its Panamax ship based on time-chartering, with expiration date T = 1 in years, strike price K = $18,500 per day, a premium of $2400 per day, 12 settlement periods, where every settlement period has the length of one month (assume there are 30 days in a month) and with the first settlement at 31 January 2018. The total premium the ship-owner has to pay the writer of the put option is $2400 × 30 × 12 = $864,000. He has to pay the daily premium everyday upfront. If the average of the freight rates in January, also the settlement price, turns out to be $15,000, the ship-owner receives the difference of $18,500 − $15,000 = $3,500 per day. This sums up to a total amount of $3,500 × 30 = $105,000. When the settlement price in February is $20,000, in contrast to the FFA in example 1, the ship-owner will decide not to exercise his put option, so in this month he will not receive any money with this option. For the writer of this put option to determine whether the sale of this option was profitable for him, he has to add up the total amount he had to pay the holder of the option (the ship-owner) and subtract this from the total premium he received. If this resulting amount would be positive, the trade would have been profitable for him, and the holder of the option would have had a negative profit.

If making profit was the purpose of the writer for writing this option in example 2, it is called speculation. Instead of using the option for speculation, the writer of this option could have also used it for hedging. For example, when the writer would have been long a similar freight put option, by writing this freight put option, he would hedge his position. No matter what happens, the writer would always end up with no losses, respectively profits (caused by these two options); If the put option would end in the money, the writer would exercise his put option, whereby he would receive a positive payoff. On the other hand, the holder of the put option he has written, will also exercise his option, also the writer has to pay this holder the exact same amount as he received himself with his put option. Conversely, if the option would end out of the money, no one would exercise his/her put option, so the holder (writer) of the first option has a loss (profit) equal to the premium of the option and, similarly, the writer in this example has a loss equal to the premium, caused by the second put option.

We can conclude that the main difference between the payoff of an option and the payoff of an FFA, is that with an option, the negative payoff cannot grow larger than the amount of the premium, while the negative payoff of an FFA in theory can grow until the negative value of the contract price. This is summarized in figure 4.5.

Figure 4. 5 Payoffs from an FFA and a put option



The payoff of the option has a lower bound, while the payoff of the future keeps on decreasing as S(T) decreases. The FFA makes profit with a lower S(T) than the put option does, because of the premium that has to be covered with an option.

Now, consider figure 9, similar to figures 6 and 7, to see how hedging using a freight option works. Again, the blue line indicates the average Baltic Index or the spot freight rates, the blue and pink volumes equal the profits and losses and now the pink line indicates the value of a call option.

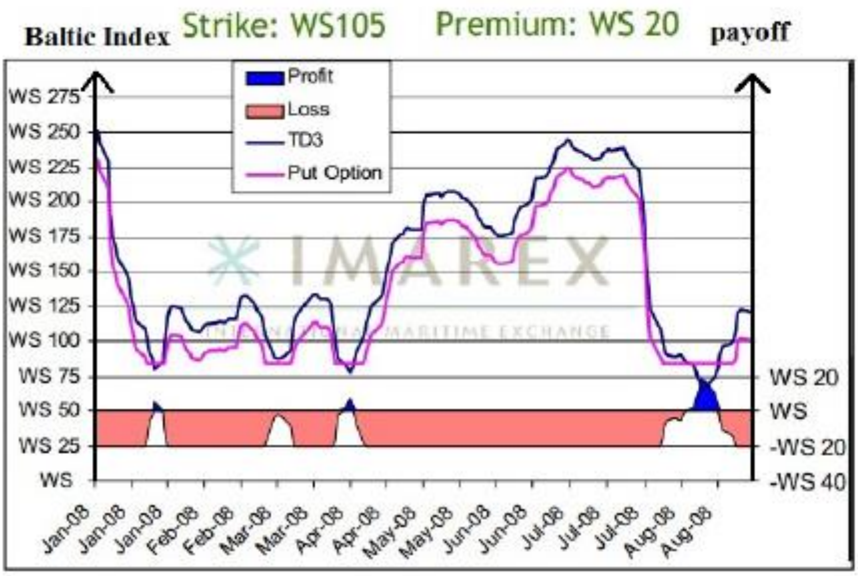
Figure 4. 6 Profits and losses made by the buyer of a call option with strike price WS105 and premium WS20 for tanker cargo

As found on www.balticexchange.com

The losses indeed never transcend the premium of WS20, because otherwise the buyer of the call option would not exercise his right. Furthermore, when the blue line exceeds the pink option price line, the buyer makes a profit, while when the blue line lies beneath the pink line, a loss is made. Logically, when the blue and the pink line intersect, neither a profit, nor a loss is made.

Similarly, we can look at a put option with the same strike price and premium. Figure 10 shows the profits and losses made by the buyer of this put option. The realized average freight rates turned out to be significantly higher than the expected average freight rates. Therefore, the strike price of the put option was determined too low, which resulted in very few profits for the buyer of the put option. Again, we see that the losses made, never exceed the premium of WS20.

Figure 4. 7 Profits and losses made by the buyer of a put option with strike price WS105 and premium WS20 for tanker cargo



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CHAPTER 5 HEDGING RISK OF INDICES USING FFAs UNDER VECTOR ERROR CORRECTION MODELS (VECM)

The aim of this study was to examine whether the shipping derivatives could compensate the risk of unstable spot rates market. Since this potential strategy could compensate potential losses it would be very interesting to know whether or not shipping derivatives could play this role. Therefore, we have chosen to investigate the relationship between two time series, one spot rate and one derivative. More precisely, we have used the FFA Cape 180 TC and the BCI 180 rate.

A sample of daily observations was gathered for the time series FFA-Cape 180 5TC and BCI 180 rate. The total number of observations was 368 and covered the period from 22/2/2016 until 18/8/2017. The data were obtained from Simpson, Spence & Young Broker daily report.

