FFA

FORWARD FREIGHT AGREEMENTS

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INTRODUCTION

Present thesis deals with the market of shipping derivatives and particularly the way the Forward Freight Agreements influence the current freight market (Spot Market).

Initially we present a general reference in derivatives and the influence they have at different markets, the reasons of their expansion, as well as the way transactions are made and cleared. Specifically in the shipping derivatives market we quote the basic types among them, whereas on the FFAs there is an extended reference in their advantages and disadvantages along with the way contracts are made and executed.

In the main subject of this thesis we test the hypothesis of variables independence (unbiasedness hypothesis), if the FFAs may be used as good predictors of the spot market. Initially, we test the two variables without taking into consideration the presence of cointegration between them. Second to that, we decide to include cointegration in order to correct our initial model.

The cause-effect relationship, as well as the way the variables are connected, both short and long term is depicted following our initial hypothesis. With the assistance of econometric tests, we manage to define the relationship that connects the Forward and the Spot market. On top of that, an additional test is used to get round the problems of cointegration and variance, in order to verify the causal relation between timeseries.

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THE DERIVATIVE MARKET

1.1 **Introduction – The history of derivatives**

Derivatives are financial products which are placed among risk management techniques of contemporary companies. Although there is not considered to be a new product, view similar mechanisms can be found even in ancient years, last decades is observed an increase in their use, a fact which is owed mostly due to unstable and difficult financial environment, among which contemporary companies are called upon to act and thrive. Our era is characterized from changeable interest rates, changes in exchange rates, fluctuations in commodity prices, increased competition between financial trusts, globalization of commerce and other hot and unstable economic circumstances. The creation of derivatives therefore occurred from the need to control the above mentioned factors, as better as it could.

Derivatives have made their appearance in recent years. They said to originate from farmers' need to secure, against every big fall of commodity prices, which may be attributed to weather factors, increased production and other similar reasons. Eventually, they developed in the form we know them nowadays, because of the evolution of financial mechanics as well as the wide diffusion of computer science and its applications that made everything more simple, accessible and easy to use from the wide public.

The purchase of derivatives covers the most important products, natural or financial. In its modern form they initially revealed with the establishment of Chicago Board of Trade in 1948 that was specialized in commodities and with the establishment of International Monetary Market in 1972 from the commodity's stock exchange in Chicago that was specialized in market values. The wide acceptance of derivatives led to introduction of many new stock market future contracts worldwide, like the London International Financial Futures Exchange in 1982 (which renamed as Euronext liffe), the Deutsch Terminborse (which renamed Eurex) and the Tokyo Commodity Exchange (TOCOM). Likewise they appeared over 75 stock market future contracts worldwide.

As regards the reality in Greece, on 17th July 2002 there carried out a general meetings of the "Athens Stock Exchange Ltd" and the "Athens Derivatives Market Ltd", where it was agreed the said companies' merging, as well as the modification of their articles of association. The name of new company formed was "Athens Stock Exchange Ltd".

In derivatives' market today, take part nations, banks and firms of every size and magnitude, with the view to gain profit and cover financial risks from the use of derivatives. Concurrently though, derivatives offer the capability (usually in small firms or independent investors) for speculative games with commitment of small capital, acting as such to the opposite direction, view in this particular case, as we see below, the risk is heightened and not compensated.

1.2 **Definition**

Because of their name we may define derivatives as financial values, the price of which is derived from the actual rate of the active assets on which are based, whether they are financial or natural. These values represent some estimation of future process of the price of every product or asset. Therefore, the price of derivative commodity is closely connected with the evolution of the price of other primary products.

It must be clarified that derivative contracts do not constitute property on their own because they are acquired without actual monetary deposit (except the payment of the margin, for which shall refer later). Therefore the value of derivative products exists, because the subordinate individual titles and the variation of their values have direct connection and follows the change of value of individual products (actively).

Essentially therefore derivative means are financial tools that created from participants in the market so as to negotiate and manage more effective the asset on which they are based. They constitute therefore an agreement between two parties which is admitted today for trading actually at a specified price, in a particular time in future.

USE OF DERIVATIVES

2.1 **Users**

Initially, we think it advisable to mention who are the most important users of derivatives so as to be perceptible and clear that the reason of using them and their contribution in every one of the following "players" category.

* Investment Companies* Manufacturing Companies

* Investors* Brokers (Market Makers)

Mutual funds Value Dealers

* Banks* The State

* Insurance Companies

2.2 **Ways of usage**

Before we go on to the main reasons of involvement of the above categories in derivatives market, we reckon is advisable the understanding of some clauses which from now on will be met in the current postdoctoral dissertation.

Spot: The natural (actual) market, where the transactions are cleared immediately.

Assets: Every asset (natural or financial) which is negotiated in the spot market and substituted from derivatives in derivatives market.

Short position: Short position or neutral position adopted by negotiator who agrees to sell some good (natural or financial).

Long position: Long position is taken by negotiator who agrees to purchase some good (natural or financial).

Derivatives therefore were created in order to serve traders in the business and investment world. Their primary purpose was to protect from investment risks. Concurrently though, with their potential to offer easy activation to users in their field with a small deposit, they gained a new capacity, which is the one of speculation.

The effect of derivatives is decisively favorable for the survival and growth of companies in financial environment, as it has evolved. They offer the offsetting of risks, which occur from sudden fluctuation of rates in the market and may regarded as tools for ironing out and restriction of said fluctuations during financial business. Derivatives reduce the uncertainty which is connected with company's investment activities, they improve its quality and as such they offer to the company to precede with risky alternatives and as such gain more profit.

Though, as is recognized from instances in the past, as easy derivatives can acquire big profits, in the same way they can cause big losses to investor who uses them. As said previously financial derivatives is a tool in the hands of investors. It is undeniably significant for the investor on one hand to realize the services offered and on the other to take all the necessary protections before they arise, like every financial tool when in use. When derivatives are used incorrectly or without any plan then they can cause big loses.

Hedging aims initially in the protection of the asset's value. Given the uncomplicated and swift trading of derivatives, together with the rest accounting and other advantages, derivatives offer to risk manager's valuable tools for management and adjustment or get round particular dangers.

The basic principle of operation is the investor to adopt an opposite stance from the one he has in the asset. Particularly, if he possesses an asset or gains one in the market who trades, he can protect the value of his asset by taking the opposite stance in derivatives market. The acquisition of the opposite stance in the long run (asset) is attained by taking short run derivatives, and in the short run (asset) is attaining by taking long run derivatives. Therefore, if the compensator intends to obtain (long position) an asset in the future and is anxious if its value increases till the purchase is made, an opposite or positive act of trading/sale of derivative (short position) are the most appropriate.

It is necessary to realize that the compensation does not aim necessarily in the hedging of all the risks. The price of one derivative may not walk entirely with the price of the commodity which is compensated. One reason for instance, is the fact that the derivative mean represents different variety of the compensated commodity. Beyond different varieties of the subject means, the compensators most of the times are forced to use a derivative which is somewhat similar but not the same with the good which is compensated (view exactly the same commodity might not be available as derivative). By using anyway one derivative which is not the same with the good that is compensated, the compensator in essence replaces the one kind of risk with another.

Speculation

Some brokerage firms and professional individuals practice the strategy of speculation. They act on the basis of anticipation as they make a bet on the market changes. This is achieved either with purchase/sell of derivatives and attempt of selling/purchasing them at higher or lower price from the one achieved, or with daily purchase/sale because they do not want to shoulder the risk of next day. Speculation increases the risk instead of reducing it and then it is incompatible and opposite with the philosophy of hedging.

Speculative trends operates positively in markets in view of the fact that they furnish them with liquidity and shoulder risks which are unwanted among businessmen and investors.

Speculative compensation (Arbitrage)

The Arbitrage strategy is based on taking advantage of possible difference in prices between the same assets which are traded in different markets. Said activities fall usually in the subject matter of trading derivatives and not on final users. Only the big and powerful final users may enter in these transactions.

Also, there are other reasons as well for using derivatives, as the entry/participation in and the stoppage in the market or the reduction of likely debts which may be under the above categories but not itemized further for avoidance of disorientation from the subject and the target of the business.

If derivatives are used correctly they may constitute a valuable leverage for investors, professionals and not, in their attempt to survive during falling periods or during periods with intense fluctuations.

Finally, it is mentioned that derivative contracts form a part of the entire business success in a world where the control of cost has primary and major importance. The contribution of derivatives rests in the fact that they add value, which in turn creates motives for transactions with them. Also, it must be comprehensible that in order to earn money and be the winner with derivatives there must be a loser at the other side. The amount of profit gained by one side is exactly the same as the loss of the counterparty, a fact that constitutes impossible in accomplishment of permanent profit in derivative market. All investors, companies, organizations etc who take part in trading such contracts must act prudently, scrutinizing, checking carefully every move of theirs and avoid acting instinctively and impulsively.