5.1 Statistical Analysis

In order to check if the time series BCI 180 rate and FFA-Cape 180 5TC cointegrate or not we have used the Engle-Granger two-step method since we have two time series. The implementation of the method is very straightforward, in risk management applications it is generally the –Granger criterion of minimum variance, rather than the Johansen criterion of maximum stationarity and finally there is often a natural choice of dependent variable in the cointegrating regressions. In the Engle –Granger method one simply performs a cointegrating regression between the integrated series, and then tests the residual for stationarity. A non-stationarity variable is a variable with a changing mean, variance or autocovariance (the autocoavariance is the covariance of a variable between itself and its own lagged values.

Non –stationarity is caused by trends in variables and there are two broad types of trends: deterministic trend and a stochastic trend. A deterministic trend is a systematic, stable upward movement in a variable and can be captured using a deterministic time trend variable. A stochastic trend emerges as a consequence of randomness in variables. (Baddeley M.C, 2009)].

As far as now a group of variables to be cointegrated it is required that: i) they should all be I(d) i.e. integrated to the same order, often I(1) the first difference of the time series is stationary, ii) a linear combination of the two series should exist, which is integrated to a lower order (generally I(0)). In order to test a variable is stationary or not we are using the Augmented Dickey-Fuller test and the Phillips–Perron test; both test if a variable follows a unit-root process. The null hypothesis is that the variable contains a unit root, and the alternative is that the variable was generated by a stationary process. In case that the variable is not stationary we take the first difference, the second, the third etc.

After evaluating the stochastic link between the two time series we have also investigated the causality between them. For this reason the Granger causality test has be used. Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another. The idea is to regress 'y' on lagged values of 'y' and 'x' and the coefficients of the lag of 'x' are statistically significantly different from 0, then we can argue that 'x' Granger-cause 'y', this is, 'x' can be used to predict 'y' (Stock & Watson, 2007).

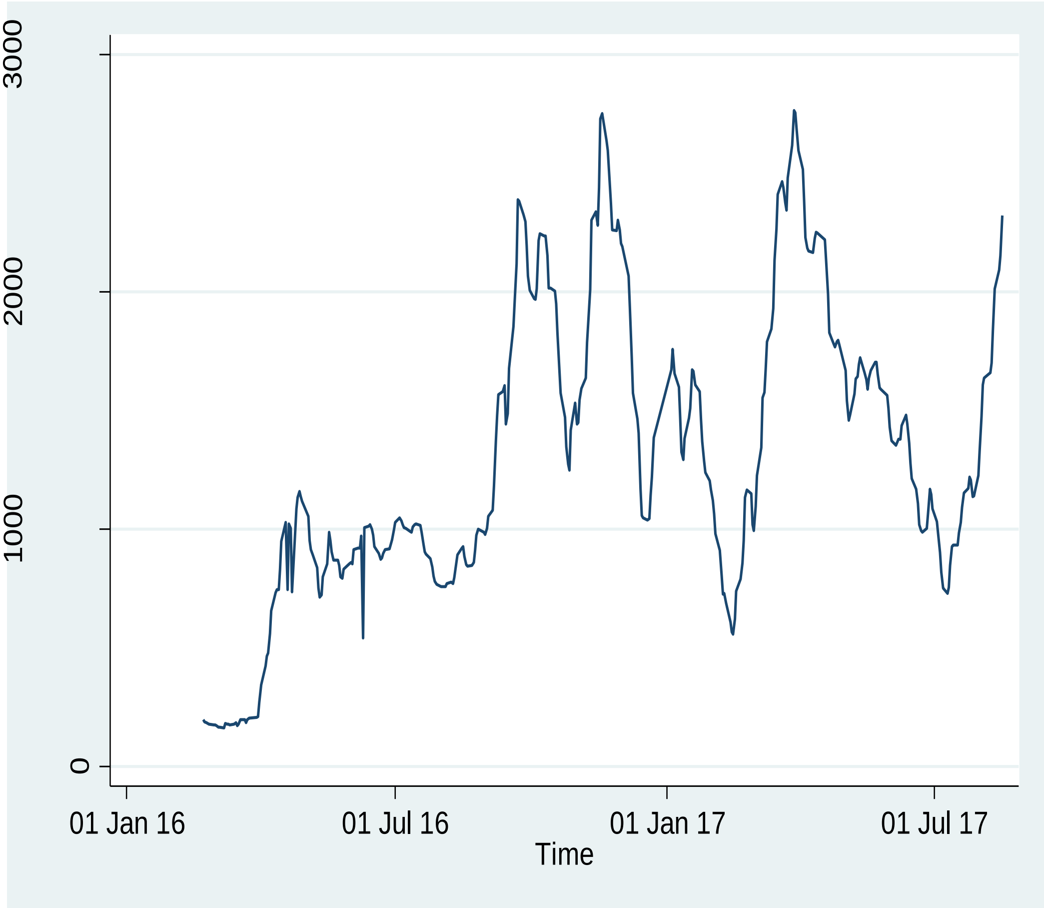
The same has be done for x on y, x has been regressed on y in order to see if 'y' Granger-cause 'x'. Here the Granger causality test has been be implemented on the first differences of the time series as we will see in the analysis below. Critical is the choice of lags; insufficient lags yield autocorrelated errors (and incorrect test statistics), while too many lags reduce the power of the test. So, for this reason the Akaike's information criterion procedure has be used in order to specify the best number of lags.

The statistical analysis below produced by using the statistical package STATA 12.

5.2 Research

In this section the descriptive and inferential statistics are been presented. First the time series are been presented graphically and tested whether they are stationary or not. Also, cointergration and Granger causality test are been presented

Figure 5. 1 BCI 180 rate



As exported from STATA 12

According to figure 5.1 the BCI 180 rate cannot be considered stationary since it presents unstable movement and upward trend. We reach the same result for FFA-Cape 180 5TC as we can easily see into the below figure 5.2. In other words the FFA-Cape 180 5TC is presented with unstable movement and upward trend.