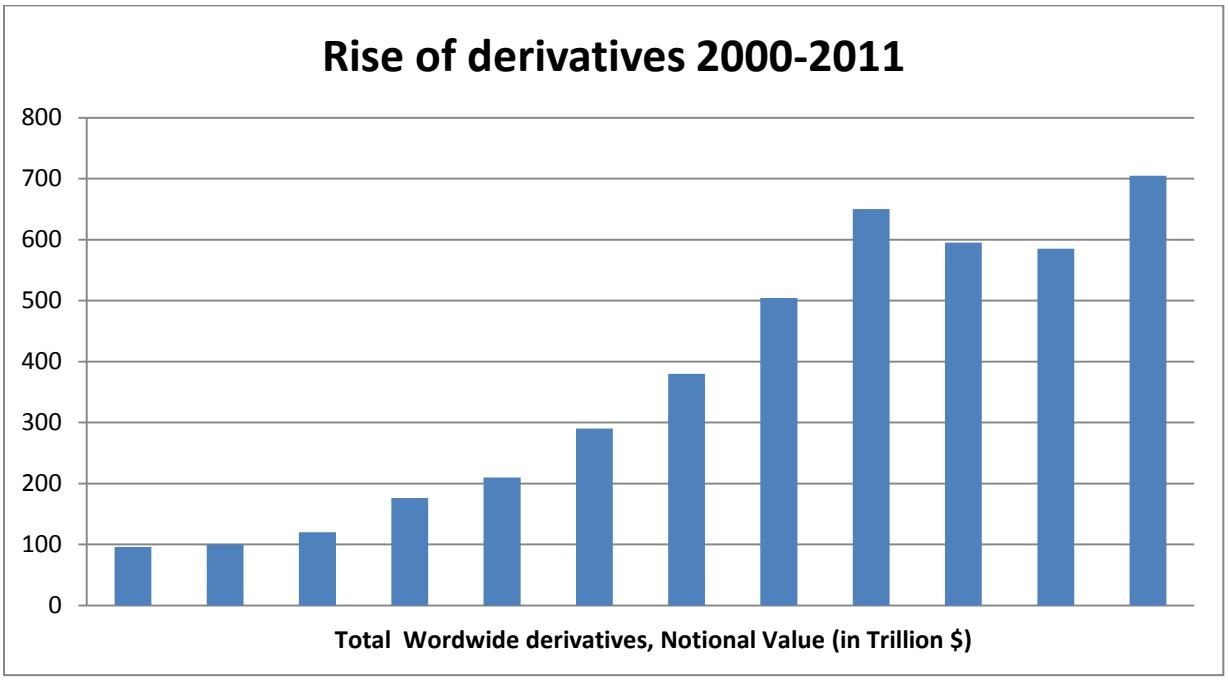
2.3 **Derivative types**

Derivative types of deferred payment basis which are divided as follows:

1. Forward
2. Futures
3. Options
4. Swaps
5. Various Derivatives such as FRA's, Caps, Floors, Collars, Warrants (Hybrids)

Initially we can define forwards/ futures as compulsory agreements of purchase/sale of assets values, for the contracts in reference, at particular price and duration. Contrary option derivatives are voluntary agreements, which are made only if they are to buyer's advantage, but their keeping is compulsory for the counter party seller. Swaps in the end, are contracts which are traded by contractors with future and pre-determined cashier inflows.

Below graph shows the unprecedented rise and the worldwide resonance of derivatives over the last fifteen years. Their growth was unlike any other financial instrument, aiding investors to their every need.



Source BIS/ISDA

Forward Agreements – Futures Agreements

Definition

Furthermore, we shall analyze the meaning of forwards and future agreements in detail, while shall make a shorter reference for the remaining two (options, swaps), in view of the fact that their understanding plays a shorter role in this written work. We consider as well that it would be useful to analyze first the meaning of forwards because they resemble enough with futures in turn of their target and the reason of the agreement, whereas of their simplicity they offer easier consolidation of the basic principles which are introduced to the reader

With the definition "Future Derivatives" we mean contracts, with intangible assets between two signatory parties, which concern the sale and purchase of one particular good in a future date. They are contracts, whose clauses are formed outside organized markets, on the basis of signatory needs and compel one of them to buy at a particular price, like foreign currency, commodity or title, from the second signatory, at a pre-determined price, in a future date. At the same time, the same contract obliges the second signatory to deliver the subject matter according to the terms of the contract. After signing the contract, the rate is "locked" until its expiry. This type of contract is not only negotiable in Over the Counter market (OTC) but in Clearing Houses as well since it represents a planned action to cover the needs of two signatories.

General Characteristics

As mentioned previously, the contracts on their own do not constitute an equity value on their own, since for their acquisition is enough the payment of a marginal amount (3% min and 10% max) in case of futures or no payment at all in case of forwards. Therefore, the value of futures is zero at its inception and costs nothing, either for the beneficiary of the positive position or for the beneficiary of the negative position. On the contrary, in natural goods (consumable or not), the holder has paid a certain amount in order to come into possession of the good, which represents its value, so it constitute an (energetic) asset.

The action elaborates the asset as the future price fluctuates. If the future price increases, the value of equity becomes positive for the holder of long position (the buyer) and negative for the holder of short position (the seller) and the opposite. If "I" is the agreed price via forward in order to negotiate the asset in the spot market with a maturity date. Or even, if "R" is the real price which eventually acquires the asset (equity value)at same date. It is that in maturity, the party with the short position delivers the subject matter and the holder of long position disburses the agreed price on delivery. If at the end we define "Π" to be the profit/loss of the signatories, we have at the end:

$$\Pi = R - I$$

$\Pi > 0$: Profit for the buyer (since he purchases at lower price from the real one).

$\Pi > 0$: Profit for the seller (since he sells at higher price from the real one).

It is easily perceived here that profit for the one party means loss for the other. Therefore, we see again the presence of a winner and a loser. The absolute price of "Π" represents at the end the expiry of the deed and its value, a term which will be used later for understanding of futures, but in many other points of this thesis, (hereafter it will be denoted by "α").

At any time therefore before the delivery, the contract may have different value (a), view its equity price fluctuates, from the one agreed (I) during the signing of contract. It is remarked that the difference between forward and futures is that the forward can only be exercised at its expiry, whereas the futures may gain profits and before their expiry, in view of the fact that they are subjected in the mark to market concept. However, we shall discuss them later at the next chapter in more detail, which refer to futures.

The forwards at the end are not marked up towards the size of the contract and the date of delivery and they are not negotiable in organized stock markets (in opposition with the futures). The participants in this market are financial institutions, banks, brokerage firms, multinational companies, individual firms and independent investors. The differences between forward exchange operations and future contracts are summarized in different chapter at the end of this unity.

Future and Forward Contracts

Definition

Just like forwards, so as a forward contract is an agreement between two parties to buy or sell a commodity in a pre-determined time in future, at an agreed price. Unlike from forwards which are traded out of stock market, the futures are traded at the stock exchange. *As a consequence they are formulaic towards the delivery date and the place, the quality, and quantity of the subject matter. Moreover, they are guaranteed from the particular stock exchange wherein they are negotiated/traded* (Demetropoulos 1999).

Similarly, with the previous case of forwards; future contracts do not represent property. The contract earns value as the forward price changes. The cash flow in a future contract is the same with the cash flow in a forward act. The only thing that change is the time of the oncoming cash flows because of daily selling off which may be implemented in future contracts. (marking to market).

Future Contracts Marking to market

The procedure where profits and losses are cleared by negotiators on daily basis is called daily settlement of transactions or (marking to market). When a transaction begins with futures there is specified a safety margin which is called margin. This margin is a safety account which is opened by the broker and consists of cash or liquid bonds. Said account secure that a person involved in a transaction is capable of covering his obligations that stem from future contracts. In view of the fact that both parties of a forward contract are exposed to damages both of them must deposit a safety margin.

Therefore the account fluctuates every day according to the movements of market and the prices of futures. At the same time, a buyer/seller has the ability to change a short/long position before the expiration of the contract. In this way we achieve profit without risk (no risk profit), view essentially he cashes the papers/derivatives before the expiration date which agreed at time of concluding the contract. Certainly it is evident that the broker may not have done the most correct and profitable move, view next day may prove even better for him, but of 'course may have happened and the opposite as well. More on this perspective will be written at the next chapter which is specialized on shipping derivatives, while there are examples which indent to brief the reader.

Future Contracts General characteristics

As seen, despite that a future contract represents an obligation for delivery or delivery of the subject matter, in most cases the obligation that ends before the expiration date with the so called offsetting transaction. It is obvious of' course that even in case of contract's expiry, no physical delivery of the subject matter is done. Finally, the delivery limit starts from the delivery date, which is typically near the end of the previous month before delivery.

The exact date of delivery depends from the specific future contract. If the holder of position does not compensate the position before that date he runs the risk of receiving a redelivery notification. If anyway the contract is kept until the end the delivery is guaranteed.

All the future contracts do not include delivery of goods in exchange of some sort of payment. One particular type of forward contracts dictates that the delivery will be done with cash exchange. This type of contracts is mentioned as monetary adjusted forward contracts.

Liquidation

In futures' market, all transactions agreed between brokers are undertaken by one organization that warrants the security of the market. Said organization is called Clearing House and introduced itself as a separate legal entity or Exchange's department. It is responsible for the smooth transaction of futures S&P (Sale and Purchase), thereby liaising with investors who wants to trade/negotiate. Eventually we could resemble the clearing house as a platform on top of which the derivatives market is developed. Of course its purpose is to serve the exchange of derivatives, which is considered to be its creation.

Eventually, we could mention the below three principal scopes of liquidation company.

- Warrant for fulfillment of contracts
- Liquidation
- Carry through the deliveries

Finally we have to mention that the trade of futures is not done directly with the interested investors, but take place big broker houses, which follow the orders of their clients.

Options

Options are voluntary contracts of S&P (Sale & Purchase) of bonds at a particular price and time duration which are triggered only if the purchase favors the buyer. As regards the other party of the agreement, he is obliged to buy or sell wherever is asked by the buyer.

Option contracts appear in cases where the holder needs to enjoy the privileges of possible favorable or upward move of the market but not to expose him to risks and fall of the market.

Swap

Swaps are contracts by which two parties agree to exchange particular cash flows in future. There are two kinds of handling: the Caps, which are used to cover risks of fluctuating interests (in actual fact we buy one option in order to cover the buyer in case of interest rise) and the swaps, which are used essentially to buy an option which gives us the right to make a contract with a dealer for the signing of swap. Except of' course from the exchange of interests there are others, like the exchange of currencies, values or even obligations.

Swaps today are used by different financial organizations, Industry, Banks, Insurance Organizations and even public bodies. Swaps are used to reduce the capital cost, in order to capitalize the financial scale, for risk management and speculative counter balance at international stock markets and the creation of synthetic derivatives.

2.4 **Comparison between forwards και futures**

As seen above, the daily liquidation of transactions (marking to market), is the main difference of futures and forwards as regards their function. Forward agreements are simply kept until their expiry; capitals are not transferred until that day when contracts may be traded/negotiated.

After that, the rest differences relate to the main negotiation of contracts and generally their 'technical" features. Said features are the following:

1) In futures it is interrupted the liquidation organization and as such the identity of the parties is of no importance, whereas in forwards every member has the entire responsibility as against the other party.
2) The forward contracts are entirely formulaic contracts in as much as the magnitude of the contract, its time duration, its delivery and the mediation, except from the price which is subject to negotiation, as against futures which are made as such in order to satisfy the needs of their users, who chose to better future among a wide spectrum on instances.
3) Forwards have limited liquidity since they are private agreements with special characteristics which are defined by investors. On the other hand futures are available in stock markets and they have high liquidity, because of the high number of investors who are active in their market.
4) At Futures it appear a margin of security, which is covered from both parties of transaction and adjusted every day, thereby offering certainty to each contractor.
5) Forwards belong to out of stock market and represent mainly bilateral treaties, which are negotiated round the clock, as against futures which are subject to trade during working hours of stock exchange
6) Futures are settled every day and the profits are credited to accounts which have profitable positions whereas loses are debited to accounts which have lose positions at the end of the day. On the other hand at forwards there is only one payment at the expiry of the contract.
7) Regarding the process of delivery, in futures we define expiration dates, as well as areas of delivery, whereas in forwards, the procedure is described proportionate to each contract.

2.5 **Value of Derivatives in Theory**

We mentioned previously the value of one derivative, which essentially is identical and equal with profits and loses brought in after negotiations. It is well known that forwards and futures have specified time limit that varies depending on the contract. There must be done however some correction at the factor "α" (value). This correction in reality indicates the (Carrying Cost) or the cost of commitment – money which is on top of the asset market price, in which case the buyer has to make an offer.

The factor k according to the theory of carrying cost includes:

The cost of preservation and storage that has to do mostly with natural goods.

The cost of borrowing or opportunity cost, is the interest which could have earned if the money were not invested in the market of derivatives but remained in the spot market.

Eventually though the value is calculated with the following formula.

$$\alpha = |R - I| - \kappa$$

The cost of carry theory is also defined as base "θ" the difference of derivative price (forward or future) "I" and the price in actual market (spot) "R". If the value is equal to zero then $\kappa = \theta$ and $|R - I| - \theta = 0$, therefore we have:

$$\theta = |R - I|$$

It is highlighted that the coming cost plays an important role in understanding the hedge and act negatively only in long positions. It is understandable that in case of short sale there is no cause for concern; on the contrary the money which is earned can offer big proceeds.

When an investor therefore makes a move in derivatives' market (to make mainly hedge the asset at hand), he must study and make an allowance for the above factors before he enters the market and calculate the final valuation of the investment. In a few words, he must act with maturity, thereby decide if there is a bargain indeed before he joins the market of derivatives or rather it is better to stay in the normal market, weighing and calculating other parameters as well.

SHIPPING DERIVATIVES

3.1 **Introduction**

Sea transport played always and will play an important role in the transaction of world's commerce. If we consider that every year are transported through seaways merchandise valued 120 billions of dollars, we come to conclusion that shipping constitutes and indispensable cell of the world's economy. Furthermore, the last decade the fleet of available ships has increased substantially, a fact which in conjunction with the high volatility of freight rates and the complication of this particular market urges the managing of risk as an imperative need.

The scope of vessels at sea is to carry cargoes – domestic merchandize, among the nations and worldwide. Automatically therefore shipping serves the current offer and demand. Also, the capacity of the market is determined according to the price of bunkers, which depend on the available oilfield and other factors closely connected with other deposits and unexpected military actions around the world. The above factors though are closely connected with value of strong currents, so when they are affected it occur serious disorder and unrest in interest rates and available capitals. However there are other factors as well and which is the price of iron ore; coal etc, which may destabilize the market.

The above factors are connected with shipping market and give sudden and unintentional variations in the market, which may toss the capital of a charterer or a ship-owner sky high and lead them to bankruptcy. It is worth mentioning that the freight rates may fluctuate till 70% in a period of 20 days only.

This reality and the recent increase of capital risks brought into play the shipping derivatives. Although they were faced initially with skepticism, eventually they proved to be a valuable tool capable of offering a new leverage in the volatile and complicated shipping market, thereby opening new horizons in managing risks.

Definition

We may define the FFAs as deferred payment agreement where both contractors consent and bind the purchase/sell of commodity and its transportation from one place to another, at a pre-determined price which is agreed beforehand.

The settlement is monetary so there is no physical delivery. The payment is done at an agreed date by both contractors. Before making a contact, said Contractors take into consideration the Baltic Exchange in London, the BDI (Baltic Dry Index) and BITR (Baltic International Tanker Routes).

Taking into consideration all of the above, the managing of risks is a value which is developed continuously is shipping, since more and more investors, companies and organizations recognize that their survival and well being is based on the FFAs. The FFAs is something more than a financial tool which is used from those involved in order to make better calculations and programmed their future better.

Derivatives and Shipping

The Shipping Derivative or Freight Forward Agreements (FFAs) that developed aim at managing risks, which come from the fluctuation of freight rates, warehousing costs, value of vessels, price of scrap, interest rates, exchange rates etc. Said risks therefore with the involvement of derivatives can be handled in a more flexible and cheaper way.

Their consolidation and use in shipping, except from big liquidity of capitals, contributed to creation of formal contracts, offered in shipping transport (with regard to cargoes, sea routes and type of vessels), as well as the fact that in shipping market there is big transparency. Said derivatives are mentioned below.

FFAs & History

The first derivative contracts in Shipping made their appearance in 1985 with the establishment of BIFFEX (Baltic International Freight Futures Exchange). Initially, there was a contract with an index BFI (Baltic Freight Index). Gradually and because of the splitting of market there appeared and other indexes BFI. As private agreements between two contractors who were negotiating out of market appeared in 1992.

3.2 **The Freight Derivative Market**

Shipping derivatives, like other derivatives can be categorized as follows:

Forward Freight Agreements or FFAs: They are private agreements which are made mostly between Ship-owners, Charterers and Traders. The up and downs of freight rates in shipping market is a problem which is usually faced by Charterers and Owners. Increasing freight rates therefore lead to higher costs for Charterers. Lower freight rates on the other hand burden the Ship Owners who seek employment for their vessels. Both Charterers and Ship Owners however need a tool to lessen their exposure and minimize their costs. In this case, the FFAs are the right leverage and used to hedge this freight risk. With the FFAs, it is aimed to manage risks which are widespread in shipping market and protect their users against fluctuation and changeable freight rates. This instability amplifies the need for efficient management plan.

Like other derivatives, so as the FFAs are used for hedging, speculation and arbitrage. There are many people who believe that they have some information on the progress of the market, although the programming of a company on the basis of shipping derivatives is a dangerous decision and must be avoided. We must not forget that derivatives form and estimation of the market and not prognosis.

FFA contracts are usually based on terms and conditions of the Forward Freight Agreements of Brokers Association and the International Swaps and Derivatives Association.

The characteristics of FFAs are the following:

- Paper Swap, which is dealt between 2 parties.
- FFAs can be bought and sold at an agreed rate per ton or daily time-charter rate. One party believes that the freight at an agreed route and period/time will be higher than the present rate. Therefore, he buys FFA contracts. The Ship Owner on the other hand adopts different view and sells FFA contracts. In said cases therefore Ship-owners take the short position whereas Charterers take the part of the buyers (long position).
- It fixes a price today for settlement against an agreed period or date in future.

Traders usually get the benefit of liquidity as the FFA contracts are very fluid. The costs such as basis expense and brokerage fees are less compared that of the cash market. In FFAs' market individuals can make big business with less money.

Settlement terms of the FFAs vary as follows:

- On average of 1st7 days index of agreed month in future. This is usually done in the dry market, where voyage charters are concluded on the difference between the agreed/contracted rate and the average spot price of the index at the specific route. Time charters on the other hand are settled between the agreed/contracted hire and the average hire over the calendar month. In the tanker market, the FFA contracts are fixed in World Scale, on an agreed route/time and price.
- Every day at the end of each month can be "over-the counter" agreement or traded through a clearing house, NOS, LCH-Clearnet, NYMEX, SGX.

FFA contracts in the beginning were traded in OTC derivatives markets.

As mentioned above the FFAs are considered to be a paper freight-hedging mechanism in order to fight the fluctuation of shipping market and minimize participants' exposure. Although FFAs were widely recognized as an important tool, some professionals were unaware of their function and a many of them had not used them.

Nowadays, a big part of transactions in shipping industry is connected with the use of FFAs. The boom of FFAs incurred view they provide contractors with better opportunities in managing risks and can produce good results and benefits for its user.

Freight Futures: The function of the Freight Futures is the same with the FFAs with the difference that they are negotiated in organized stock exchanges like the IMAREX (International Maritime Exchange) and the NYMEX (New York Mercantile Exchange) and generally keep the characteristics of futures. The first freight futures contract launched in 1985 by the Baltic Exchange.

However, in 2001 it was created the International Maritime Exchange (Imarex) in Olso and began to offer freight futures contracts written on single routes. Therefore the freight forwards considered to be a new market.

The main purpose for creating futures contract was to give a hedging tool in the shipping market in order to coop with freight fluctuations on the spot market.

Freight Futures like other derivatives are settled in future, therefore it provides better opportunities. For instance, if someone wants to short some stock for long time, he can do it only in Freight Futures or Options.

Since the spot market is very unstable and carries many risks for ship owners and charterers it is necessary to hedge the risk in order to diminish their exposure. Therefore, freight futures were established to meet this demand.

Freight Options: In addition to FFAs and forward contracts, freight options contracts are another derivatives mechanism for managing risks. These contracts are used very much in finance, including exchange and interest rates. Freight Options were introduced in 1991 in Baltic Exchange. They were used mainly in order to avoid problems with manipulation of the price of goods during or close to its expiration date.

The normal freight option contract is freight put option or a freight call option. Such contracts are concluded on the difference between the average spot rate over a specified period and an agreed/contracted rate.

A ship owner usually purchases a put option, wherein he agrees to sell freight at an agreed price in future. Therefore, if the freight falls, he would exercise its option to sell at an agreed price. A Charterer on the other hand usually buys a call option and uses this option if the freight rate at expiry is higher than the agreed price. In order to buy an option contract one must pay a premium.