Figure 5. 2 FFA-Cape 180 5TC

As exported from STATA 12

Figure 5. 3 FFA-Cape 180 5TC and the BCI 180 rate

As exported from STATA 12

According to figure 5.3 it can be observed that there is a co-movement between the FFA-Cape 180 5TC and BCI 180 rate since the pattern they follow is almost identical for the time period under investigation. This is the first sign that we receive, that maybe each series is the "cause" of the other.

In order to be certain about the lack of stationarity as characteristic for both time trends we have used the Augmented Dickey-Fuller test and the Philip Perron test to confirm it. The results can be seen in tables 5.1 to 5.4.

5.3 Stationarity of the time-lines

From table 5.1, which is the Augmented Dickey-Fuller test for the BCI 180 rate it can be observed that we have to accept the null hypothesis. The null hypothesis is that the variable does contain a unit root, which means that the time variable is a not stationary process. This can be easily concluded since -1.124 > -2.878.

From table 5.2, which is the Phillips-Perron test for the BCI 180 rate, it can be seen that we have to accept the null hypothesis. In that case the null hypothesis is that the variable does contain a unit root, which means that the time variable is a not stationary process. We can reach the point since -1.456>-2.878.

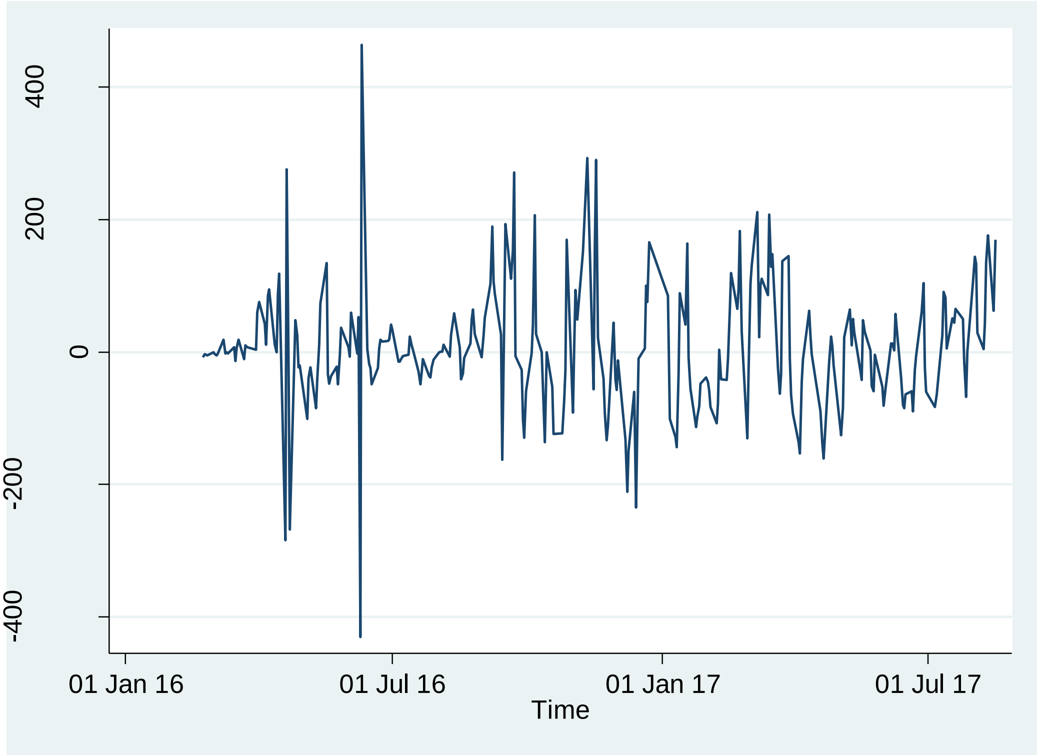
The table 5.3, shows as the Augmented Dickey-Fuller test for the FFA-Cape 180 5TC rate and can be observed that we have to accept the null hypothesis.

From table 5.4, evidently it can be observed that we have to accept the null hypothesis. The variable does contain a unit root, which means that the time variable is a not stationary process. We reach the outcome since -1.607>-2.878.

The next step that we have to follow is to make the variables stationary. In order to do the variables stationary, we have calculated the first differences and we have tested with the unit root test as it can be seen in tables 5.5 to 5.8.

The differences of the variables were stationary as the figures 5.4 and 5.5 can easily show us.