Their use in shipping market judged to be a failure and as such they appear today as an out of stock exchange contract in freight rates and they are available at limited and individual routes of the Baltic Exchange, tanker index (measured in Worldscale points) and t/c (time charter) routes index and the FFA contracts. They are traded by the same brokers who trade FFA contracts.

Hybrid FFAs : This FFA contract is another derivative instrument which brought up to meet the demand of traders, Owners, Charterers and other professionals involved. This contract is an OTC agreement, they are out of market agreements but they are liquidated through LCH Clearnet. They keep however the flexibility of the FFAs, the futures and against a price they diminish the credit risk. The LCH Clearnet introduced in 2005 a settlement service for OTC FFAs, thereby becoming the counter party in the agreement and offered the management of margin and cashflows.

These are used mostly by ship owning and brokerage companies as well as from oil companies, which charter the active vessels for transportation of cargoes. Their use has spread to agricultural products suppliers and various other commodities, especially with the participation of Asian investors, which is calculated to reach the $1/3^{rd}$ of the activity in bulk cargoes. Furthermore, shipping derivatives have attracted investors from various places like financial institutions, international banks, organizations and independent businessmen. The addition of the FFAs in shipping markets has given prestige and competitiveness, whilst the big inflow of capitals offers the necessary liquidity which is necessary to a healthy financial market.

The benefits of hybrid FFAs include the cut out of credit risks, multi-lateral transaction netting and improve operational and capital efficiency.

4.0 **Reasons for expansion**

The financial crisis has delayed the expansion of the freight derivatives trade. In shipping however there were cycles of good and bad market, nevertheless, it is believed that the market will recover. In this crisis therefore freight derivatives expanded view there are opportunities with long term positions on the shipping market for ship-owners and others to enter the market. Before 2008 shipping encountered a blossom with high freight rates, however, the uncertainty of spot freight rates had always existed, which aggravated by the current economic crisis.

The amount of transactions at the main stock exchanges of freight derivatives remained steady and increased. Presently the value in derivatives market is about USD 150 billion and will soon surpass the physical freight market. The FFA market on the other hand has shown indications of obtained experience and depth during preceding years. Nowadays, FFAs negotiated in Stock Exchanges OTC's and others have surpassed non-cleared. This blossom and growth of FFAs was the result of contractors concern to reduce and diminish as far as possible the risks. FFA therefore has become a necessary tool in investors' portfolios. The reasons of the FFAs taking an active part in transactions were the involvement of cargo owners, traders, finance companies, funds and hedge funds. We see therefore that non-shipping counterparts represent now the plurality in the FFAs dry market.

In spite of the fact that there has been some opposition in the market due to extreme involvement and speculation by non-shipping people, their involvement is fruitful, view is assists to widen the market. Said involvement has risen from 17% to 40 % in 2007, which brought big funds in the market and offered liquidity.

5.0 **Clearing Houses**

Viewing the significance of Clearing Houses, we shall examine the importance of derivatives in financial markets, importance that is hidden in the average retail investors, but nonetheless gain a lot of press attention and comments, particularly nowadays that Euro-zone debt problems have emerged.

For instance, if you are a clearing house broker and you have a good number of clients who want to buy shares and they are placing their orders with you, what you might do, is to try and group all these orders together, in a big order form, so as to enter the exchange market pay less transaction costs and subsequently earn bigger profit. The market to place such big orders is the usually London stock exchange market. Of course, this is not the only exchange market, in which case you may place your order with a different stock exchange market, however, the London stock exchange is the place brokers usually go to make large transactions. Basically, very big and reputable stock exchange markets offer security and as such they gather buyers and sellers to do business under their protection and support.

The issue at hand is that even if you have agreed the price with the seller, it takes about 3 working days for funds and ownership of shares to change hands. Here lies the actual problem therefore, what will happen, if the buyer doesn't disburse and settle the agreed amount, or seller doesn't deliver the shares?

Here come the clearing houses, whose role is to provide guarantees, when a deal is stuck or temporized, due to above and other reasons, in which case they intervene and provide guarantees in order to get round the problem. For example, they bridge the gap when a deal is concluded and actual legal entitlements are gained. If the seller doesn't deliver the shares, they give necessary assurances, that clearing house will deliver them, even if the buyer does not pay the amount on due date of payment.

Here is therefore the big deal and the advantage a clearing house is offering, because investors do not usually have much faith in stock exchanges or other markets to make such big deals, without revealing their identity, which encourages people to come and deal with them.

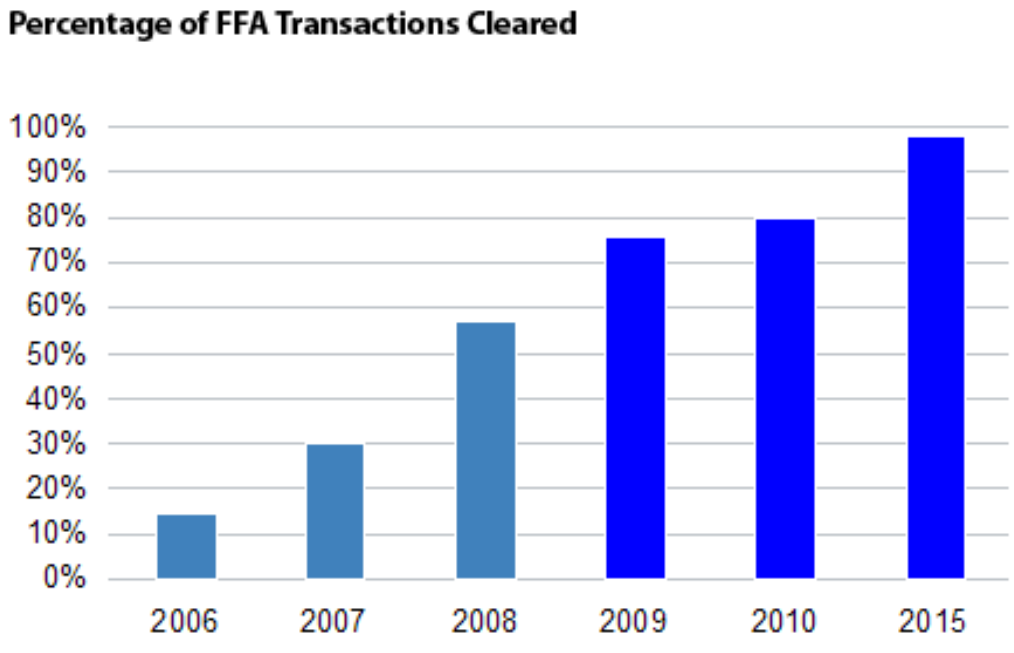
The third role of the clearing houses is settlement, when you actually take legal title of the shares, because shares have to be legally registered, like property, which means that the sellers' and buyers' name firms must appear mentioned and registered somewhere. Funds are well received by the sellers and buyers margin account.

What clearing houses actually do is to intervene between the buyer and the seller and take over the entire contract. The moment the contract is agreed, clearing houses issue two separate

contracts, one between the seller and the clearing house, and another one between the clearing house and the buyer. There is no need therefore for counterparties to meet each other, view everything is arranged by the clearing house through margin accounts, that both are obliged to retain. This is where they advance the deposits, but not the full value of the contract price. A pre-payment of (10-15%) of the full contract amount is necessary, as long as the buyer pays the full amount and the seller delivers all the shares, the deposits are returned.

Particularly in the freight market and the role of clearing houses is widely used mainly because of the size of the contracts and the nature of the asset as stake. A Forward/Future Freight Agreement is an indivisible asset, unlike stocks that are bought or sold by thousands in a single transaction. On the contrary, an FFA contract, is a single transaction amounting hundreds of thousands with several months of maturity. They provide a virtual elimination of counterparty risk along with multilateral netting between buyers and sellers. The increased liquidity that they offer via introduction of non-shipping market participants and daily realization of a Profit & Loss account, makes clearing houses a more desirable way for safe transactions.

Nonetheless setting up a margin account might not be something that everyone is willing to undergo. Some players prefer trading OTC contracts knowing the risks involved. Adding to that, Clearing Houses offers standardized contracts and that is why most players choose to operate outside of its norms and have a contract tailor-made with the opposing counterparty though their brokers.



(celent.com)

FUTURE FREIGHT AGGREEMENT EXAMPLE

In the following pages we have an actual example of a future freight agreement (vessel being under time charter), the way it can be executed after the agreement with a bank (for opening a margin account).

Trading date is the date that the contract is signed, followed by effective date on the next day and termination date to state the length of the agreement. Total notional quantity reveals the frequency in which the freight is paid from the charterers to the owners.

Along with the company's name and the approved by both parties clearing house, the fixed price is about the daily hire rate settled. Clearing house fees is the initial sum that both parties have to pay (accumulated) in order for the FFA to take effect, from said amount, the commission is deducted. Same goes to the Brokerage fees, the commission will be withholded from the agreed amount. Clearing fees are the total freight (hire in our instance) amount for one month period.

Referring to the commodity under agreement (freight rates) along with the market from which the rates will be taken. Multiplier states the number of contracts and the particular vessel in reference. Floating price explains the four charter routes.

Calculation period revises the contact period and payments date informs the participants about the settlement date. Price publication revisions inform the parties how the changes on the indexes will be applied.

Credit terms are the most important part of the agreement in a future freight contract. Both parties accept the commitment as well as the terms of the agreement and in case anyone of them diverts or fails to comply with them, is penalized by the clearing house (along comes the end of partnership between the broker and the party). Credit terms do not apply only to future contracts, forward contracts can be subject to credit risk clauses as well. Most times they correspond to either currency risks or legal reassurance towards another in case of one's default.

Trade Date	January 31st, 2011
Effective Date	February 01st, 2011
Termination Date	February 28th, 2011
Notional Quantity per Calculation Period	01/02/2011 – 28/02/2011 – 15 days
Total Notional Quantity	15 days
TRANSACTION DETAILS	
Fixed Price Payer	*Company Name*
Floating Price Payer	LCH (London Clearing House)
Clearing Agent	*Bank*
Fixed Price	USD 12,750 per day
LCH Fees	USD 105,000
Clearing Fees	USD 375,000
Brokerage Fees	USD 286,875
Reference Commodity	Freight – Baltic Exchange – Panamax Index, Average of the 4 Time Charter Routes (1A, 2A, 3A, 4A) in USD per day.
Multiplier	1 Panamax Vessel
Floating Price	The arithmetic average of Routes 1A, (Transatlantic Round Timecharter) 2A, (Continent to US Gulf to Far East Timecharter) 3A, (Transpacific Round Timecharter) and 4 (Far East to NOPAC to Continent Timecharter) of the Baltic Panamax Index as defined on the Contract Date including any relevant office forthcoming amendments published at the Contract date which will become effective prior to the settlement of this agreement.
Calculation Period(s)	Each calendar month, from and including the effective date to and including the Termination date.
Payment Date(s)	The latest Five (5) Business Days after each respective Calculation Period, subject to adjustments in accordance with the Business Day Convention.
Price Publication Revisions	Should the relevant publication publish a correction to a previously published quotation, then the corrected quotation shall be applicable, and retrospective settlement of any difference should be made.
Credit Terms	Credit line provided by *Bank*, subject to margin call rule as follows: Initial Margin = 10% of notional amount of existing Net Position. Net Customer Funds Position = Credit Line + Deposited Margins + MTM of existing Net Position Bank Call Rule: • -If Net customer Funds Position < 75% of initial Margin: Counterparty is required to make a deposit to *Bank* of an amount of 30% x Initial Margin in 1 business days • If Net Customer Funds Position < 90% of Initial *Bank* has the right to close the position to the market automatically.

Business Days	London, Athens, New York
Contact Details for the Purpose of Giving Notice	
Bank	*Name, E-mail and telephone of Bank corresponder*
Companys' Name	*Name, E-mail and telephone of Company's correspondant*

2. **Calculation Agent**

Bank, who shall make Commodity Reference Price calculations to 4 decimal places and all cash settlements, shall be rounded to the nearest cent.

3. **Account Details:**

Payment to bank

Standard as agreed

PAYMENT TO COUNTERPARTY

4. **Early Termination**

In case part B would like to terminate in whole or in part the above mentioned transaction, said early termination, will be affected as per the terms designated by Party A in accordance with current market conditions. Accordingly the early termination may prove to be beneficial to Part B and the related profit will be attributed to the later, or may result in damages which will be incurred by part B.

5. **Closing:**

Please confirm your agreement to be round by the terms of the foregoing by executing a copy of this Confirmation and returning it to us.

For and on behalf

(Bank)

INTRODUCTORY COMMENTS TO OUR STUDY

LITERATURE

So far, the literature regarding Forward or Future Freight Agreements is rather limited. Very little has been written about FFAs or Forward Contracts, the way they operate or their close connection with freight rates. This is mainly because they are rather new derivative contracts compared to the derivatives used in other financial assets, such as stock or housing markets.

Their presence counts a little more than 20 years in Shipping industry but most players used to avoid them due to the BIFFEX weaknesses and the rather shallow market. This situation however changed from 2004 since the boom in commerce followed by a unique (in history) growth in freight rates. The main reason for this was the poor availability of data (Kavussanos & Visvikis 2006) in the BIFFEX where all transactions performed and as such it did not gain the confidence and support of traders. In 2002 however, the freight market (BIFFEX) ceased to exist, other trading houses were created and put into play, thereby regained the confidence of traders, which resulted in prosperity and growth of the FFA market.

In parallel with the spot values, the future prices or the forward contracts were developed as well. The interest in the market matured and increased and since then many studies have been published. Most of them are focused mainly on dry bulk carriers and certain trade routes. On the other hand, there were pioneers like Thuong & Visscher (1990) or Collinane (1991) who chose to study to the hedge efficiency of BIFFEX 5 years after it started. They found that most shipowners did not accept BIFFEX as the proper hedging tool .Kavusanos & Nomikos (1999) where the first to test the unbiasedness hypothesis on BIFFEX contracts, using monthly observations from 1988-1997,where they found that contract's time to maturity is liable for biasness. Haigh (2000) supports their findings but he adds that (according to his study) the "up to one month maturity contract" can be an accurate forecasting medium.

Kavussanos & Nomikos (2000) found a variance reduction up to 19.2% on weekly spot and future prices in accordance to each route. As a follow-up, Kavussanos & Nomikos (2010) investigated the variance reduction using weekly data (from 2004 to 2008) using the C4 route prices (weighted average of all 4 main charter routes) and found a sample variance reduction from 55% to 65% on all routes. Kavussanos (2004) addressed the unbiasness matter once again using contracts with maturity 1-3 months. The one and two month FFA contracts proved to be unbiased estimators to spot prices. Groder (2010) came as an assurance to analysts before him. Using monthly data from 2005 to 2010 he found FFA to be unbiased estimators to FFA. He also discovered that the FFA leads to spot prices on low volatility markets and the Spot precedes the FFA prices when same are traded on high volatility markets.

The studies that we chose as a yardstick are written by Manolis Kavussanos and Ilias Visvikis (2002 & 2003), thereby addressing the issue of unbiasedness hypothesis as well as the cointegration between variables. They investigate the lead-lag relationship as well as the efficiency of FFA prices in all four major market routes separately.

What we are going to do is follow a similar path with different and more up to date data series. Our main difference lies in the data collection. The data that we use is that of one month maturity, contrary to 3months of other studies. Similar to that, we chose the four time charter route in contrast to analyze each sea route separately. Other than that, we will chose the same econometric tests and follow the same path as the initial paper, on account of our findings to be comparable.

Bias & Unbiased estimators

In statistics : "*the bias of an estimator is the difference between this estimator's expected value and the true value of the parameter being estimated*". When an estimator is considered to be biased, the characteristic at hand is whether the estimator overestimates or underestimates a parameter. On the other hand, when an estimator has zero bias is called unbiased.

In theory, a forward price is equivalent to the expected spot price at maturity (for whichever the underlying asset might be), under the joint hypothesis of no risk-premium and of rational use of information. We have to test the relationship empirically (or by trial and error) and try to define whether our estimators can be regarded as unbiased. Unbiasedness of the estimators is of primary importance and concerns us because we investigate the relationship between future and spot freight prices.

Forward and Future Freight Agreements fall into the category of consumption commodities but unlike any others, they do not have any storage costs. In fact, it is a consumption commodity that cannot be stored like an agricultural or investment commodity.

$$F_0 < S_0 \, e^{(r+u)T}$$

That being said, we come to terms that the two prices (spot and FFA) are not linked by a cost of carry relationship, hence their co-dependence with each other is not as strong as in storable assets. In addition the transaction costs in FFA market are far less, as it doesn't include the physical asset (vessel), thus making the forward contract a more desirable commodity for both parties.

DATA

The data was taken from the SSY Shipbrokers and corresponds to the last six year period of the FFA market. Our study originates from the beginning of 2007 where the freight market (and by definition all derivative corresponding with freight rates) evolved and started an unprecedented rise. We saw Spot rates to reach ten times their price, only to fall back to the same rates 2 years later. Through these unforeseen circumstances, we gathered the Spot and FFA rates in order to be able to replicate the results for this troublesome period.

That unpredictable rise in the freight market led to a vast demand for Future and Forward contracts for both Shipowners and Charterers side. Each one of course, for their own needs, made the FFA market grew bigger day by day, making it a topic worth investigating. All above was done for the purpose of clarifying the connection between the two variables.

Our data is the average of aggregate four time chartered routes for Panamax vessels (62-76 DWAT) from 2007 to September 2013. The duration of the contract is for one month period, which is the same as its maturity. For the prices to be more conservative and to cater our needs, we chose to take the arithmetic mean of the first five FFA and Spot prices for every month for eliminating the unexpected phenomenon of a "shock" in the market. We then compare them with the respective spot prices of the next month. The forward price and the "real" price of the asset for the same period are placed next to each other, forming our time series in our tests.

The study is separated in two main themes. The first one corresponds to our attempt in finding whether one variable can be considered to be an unbiased estimator toward the other. We can do this by regressing our model and after testing for autocorrelation and heteroskedasticity, we have to perform a Wald test with restrictions on both parameters. The second section wades into matters of cointegrasion and causality on the series. Through the use of Johansens cointegrasion test, VECM, and Granger causality test we search for existence of a common stochastic drift or the presence of a causal relationship between variables.

TESTING FOR UNBIASSNESS

We refer to the main subject where we have chosen one vanilla autoregressive model, a "toy model", as a primary attempt for accomplishing our objective.

The above pricing model works under the joint hypothesis of no risk-premium and rational use of information. We know as a matter of fact that said problems are some of the major issues for any try of modelizing an economical phenomenon by using econometrical methods.