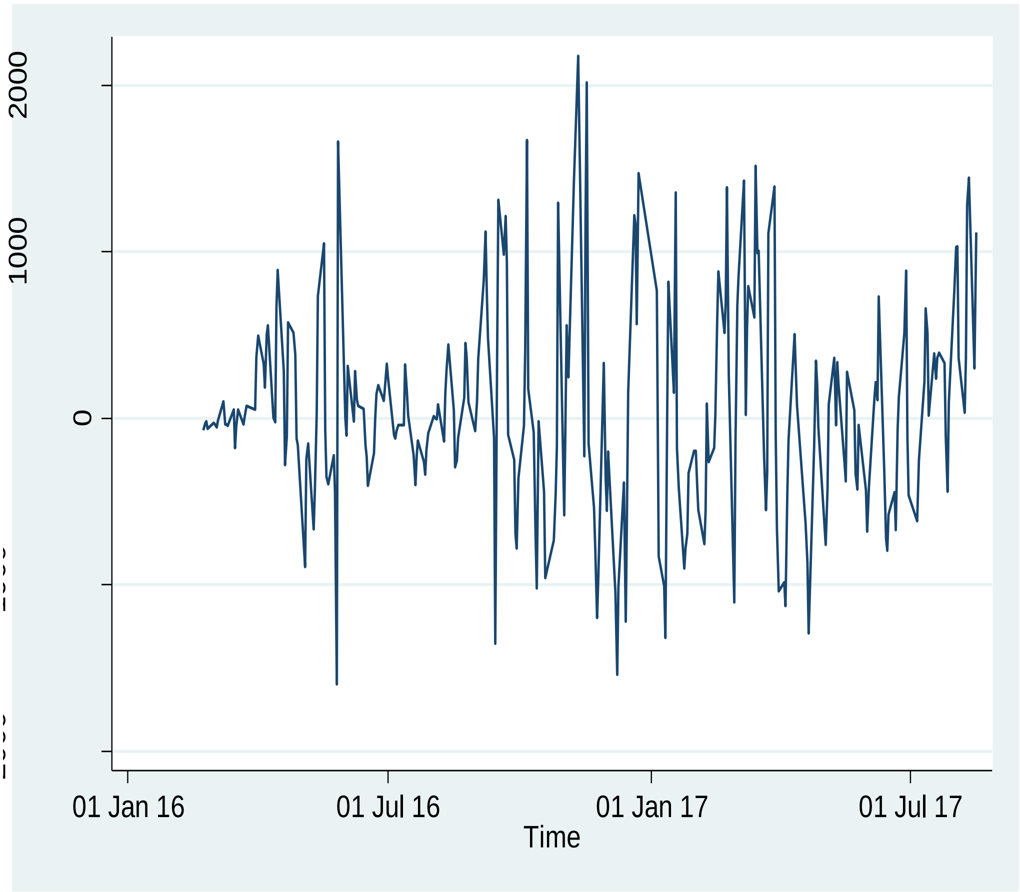
Figure 5. 4 First difference of BCI 180 rate



As exported from STATA 12

From figure 5.4 it is clear that the first difference of BCI 180 rate is almost stable with one spike and no trend at all. Same point we reach, while seeing figure 5.5. In other words it can be seen that the first difference of FFA-Cape 180 5TC is also almost stable, with few spikes pike and almost no trend at all.

Figure 5. 5 First difference of FFA-Cape 180 5TC



As exported from STATA 12

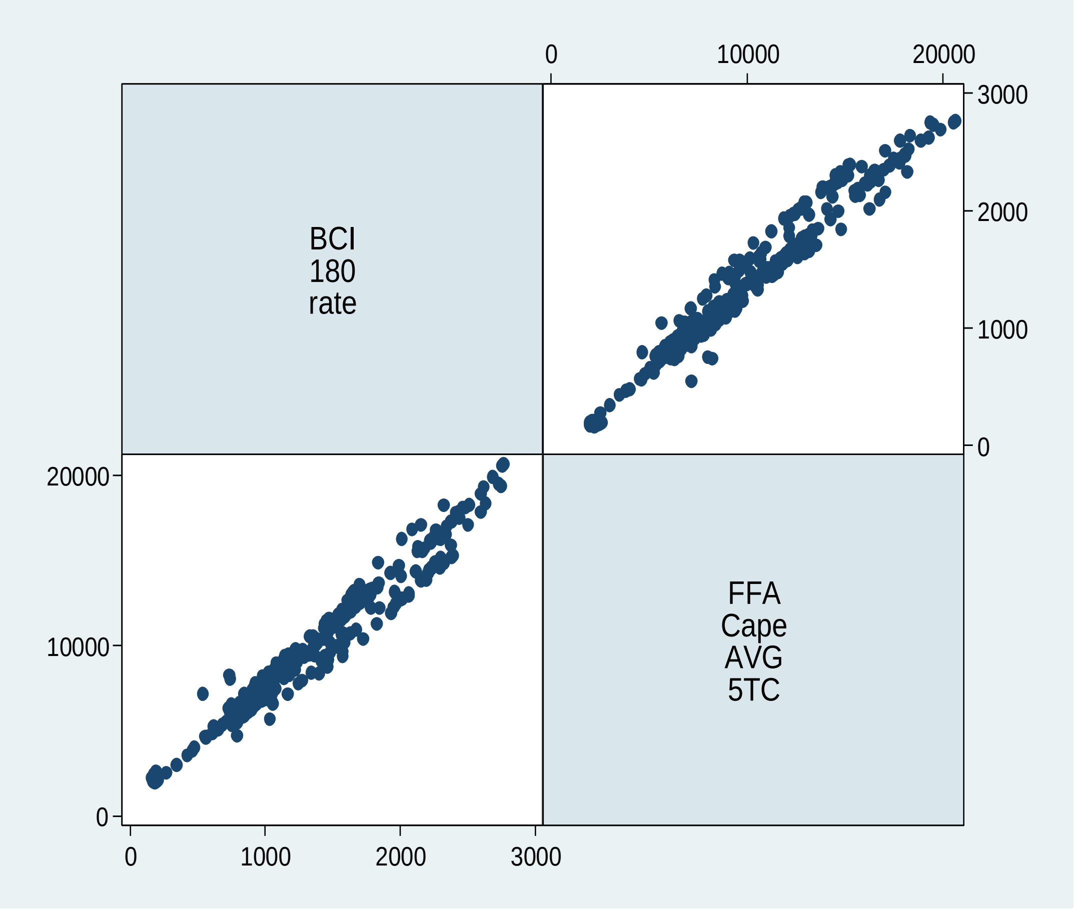
Next step is to proceed with Augmented Dickey-Fuller test with first difference of BCI 180 rate. The table 5.5 obviously shows us, that we have to reject the null hypothesis. The variable does not contain a unit root, which means that the time variable is a stationary process. The point comes since -9.595 < -2.883.

At table 5.6, we have some results after using Phillips Perron test for first difference of BCI 180 rate. It can be noticed, that we have to reject the null hypothesis. The variable does not contain a unit root, which means that the time variable is a stationary process. We can very easily understand since -9.245 < -2.883.

We proceed exactly with the same way, using Augmented Dickey-Fuller test for the first difference of FFA-Cape 180 5TC. From table 5.7 it can be observed that we have to reject the null hypothesis. The variable does not contain a unit root, which means that the time variable is a stationary process. Coming to this point as -7.299 < -2.883.