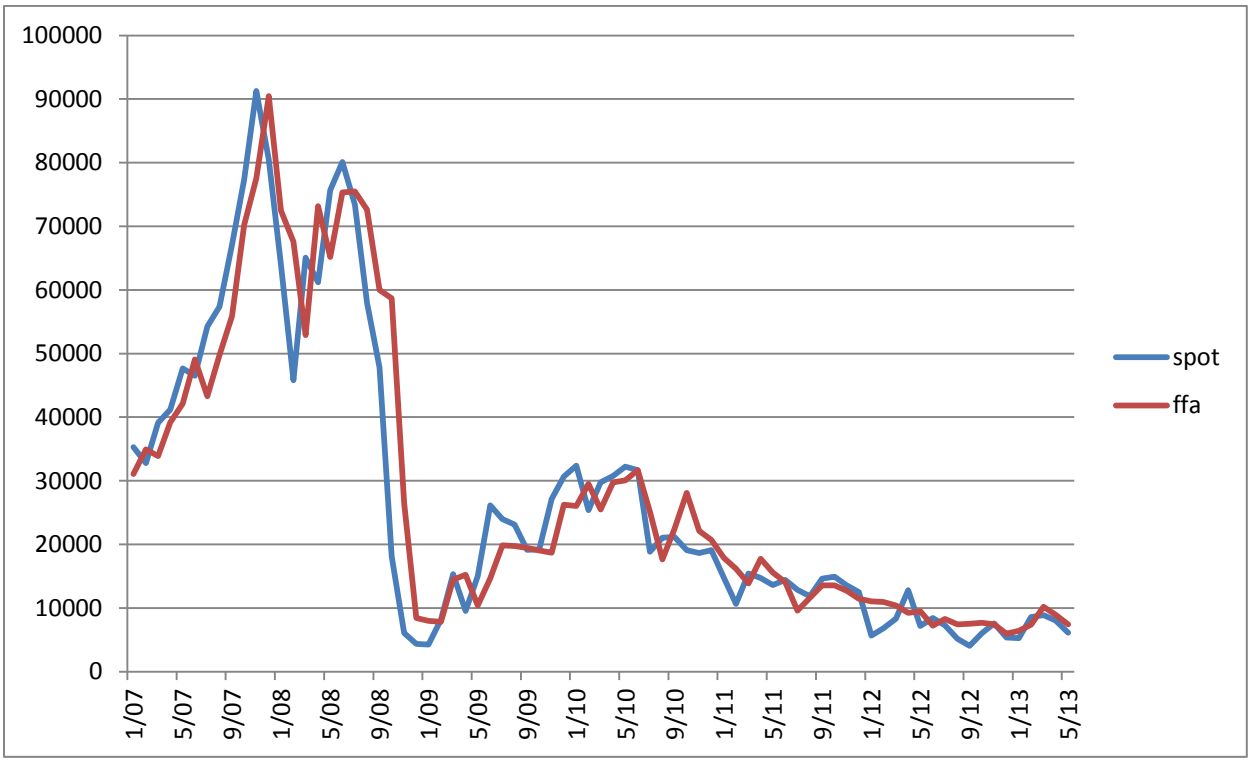
The model we apply is of the following form and is expressed in FFA terms as :

$$S_t = a + bF_{t,t-n} + u_t$$

S : stands for the spot price of the freight at time
a : is equal to our constant term,
t : is the price of our forward contract in a particular time (t-n) for a
n : period maturity contract.
u : is the white noise error process.

We are going to make an empirical test of a forward contract which can be used as an acceptable way to envisage the spot price at the maturity contracts. The unbiasedness will hold if the parameter restrictions: a=0 and b=1 are valid.

By following our way through the data process, we initially have to view the graphs of our 2 variables and their paths from 2007 to 2013. We clearly identify the common paths of our variables through the timeline with FFA having a smoother pace, while following closely the Spot freight rates.



Combining the graphs together, we see that the lag in FFA is visible in every bit of its way, signaling the mutual paths of the two timelines. The FFA one is a lot smoother in lines and tries to keep up with the rapid changes in the spot rate market.

Our data (as most economic timelines) are discontinuous due to the fluctuations of the freight market, been in its peek for the years following the great boom in global commerce but ending in a spectacular "dive", during the years after the economic crisis.

That being said, we must test our variable for unit roots. After performing the necessary tests (such as Augmented Dickey-Fuller and the Philips-Perron) both the FFA and the Spot variable has at least one unit root and therefore cannot be used in our tests. In order to be able to process our data, initially we have to convert them into continuous variables, through the process of first differences. In this way we can perform various econometric tests adding up to our goal as unbiased estimators and “if the FFA series can be used as a significant factor for predicting Spot freight rates".

After converting the two timelines into continuous series, using the logarithmic first difference [series R_spot=log(spot)-log(spot(-1))] we then re-apply the Augmented Dickey-Fuller test along with the Philips-Perron in each of the variables in order to eliminate the undesirable factor.

With the null hypothesis being that our variables have (at least) one unit root, we infer that they both have no unit root, they are both I (0) and so we can proceed with our study.

The first we have done is to state the autoregressive model and test it with our continuous series. Our model is of the form y=a+bx, which in our study is translated to $\underline{SPOT_t = a + b\ FFA_t + u_t}$.

Dependent Variable: R_SPOT
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014936	0.034457	-0.433468	0.6659
R_FFA	0.428265	0.143	2.99487	0.0037

R-squared	0.108103	Mean dependent var	-0.02301
Adjusted R-squared	0.096051	S.D. dependent var	0.314977
S.E. of regression	0.299469	Akaike info criterion	0.452349
Sum squared resid	6.636424	Schwarz criterion	0.513684
Log likelihood	-15.18924	Hannan-Quinn criter.	0.476861
F-statistic	8.969249	Durbin-Watson stat	2.126924
Prob(F-statistic)	0.003733		

From the previous graph we can take various information about the nature of our equation. For instance the steady variable proves to be non important, due to the high P-value that supports strongly the initial hypothesis (that the variable is not a significant addition to our equation). On the other hand the “b” is by all means of considerable importance because of the low P-value and “a” reasonably high coefficient value.

Following our research data, we have to test our equation for either autocorrelation or heteroscedasticity problems. These tests will be made on the equation's residuals. The sole purpose of said tests is the importance of proving our equation which can be a close estimate to the relation connecting the spot and future prices, free of any econometric discrepancies that might falsify the final result.

Serial correlation has a larger impact on standard errors and efficiency of estimators than heteroscedasticity. However it may be of same concern in smaller samples, like ours.

TESTING FOR HETEROSKEDASTICITY

When testing for heteroscedasticity, residuals should not be found serially correlated because any serial correlation between the residuals will generally invalidate the tests. For Heteroscedasticity to be present var(u_i) must be equal to E(u_i), equal to σ_i^2. The cost for its presence is once again the estimator problems that arise. The estimators calculated with the least square method are still consistent and biased, but lose their effectiveness. The residuals are not estimated correctly. We can either modelise variance or reevaluate the residuals to meet the hypothesis testing.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |** |	. |** |	1	0.255	0.255	5.1564	0.023
. | . |	.*| . |	2	-0.051	-0.125	5.3682	0.068
. |*. |	. |*. |	3	0.105	0.165	6.2676	0.099
. |*. |	. |*. |	4	0.205	0.136	9.7346	0.045
. | . |	.*| . |	5	0.007	-0.073	9.739	0.083
. |*. |	. |*. |	6	0.084	0.143	10.332	0.111
. |*. |	. |*. |	7	0.17	0.076	12.821	0.077
. | . |	.*| . |	8	0.01	-0.077	12.829	0.118
. | . |	. | . |	9	-0.059	-0.014	13.135	0.157
.*| . |	.*| . |	10	-0.119	-0.189	14.399	0.156
.*| . |	.*| . |	11	-0.131	-0.116	15.976	0.142
.*| . |	.*| . |	12	-0.133	-0.088	17.623	0.128
. | . |	. | . |	13	-0.02	0.015	17.66	0.171
.*| . |	.*| . |	14	-0.097	-0.079	18.554	0.183
.*| . |	. | . |	15	-0.095	0.024	19.436	0.195
.*| . |	. | . |	16	-0.116	-0.06	20.767	0.188
.*| . |	. | . |	17	-0.104	-0.011	21.855	0.19
.*| . |	. | . |	18	-0.134	-0.043	23.701	0.165
.*| . |	.*| . |	19	-0.172	-0.135	26.774	0.11
.*| . |	. | . |	20	-0.113	-0.054	28.118	0.107

In the above table we can see the correlogram for the squared residuals giving us a hint for whether we have heteroscedasticity or not. The p-values are reasonably low, but heteroscedasticity is present and it might be a problem in future econometric tests.

Another test for heteroscedasticity is the White test. The white test enables us to see if the residual variance in a model is constant.

The White test, assess the null hypothesis $H_0 : \sigma_i^2 = \sigma^2$,for all i. White's test is general because it makes no assumptions about the form of the heteroscedasticity. Because of its generality, White's test may identify specification errors other than heteroscedasticity and it may be significant when the errors are homoscedastic but the model is misspecified in other ways.

Heteroskedasticity Test: White			
F-statistic	1.499809	Prob. F(2,73)	0.2300
Obs*R-squared	2.999633	Prob. Chi-Square(2)	0.2232
Scaled explained SS	4.370896	Prob. Chi-Square(2)	0.1124

In the test described above we can only see the absence of heteroscedasticity (in contradiction to previous analysis of the residuals, by the correlogram). Nonetheless, the data described in White only dictates the loss of heteroscedasticity according to certain test.

On top of white test, we choose to retest it ARCH test.

The ARCH-LM is a Lagrange Multiplier test for autoregressive conditional heteroskedasticity on the residuals. This method assumes the following relationship for the regression residuals:

$$u_t^2 = \gamma_0 + \gamma_1 * u_{t-1}^2 + \gamma_2 * u_{t-2}^2 + \ldots + \gamma_k * u_{t-k}^2 + \varepsilon_t.$$

The distribution function for the test is : $LM \cong T * R^2$
Where : T is the number of observations and
R^2 is calculated as an indicator for how well this model accommodates the data

The LM distribution function, under the null hypothesis H_0 follows x^2 distribution, with k degrees of freedom. The null hypothesis under investigation is $\gamma 1=\gamma 2=\ldots=\gamma k=0$ (non heteroskedasticity) against the alternative $\gamma i \neq 0$ for at least one $i \in \{1,2,\ldots,k\}$ (heteroscedasticity).

.Heteroskedasticity Test: ARCH			
F-statistic	3.058153	Prob. F(1,73)	0.0532
Obs*R-squared	5.869143	Prob. Chi-Square(1)	0.0532

The null hypothesis is the same as other tests, H_0: we have no heteroskedasticity. The p-value is not high enough, but we can accept the null hypothesis with 95% certainty. That being said, we find that heteroscedasticity is not present in either form.

AUTOCORRELATION

For the autocorrelation tests we will use at first the Q-statistics to see whether we have serial correlation among our observations.

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.067	-0.067	0.3508	0.554
.*| . |	.*| . |	2	-0.071	-0.076	0.7566	0.685
. | . |	. | . |	3	-0.047	-0.057	0.9339	0.817
. | . |	. | . |	4	-0.019	-0.033	0.9649	0.915
.*| . |	.*| . |	5	-0.14	-0.154	2.5969	0.762
. | . |	. | . |	6	-0.011	-0.043	2.6067	0.856
.*| . |	.*| . |	7	-0.136	-0.175	4.1985	0.757
. | . |	.*| . |	8	-0.025	-0.083	4.2552	0.833
. | . |	. | . |	9	0.063	0.008	4.6097	0.867
. | . |	. | . |	10	0.049	-0.001	4.8272	0.902
. | . |	. | . |	11	0.036	0.021	4.9441	0.934
. | . |	. | . |	12	0.06	0.027	5.2775	0.948
.*| . |	**| . |	13	-0.2	-0.219	9.0548	0.769
.*| . |	.*| . |	14	-0.113	-0.174	10.281	0.741
. |*. |	. | . |	15	0.081	0.009	10.917	0.758
. | . |	. | . |	16	-0.026	-0.059	10.981	0.811
.*| . |	.*| . |	17	-0.12	-0.15	12.42	0.774
. | . |	. | . |	18	0.061	-0.044	12.797	0.803
. | . |	.*| . |	19	0.025	-0.069	12.86	0.846
. | . |	.*| . |	20	0.038	-0.071	13.014	0.877

The above chart dictates our first thoughts about the existence of autocorrelation and partial autocorrelation in the model. According to it and the high p-values, correlation does exist in our data but we will have to test its importance to our results.

The autocorrelation problem arises when the hypothesis for non correlated residuals does not apply. The assumption for $\text{cov}(u_i, u_j) = 0$ is violated. Therefore, the estimators that arise from the least square method tend to lose some of their properties. They continue to be biased and consistent, but they stop being effective.

At the off-chance that our model has time lapses, then the estimators are not consistent and we can no longer estimate our model. On top of that, the residuals are not assed correctly. The problem lies in our model and not in its estimation.

On second note we will also perform another autocorrelation test on the account of being more precise.

The Breusch-Godfrey LM test assumes that our initial regression is of the form :

$$Y_t = \alpha_0+\alpha_1*Y_{t-1}+\alpha_2*Y_{t-2}+...+\alpha_n*Y_{t-n}+u_t \quad (1)$$

and that the white noise error can be described by the autoregressive model :

$$u_t= \gamma_0+\gamma_1*u_{t-1}+\gamma_2*u_{t-2}+...+\gamma_k*u_{t-k}+\varepsilon_t \quad (2)$$

With help from (1), (2) Breusch-Godfrey proved that the auxiliary regression is fitted:

$$Y_t= \alpha_0+\alpha_1*Y_{t-1}+\alpha_2*Y_{t-2}+...+\alpha_n*Y_{t-n}+ \gamma_1*u_{t-1}+\gamma_2*u_{t-2}+...+\gamma_k*u_{t-k}+\varepsilon_t$$

The distribution function for the test is : $LM \cong T * R^2$
Where : T is the number of observations and
R^2 is calculated as an indicator for how well this model accommodates the data

The LM distribution function, under the null hypothesis H_0 follows x^2 distribution, with k degrees of freedom. The null hypothesis under investigation is $\gamma1=\gamma2=...=\gamma k=0$ (non autocorrelation) against the alternative $\gamma i\neq0$ for at least one $i \in \{1,2,...,k\}$ (autocorrelation).

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.662569	Prob. F(2,72)	0.5186
Obs*R-squared	1.373478	Prob. Chi-Square(2)	0.5032

The LM-Test has the null hypothesis Ho : There is no correlation and the answer is based on the F-statistic. On account of the p-values, been that high, we can state without doubt that there is no autocorrelation in the residuals. The first try was done with 2 lags, in order to be more precise we run the test for multiple times with different lags each time (1-5). The results, came back each time the same with high probabilities all around, accepting the null hypothesis (Ho : there is no correlation among the residuals) and we can reject the existence of autocorrelation with certainty.

TESTING FOR UNBIASNESS

Moving on to the final stage of robustness analysis we have to test our data for the possibility that our constant term is zero and the beta is insignificant. We will use the Wald test to state whether the two different hypotheses can happen simultaneously.

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	7.999921	(2, 74)	0.0007
Chi-square	15.99984	2	0.0003

Null Hypothesis: C(1)=0,C(2)=1
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	0.014936	0.034457
-1 + C(2)	0.571735	0.143

Unfortunately the evidence provided in this analysis is definite. The unbiasedness hypothesis, stated in the beginning is not valid.

Because most macroeconomic time series are found to be non stationary, using an ordinary least square (OLS) to estimate our equation can result in inconsistent coefficient estimates. We must test our equation on a stable cointegration framework, where as Eagle and Granger (1987) demonstrate, when two non-stationery variables are cointegrated they follow an error correction model where the coefficient estimates and standard errors of the coefficients are consistent.

COINTERGRATION

Following our autoregressive model we will also check the two time series for signs of cointegration.

As previously seen from the initial data processing the two variables are both I(1), which have at least 1 unit root according to the test.

To make sure that the Spot and FFA variables have only 1 unit root we have to test both timeseries again, with the Augmented Dickey-Fuller test but this time we will take into account the first differences. For that, we will address the augmented Dickey Fuller (1979) test. The testing procedure of aforementioned stationarity test is applied to the model :

$$Dy_t = \alpha + \beta_t + c + \gamma_{t-1} + \delta_1 \Delta_{y-1} + ... + \delta_{t-1} \Delta_{y-p+1} + u_t$$

The Dickey-Fuller test is performed under the hypothesis that both $\alpha = 0$ and $\beta = 0$, similar to a random walk model. For the Augmented test to take effect we have to included p lags allowing for a higher order autoregressive process. In order to do that, we impose the $\gamma = 0$ null hypothesis against the alternative $\gamma < 0$.

Once the test statistic is computed by : $DF_t = \frac{\gamma}{(SE)\gamma}$ we can compare it against the critical value of Dickey Fuller test. We either accept the null hypothesis ($\gamma = 0$) or reject it, in which case, there is no unit root present

Null Hypothesis: D(FFA) has a unit root
Lag Length: 0 (Automatic - based on SIC, max lag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.893263	0.00
Test critical values:	1% level	-3.520307	
	5% level	-2.90067	
	10% level	-2.587691	

Null Hypothesis: D(SPOT) has a unit root
Lag Length: 0 (Automatic - based on SIC, max lag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.581944	0.00
Test critical values:	1% level	-3.520307	
	5% level	-2.90067	
	10% level	-2.587691	

The Probability is zero for both series and therefore the null hypothesis (that there is at least one unit root) is declined. That means that our time series are not I(2), but they are both I(1).

Another way to prove that both variables have only 1 unit root is the Philips-Perron Unit root test. Respectively, with the previous AugmentedDickey-Fuller unit root test, we search initially at level and then move on to the first differences. As anticipated, both methods give us the same outcome and we are positive that our variables are both I(1).

Philips and Hansen (1989) proposed another way to conclude that 2 non stationary series are cointegrated. An I(1) series is rather smooth, having dominant long swings, compared to an I(0) series. We know that the sum of an I(1) and an I(0) series will be I(1), mainly because of the relative size of the variances. If a, b ($b \neq 0$) are two constant variables with $x_t \sim I(d)$ and $y_t \sim I(d)$ then it is generally true that their linear combination will also be I(d).

$$z_t = x_t - a\, y_t$$

However it is possible that $z_t \sim I(d-b)$, $b > 0$. When such a thing occurs a special constraint operates on the long run components of the series. The constant term "a", is such that the long run components of x_t and y_t cancel out. For a = 1, the main idea is that x and y_t cannot drift too far, " their difference will be I(0)". We must state that there is not always an "a" that makes $z_t \sim I(0)$.

In order for the cointegrassion to take place, we must conclude that the union of these I(1) series provides us with an I(0) final , after performing the stationarity test to the residuals of the initial autoregressive model :

$$Spot = c + bFFA + u_t$$

The main difference is that in this case we will use the non-stationery variables and then test the residuals for stationarity. In this case it is clear that the residuals have no unit root. They are I(0) and accordingly we can safely deduct that out initial variables are cointergrated.

TESTING COINTEGRATION HYPOTHESIS WITH JOHANSEN'S

The Johansen System cointegration test will give us the desired result along with additional information about the cointegrated variables.

The Johansens methodology (1988) is ideal for our study because it is normally used in a setting where the variables are I(1). It has its starting point in the vector autoregression model (VAR) of order k, given by the following formula:

$$y_t = \mu + A_1 y_{t-1} + ... + A_k y_{t-k} + \varepsilon_t$$

In the above equation "y" is a "n" vector of variables that are integrated of order one I(1),and ε_t is a "n" vector of innovations. We can rewrite therefore our VAR as follows:

$$\Delta_{yt} = \mu + \Pi y_{t-1} + \sum_{i=1}^{k=1} \Gamma i \Delta y_{t-1} + \varepsilon_t$$

$$\Pi = \sum_{i=1}^{k} Ai - I \quad , \text{and} \quad \Gamma_i = -\sum_{i=1}^{k} Aj$$

The study indicates that if the coefficient matrix "Π" has reduced rank there exist n x r matrices **α** and **β** each with rank "r" such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is stationary. "r" is the number of cointegrating relationships, the elements of **α** are known as the adjustment parameters in the vector error correction model and each column of **β** is a cointegrating vector.

To test the significance of these canonical and the reduced rank of the "Π" matrix correlations Johansen proposes two different likelihood ratio tests for "r" : the trace test and maximum eigenvalue test:

$$\lambda_{\text{trace}} = -T \sum_{i=r+1}^{k} \ln(1 - \lambda i)$$

$$\lambda_{\max}(r, r+1) = -T \sum_{i=r+1}^{k} \ln(1 - \lambda i)$$

In the above equations λ denotes the estimated values of the characteristic roots, while "T" is the sample size. The trace test checks the null hypothesis of "r" cointegrating vectors against the alternative hypothesis of "k" cointegrating vectors. The maximum eigenvalue test, on the other hand, tests the null hypothesis of "r" cointegrating vectors against the alternative hypothesis of "r+1" cointegrating vectors.