As used for BCI 180 rate, we are using again Phillips Perron test for first difference of FFA-Cape 180 5TC. From table 5.8 it is visible that we have to reject the null hypothesis. The variable does not contain a unit root, which means that the time variable is a stationary process. The -9.023 < -2.883, shows us why.

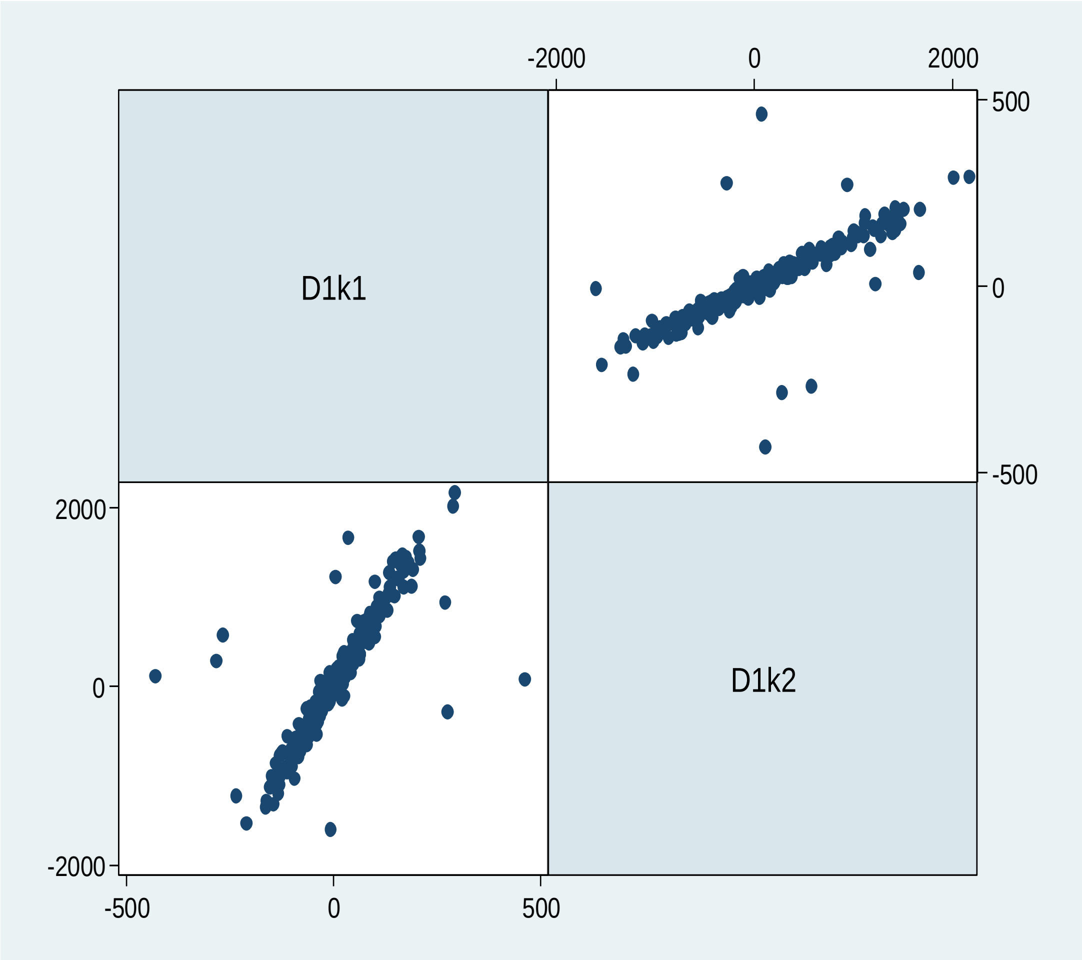
Figure 5. 6 Scatterplot between the BCI 180 rate and the FFA-Cape 180 5TC



As exported from STATA 12

But what about the relationship between the two series, FFA and BCI 180? Figure 5.6 depicts the two time series of FFA and BCI 180. It can be observed that there is a linear relationship between the two variables.

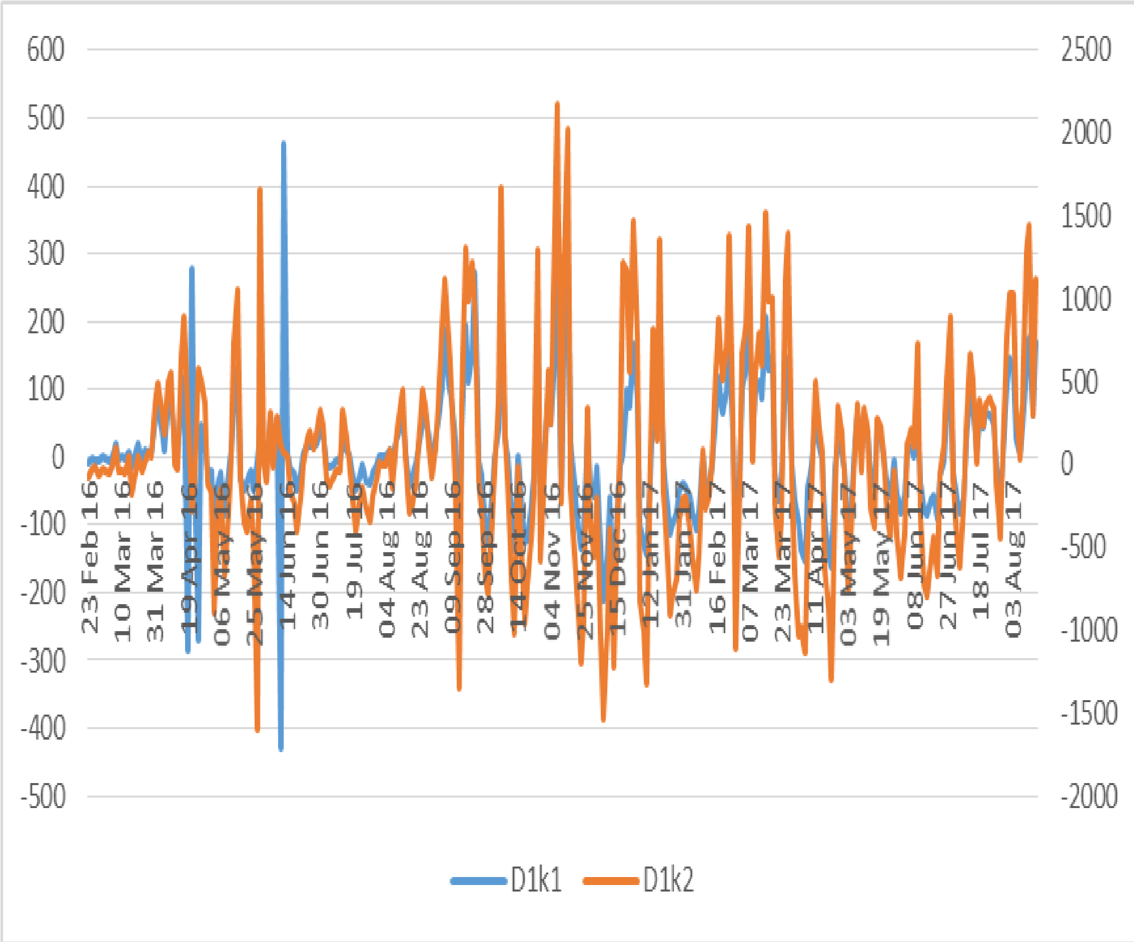
Figure 5. 7 Scatterplot between the first difference of the BCI 180 rate (D1k1) and the first difference of the FFA-Cape 180 5TC (D1k2)



As exported from STATA 12

At this point, it is important to investigate further the relationship of the BCI 180 and FFA-Cape 180 5 T/C. We have created the first differences for the BCI 180 (D1k1) and for the FFA-Cape 180 5TC (D1k2) and the next step is to check the relationship of this “differences”. The above figure 5.7, showing us that there is a linear relationship between the first difference of the BCI 180 rate (D1k1) and the first difference of the FFA-Cape 180 5TC(D1k2).

Figure 5. 8 First difference of FFA-Cape 180 5TC and the first difference of BCI 180 rate



As exported from STATA 12

We have to underline that we have checked initially (with the figure 5.3) if the two series follow the same pattern. Now it's time to re-check re "revised" series. According to figure 5.8 it can be observed that there is a co-movement between the first difference of FFA-Cape 180 5TC and the first difference of BCI 180 rate. As a result, we have another hint that both of the values are "walking together".

The table 5.9 presents some descriptive statistics as the average value of the BCI 180 rate and the FFA-Cape 180 5TC. Also, the standard deviation with the minimum and maximum value for the whole time period are been presented.

According to table 5.10 there is a statistical significant positive correlation between the BCI 180 rate and the FFA-Cape 180 5TC. Easily can be seen as rho=0.977 & p<.001.

Also, there is a statistical significant positive correlation between the first difference of the BCI 180 rate and the first difference of the FFA-Cape 180 5TC. Reaching the point as rho=0.9263 & p<.001.

5.4 Co-integration of time-lines

In this section we are examining if the first differences of the variables BCI 180 rate and FFA-Cape 180 5TC cointergrate or not. We have run first the regression model between D1.BCI 180 rate and D1.FFA-Cape 180 5TC.

In the table 5.11 - Regression model between first difference of BCI 180 rate (D1k1) and the first difference of FFA-Cape 180 5TC (D1k2) - it can be observed that the degree of the explanatory power is significant high, R2=65.02%. Since our variables are stationary there is no concern for spurious regression. The next step is to check the residual of the regression with the unit root test.

As now we have to proceed with Augmented Dickey-Fuller test, Unit test root for residuals, from table 5.12 it can be observed that we have to reject the null hypothesis. The variable does not contain a unit root, which means that the time variables cointegrate. Obviously can be proven as -21.650<-2.883.

Proceeding with Philips Perron test, Unit test root for residuals, the table 5.13 shows us that we have to reject the null hypothesis; the variable does not contain a unit root, which means that the time variables cointegrate (-22.820<-2.883).

The results from tables 5.12 and 5.13 mean that there is co-movent of the time series in the long run. Therefore, we reach the point that there is a stochastic link between BCI 180 rate and FFA-Cape 180 5TC.

5.5 Granger Causality Test

Next phase is to check what is the best lag number, for both variables. From the Akaike's information criterion it was determined that the best lag number for both times series is the number 4 (table 5.14). Into the table 5.14 we can see how we reached the point to run the analysis with 3 lagged values. However, because there was a restriction in relation to the number of observations we have run the analysis with 3 lagged values. In other words, the 368 observations being available were not enough in order to proceed with 4 lagged values.

5.5.1 Testing "BCI 180 rate" Granger-cause "FFA-Cape 180 5TC"

As it's time for the regression model, we set as dependent variable the first difference of FFA-Cape 180 5TC and independent all the lag values of the first difference of FFA-Cape 180 5TC & and the first difference of BCI 180 rate. We can see the outcome from the regression into table 5.15.

Since we have run the regression model now we will see whether all the coefficients of the three lagged values of the first difference of the BCI 180 rate, are zero.

We cannot reject the null hypothesis that all coefficients of lag of 'first difference of BCI 180 rate' are equal to 0. Therefore 'first difference of BCI 180 rate' does not Granger –cause 'first difference of FFA-Cape 180 5TC'. This result is striking into table 5.16.

5.5.2 Testing 'FFA-Cape 180 5TC' Granger-cause 'BCI 180 rate'

Now we set the dependent variable the first difference of BCI 180 rate and independent all the lag values of the first difference of FFA-Cape 180 5TC & the first difference of BCI 180 rate, into the table 5.17. Since we have run the regression model now we will see whether all the coefficients of the three lagged values of the first difference of the FFA-Cape 180 5TC are zero.

Now, we are testing all coefficients of lag of 'first difference of FFA-Cape 180 5TC' equal to zero. Into the table 5.18, there is no evidence to accept the null hypothesis that all coefficients of lag of 'first difference of FFA-Cape 180 5TC' are equal to 0. Therefore 'first difference of FFA-Cape 180 5TC' does Granger –cause 'first difference of BCI 180 rate'.

5.6 VECM Model

As it can be seen from table 5.19 the short run estimates are read from the first part. The two coefficients on ._ce1 make up the long run disequilibrium adjustment matrix α for our model.

The second part of the Table presents the β parameters of the cointegrating vector. The equation between the first difference of BCI 180 rate and the first difference of FFA-Cape 180 5TC is the following:

First difference of BCI 180 rate = - 0.1327 * (first difference of FFA-Cape 180 5TC) + 2.5

CHAPTER 6 CONCLUSION

The conclusions rising from the analysis, showed that there is a stochastic link between FFA-Cape 180 5TC and BCI 180 rate. Also we showed that the BCI 180 is not affecting the respective FFA. On the other hand, the results indicate that that the FFA-Cape 180 5TC influences the BCI 180, despite the fact that the FFA "comes" from the index itself. The findings leads us to the conclusion that a derivative which is based in a specific route – and so, to a specific index – can work backwards and determine (in a way) the respective index. The above result can be seen from the fact that BCI 180 rate does not Granger – cause FFA-Cape 180 5TC. On the other hand FFA-Cape 180 5TC does Granger –cause of BCI 180 rate.

As part of the research, a relationship between the first difference of BCI 180 rate and the first difference of FFA-Cape 180 5TC was established that lead to a model, which predicts the first difference of BCI 180 rate based on the first difference of FFA-Cape 180 5TC.

All the above probably suggest that FFA-Cape 180 5TC could be used to compensate the risk of BCI 180 rate. Thus in a market that we have no info about the BCI and knowing only the prices of FFA-Cape 180 5TC, we would be able to forecast the BCI 180 index.

In that point, it is important to underline the fact that BCI 180 index and FFA-Cape 180 5TC are covering specific "routes" and as a result, these routes do not reflect the whole market, but only a small part of it. The latter holds also for the variable data. A limitation of this research is that only 368 prices of FFA and BCI were utilised in the analysis. If the author could acquire more relevant data for a longer period and additional routes , the results of the analysis could have been more robust.

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Appendix of Tables

Table 5.1: Augmented Dickey-Fuller test, BCI 180 rate

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.124	-3.457	-2.878	-2.570

MacKinnon approximate p-value for Z(t) = 0.7054

Table 5.2: Phillips-Perron test, BCI 180 rate

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-4.638	-20.330	-14.000	-11.200
Z(t)	-1.456	-3.457	-2.878	-2.570

MacKinnon approximate p-value for Z(t) = 0.5552

Table 5.3: Augmented Dickey-Fuller test, FFA-Cape 180 5TC

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.102	-3.457	-2.878	-2.570

MacKinnon approximate p-value for Z(t) = 0.7144

Table 5.4: Philip Perron test, FFA-Cape 180 5TC

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-5.599	-20.330	-14.000	-11.200
Z(t)	-1.607	-3.457	-2.878	-2.570

MacKinnon approximate p-value for Z(t) = 0.4800

Table 5.5: Augmented Dickey-Fuller test, first difference of BCI 180 rate

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-9.595	-3.473	-2.883	-2.573

MacKinnon approximate p-value for Z(t) = 0.0000

Table 5.6: Phillips Perron test, first difference of BCI 180 rate

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-129.547	-20.167	-13.920	-11.147
Z(t)	-9.245	-3.473	-2.883	-2.573

MacKinnon approximate p-value for Z(t) = 0.0000

Table 5.7: Augmented Dickey-Fuller test, first difference of FFA-Cape 180 5TC

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-7.299	-3.473	-2.883	-2.573

MacKinnon approximate p-value for Z(t) = 0.0000

Table 5.8: Phillips Perron test, first difference of FFA-Cape 180 5TC

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-84.779	-20.167	-13.920	-11.147
Z(t)	-7.023	-3.473	-2.883	-2.573

MacKinnon approximate p-value for Z(t) = 0.0000

Table 5.9: Descriptive statistics of the BCI 180 rate and the FFA-Cape 180 5TC

Variable	Obs	Mean	Std. Dev.	Min	Max
BCI 180 rate	368	1294.853	618.729	161	2765
FFA-Cape 180 5TC	368	9429.481	4160.438	1985	20657

Table 5.10: Correlation (Spearman's rho)

	1	2	3	4
1.BCI 180 rate	1.0000			
2.FFA-Cape 180 5TC	0.9778	1.0000		
3.First difference of BCI 180 rate	0.0168	0.0252	1.0000	
4.First difference of FFA-Cape 180 5TC	-0.0261	0.0121	0.9263	1.0000

Table 5.11: Regression model between first difference of BCI 180 rate (D1k1) and the first difference of FFA-Cape 180 5TC (D1k2)

Linear regression

Number of obs =	288
F(1, 286) =	586.05
Prob > F =	0.0000
R-squared =	0.6502
Root MSE =	55.813

		Robust				
D1k1	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
D1k2	.1206333	.0049831	24.21	0.000	.1108251	.1304414
_cons	-.5411885	3.249329	-0.17	0.868	-6.936821	5.854444

Table 5.12: Augmented Dickey-Fuller test, Unit test root for residuals

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-21.650	-3.473	-2.883	-2.573

MacKinnon approximate p-value for Z(t) = 0.0000

Table 5.13: Philips Perron test, Unit test root for residuals

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(rho)	-301.888	-20.167	-13.920	-11.147
Z(t)	-22.820	-3.473	-2.883	-2.573

MacKinnon approximate p-value for Z(t) = 0.0000

Table 5.14: Determination of the lag number

Selection-order criteria

Sample: 26 Feb 16 - 11 Aug 17, but with gaps

Number of obs = 62

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-987.6				2.5e+11	31.9226	31.9495	31.9912
1	-832.403	310.39	4	0.000	1.9e+09	27.0453	27.1261	27.2511
2	-807.841	49.125	4	0.000	9.8e+08	26.382	26.5167	26.7251
3	-786.058	43.567	4	0.000	5.6e+08	25.8083	25.9969	26.2886
4	-773.958	24.199*	4	0.000	4.3e+08*	25.547*	25.7895*	26.1646*

Table 5.15: Regression model, dependent variable the first difference of FFA-Cape 180 5TC and independent all the lag values of the first difference of FFA-Cape 180 5TC & and the first difference of BCI 180 rate

regress D1k2 L(1/3).D1k2 L(1/3).D1k1

Source	SS	df	MS		
				Number of obs	= 62
				F(6, 55)	= 2.07
Model	3715787.17	6	619297.862	Prob > F	= 0.0721
Residual	16479461.2	55	299626.567	R-squared	= 0.1840
				Adj R-squared	= 0.0950
Total	20195248.3	61	331069.645	Root MSE	= 547.38

D1k2	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
D1k2						
L1.	.2930102	.1875593	1.56	0.124	-.082867	.6688874
L2.	-.1541527	.3252205	-0.47	0.637	-.8059092	.4976039
L3.	.2836531	.3127352	0.91	0.368	-.3430822	.9103884
D1k1						
L1.	1.166227	1.058249	1.10	0.275	-.9545512	3.287004
L2.	-.7377209	2.330712	-0.32	0.753	-5.408572	3.93313
L3.	-2.388092	2.187156	-1.09	0.280	-6.771251	1.995068
_cons	150.9299	72.36103	2.09	0.042	5.915143	295.9446

Table 5.16: Testing all coefficients of lag of 'first difference of BCI 180 rate' are equal to 0

```
. test  L1.D1k1 L2.D1k1
        L3.D1k1

( 1)    L.D1k1 = 0

( 2)    L2.D1k1 = 0

( 3)    L3.D1k1 = 0

        F(  3,    55) =      0.93

        Prob > F =  0.4321
```

Table 5.17: Regression model, dependent variable the first difference of BCI 180 rate and independent all the lag values of the first difference of FFA-Cape 180 5TC & the first difference of BCI 180 rate

. regress D1k1 L(1/3).D1k2 L(1/3).D1k1

Source SS df MS Number of obs = 62

F(6, 55) = 8.85

Model 276964.048 6 46160.6747

Prob > F = 0.0000

Residual 286852.726 55 5215.50411 R-squared = 0.4912

Adj R-squared = 0.4357

Total 563816.774 61 9242.89794 Root MSE = 72.218

D1k1 Coef. Std. Err. t P>t [95% Conf. Interval]
D1k2

L1. .1497973 .0247455 6.05 0.000 .1002062 .1993884

L2. .0363539 .0429078 0.85 0.401 -.0496352 .122343

L3. -.0385628 .0412605 -0.93 0.354 -.1212507 .0441251

D1k1

L1. -.693186 .1396194 -4.96 0.000 -.9729896 -.4133825 L2. -.4188245 .307501 -1.36 0.179 -1.03507 .1974214

L3. .3696645 .2885611 1.28 0.206 -.2086249 .9479539

_cons 25.40981 9.546908 2.66 0.010 6.277383 44.54224

Table 5.18: Testing all coefficients of lag of 'first difference of FFA-Cape 180 5TC' equal to 0

```
. test  L1.D1k2 L2.D1k2
        L3.D1k2

( 1)    L.D1k2 = 0

( 2)    L2.D1k2 = 0

( 3)    L3.D1k2 = 0

        F(  3,    55) =      16.44

        Prob > F =  0.0000
```

Table 5.19: VECM estimates for first difference of BCI 180 rate and first difference of FFA-Cape 180 5TC'

```
Vector error-correction model

                                                          No. of obs
=       286

AIC            =      26.41057

Log likelihood = -3767.711                      HQIC          =
        26.45668

Det(Sigma_ml)  =  9.50e+08                      SBIC          =
        26.52562

Equation           Parms     RMSE     R-sq      chi2      P>chi2

D_D1k1                 4     89.4633   0.3799   172.7304   0.0000

D_D1k2                 4     613.125   0.0340    9.93178   0.0416


Coef.    Std. Err.      z     P>z     [95% Conf.       Interval]

D_D1k1
```

_ce1

L1. -1.409426 .1634576 -8.62 0.000 -1.729797 -1.089055

D1k1

LD. .1295516 .0999663 1.30 0.195 -.0663788 .325482

D1k2

LD. -.0483762 .0154658 -3.13 0.002 -.0786886 -.0180637

_cons 2.455333 5.294104 0.46 0.643 -7.92092 12.83159

D_D1k2

_ce1

L1. 1.766808 1.120235 1.58 0.115 -.4288129 3.962428

D1k1

LD. -.6316291 .6851061 -0.92 0.357 -1.974412 .7111541

D1k2

LD. -.0610017 .1059929 -0.58 0.565 -.2687441 .1467406

_cons 1.95868 36.28244 0.05 0.957 -69.1536 73.07096

Cointegrating equations

Equation Parms chi2 P>chi2

_ce1 1 1532.313 0.0000

Identification: beta is exactly identified

Johansen normalization restriction imposed

beta	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
_ce1						
D1k1	1	.	.	.	.	.
D1k2	-.1327117	.0033903	-39.14	0.000	-.1393565	-.1260669
_cons	2.509715	.	.	.	.	.