Both tests have non-standard asymptotic null distributions. Moreover, given the cointegration rank *r* Johansen also derives likelihood ratio tests of the cointegrating restrictions on the intercept or trend parameters.

the L_{trace} test. is based on the log-likelihood ratio ln [Lmax(r)/ Lmax(k)], and is conducted sequentially for r = k-1,...,1,0. This test tests the null hypothesis that the cointegration rank is equal to r against the alternative that the cointegration rank is k. The latter implies that x_t is trend stationary.

The L_{max} test, is a test based on the log-likelihood ratio ln [Lmax(r)/ Lmax(r+1)], and is conducted sequentially for r = 0,1,..,k-1. This test compares the null hypothesis that the cointegration rank is equal to r against the alternative that the cointegration rank is equal to r+1.

Trend assumption: Linear deterministic trend (restricted)
Series: SPOT/ FFA

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.390511	46.37176	25.87211	0.000
At most 1	0.123231	9.731847	12.51798	0.1399

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.390511	36.63991	19.38704	0.0001
At most 1	0.123231	9.731847	12.51798	0.1399

Both L_{trace} andL_{max}tests indicate that we have only one cointegrated equation among our variables (it couldn't be more, since we only have two variables).

Johansens test has verified our suspicions for the existence of cointegration and for that we have to include the findings in the following unbiasedness analysis.

UNBIASED HYPOTHESIS WITH F-MOLS METHODOLOGY

The Fully Modified Least Squares methodology (F-MOLS) was first introduced by Philips-Hansen (1990). Their study tried to eliminate the bias effects wherever there was endogeinity in the regressors. For that, they suggested an alternative semi parametric correction which leads to asymptotically median-unbiased estimators. They chose modified Wald tests for testing general linear hypotheses about the coefficients in a cointegrated regression. With their asymptotic distributions being x^2 the correct modification of traditional Wald test were used.

The modified Wald tests were initially created to overcome the obstacle of limited distributions and are resolved through semi-parametric corrections. New statistics are limited by their x^2 distributions and therefore greatly facilitate inference in I(1) regression models.

Below method provides a partial alternative to the ECM methodology as well. The ECM methodology is parametric in nature and has proved successful in a variety of empirical situations. Previous studies (Philips 1988) have shown that there is a close relationship (the two methods are asymptotically equivalent in some cases) to the Fully Modified Least Squares and sometimes, fmols is preferable in terms of asymptotic behavior. This theory also applies to causality testing in VAR's and can be useful in empirical applications.

Dependent Variable: SPOT
Method: Fully Modified Least Squares (FMOLS)
Cointegrating equation deterministics: C

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FFA	0.954397	0.027485	34.7248	0.000
C	769.3775	980.0554	0.785035	0.4349

R-squared	0.879431	Mean dependent var	26870.07
Adjusted R-squared	0.877802	S.D. dependent var	22818.22
S.E. of regression	7976.53	Sum squared resid	4.71E+09
Durbin-Watson stat	1.259365	Long-run variance	28832179

$$SPOT_t = 769.377542582 + 0.954397355148 * FFA_t$$
$$(0.4349) \qquad (0.000)$$

The two series are indeed cointegrated, and by regression we extract the above model. Inside the parenthesis are the p-values for each variable. As we see the constant term is of minor importance and therefore it can be excluded from our model.

Ending our study for the unbiased hypothesis we try the Cointegrated Vector model along with the restrictions of the two parameters. First, the constant term must be 0 (C=0) and the other b=1

Wald Test:

Test Statistic	Value	df	Probability
F-statistic	1.700041	(2, 74)	0.1897
Chi-square	3.400082	2	0.1827

Null Hypothesis: C(1)=1, C(2)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
-1 + C(1)	0.045603	0.027485
C(2)	769.3775	980.0554

Using the Wald test, we see that the two restrictions we put can be simultaneously 0 and 1. Therefore our estimators are unbiased toward each other and they can be used for predictions.

After applying the cointegration framework into the unbiasedness study we were able to overcome the stationarity and consistency (for both, estimates standard errors) problems.

TESTING LONG-RUN CAUSALITY WITH VECTOR ERROR CORRECTION (VECM)

Following the afore mentioned cointegration test (F-MOLS) we have proven that the constant factor is not of significance to our model. We remove it and reevaluate.

Dependent Variable: SPOT
Method: Fully Modified Least Squares (FMOLS)
No cointegrating equation deterministics

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FFA	0.971778	0.017548	55.37785	0

R-squared	0.879197	Mean dependent var	26870.07
Adjusted R-squared	0.879197	S.D. dependent var	22818.22
S.E. of regression	7930.862	Sum squared resid	4.72E+09
Durbin-Watson stat	1.277558	Long-run variance	29757576

$$SPOT_t = 0.971777645142*FFA_t <=>$$

$$1*SPOT_t - 0.971777645142*FFA_t = 0$$

Eagle and Granger (1987) first proposed Vector Error Correction model as a common cointegration practice. They introduced the idea of the equilibrium error as a stationarity point characterized by forces that tend to push the economy back towards equilibrium. If x_t is a vector of economic variables then they may be said to be in equilibrium when the specific linear constraint occurs (1).

$$(1)\ a'x_t = 0 \quad / \quad z_t = a'x_t (2)$$

In most time periods, x_t will not be in equilibrium and the univariate quantity may be called the equilibrium error (2). Trying to interpretate the equilibrium error to our econometric models, it should appear that we prefer a small error to a big one.

According to Eagle and Granger, a vector time series has an error correction representation if it can be expressed as :

$$A(B)(1-B)x_t = -\gamma z_{t-1} + u_t$$

where u_t is a stationary multivariate disturbance, with A(0)=*I*, A(1) has all elements finite, $z_T = a'x_T$ and $\gamma \neq 0$

Vector Error Correction model calculates the cointegrated relationship between the variables with a different way than F-MOLS and that is why we choose to change the restrictions for the FFA coefficient, to the one we have already calculated (b=-0.971778)and the spot term (a=1). This way, the results we come up with are the following.

Vector Error Correction Estimates Standard errors in ( ) & t-statistics in [ ]

Cointegration Restrictions:
B(1,1)=1, B(1,2)=-0.971778

LR test for binding restrictions (rank = 1):	
Chi-square(1)	0.173334
Probability	0.677166

Cointegrating Eq:	CointEq1
SPOT(-1)	1
FFA(-1)	-0.971778

C	56.09469

Error Correction:	D(SPOT)	D(FFA)
CointEq1	-0.075403	0.710063
	-0.28652	-0.10947
	[-0.26316]	[6.48657]

D(SPOT(-1))	0.364014	0.229383
	-0.28072	-0.10725
	[1.29670]	[2.13875]

D(SPOT(-2))	-0.275194	-0.288534
	-0.27742	-0.10599
	[-0.99199]	[-2.72233]

D(FFA(-1))	0.460531	0.119438
	-0.27098	-0.10353
	[1.69949]	[1.15366]

D(FFA(-2))	-0.241	-0.06092
	-0.12616	-0.0482
	[-1.91025]	[-1.26388]

C	-327.8505	-359.0537
	-811.848	-310.168
	[-0.40383]	[-1.15761]

The VAR model for our variables are:

D(SPOT) = A(1,1)*(B(1,1)*SPOT(-1) + B(1,2)*FFA(-1) + B(1,3)) + C(1,1)*D(SPOT(-1)) +
+ C(1,2)*D(SPOT(-2)) + C(1,3)*D(FFA(-1)) + C(1,4)*D(FFA(-2)) + C(1,5)

D(FFA) = A(2,1)*(B(1,1)*SPOT(-1) + B(1,2)*FFA(-1) + B(1,3)) + C(2,1)*D(SPOT(-1)) +
+ C(2,2)*D(SPOT(-2)) + C(2,3)*D(FFA(-1)) + C(2,4)*D(FFA(-2)) + C(2,5)

VAR Models can be written, after substituting the coefficients from the above table as :

D(SPOT) = - 0.0754026266891*(SPOT(-1) - 0.971778*FFA(-1) + 56.0946850946) + 0.364014313861*D(SPOT(-1)) - 0.275193984601*D(SPOT(-2)) + 0.46053125595*D(FFA(-1)) - 0.241000226512*D(FFA(-2)) - 327.850475854

D(FFA) = 0.71006327689*(SPOT(-1) - 0.971778*FFA(-1) + 56.0946850946) + 0.229382514354*D(SPOT(-1)) - 0.288534133767*D(SPOT(-2)) + 0.119437680191*D(FFA(-1)) - 0.0609196135166*D(FFA(-2)) - 359.053701622

From the above equations we choose to the two Disequilibrium errors as a marker for further analysis.

$\lambda_1(Spot_{t-1} - 0.97FFA_{t-1} + u_t) =$ - 0.0754026266891*(SPOT(-1) - 0.971778*FFA(-1) + .0946850946)

$\lambda 2(Spott\text{-}1 - 0.97FFAt\text{-}1 + ut) =$ 0.71006327689*(SPOT(-1) - 0.971778*FFA(-1) + 56.0946850946)

The Restricted Vector Autoregration test is a test proposed by Engle and Granger (1987) with a simple method (among others) to test if a system is in equilibrium in the long run. Conditional on the estimate of the co-integrating vector from the co-integrating regression, the error correction representation is estimated. The test results rely upon the significance of the error correction term. We can calculate this using the method of Least squares.

From the equations mentioned before we have the two estimated values of the characteristic roots λ_1=-0.0754526 and λ_2=0.71006327 but we have to test them as well against the probabilities they have, on whether they have a long-term effect with each other.

Estimation Method: Least Squares

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.075403	0.286523	0.263164	0.7928
C(2)	0.364014	0.280723	1.296702	0.1969
C(3)	-0.275194	0.277417	0.991986	0.323
C(4)	0.460531	0.270983	1.699485	0.0915
C(5)	-0.241	0.126162	1.910247	0.0582
C(6)	-327.8505	811.8478	0.403832	0.687
C(7)	0.710063	0.109467	6.486565	0.000
C(8)	0.229383	0.107251	2.138745	0.0342
C(9)	-0.288534	0.105988	2.722332	0.0073
C(10)	0.119438	0.10353	1.153657	0.2507
C(11)	-0.06092	0.0482	1.263882	0.2084
C(12)	-359.0537	310.1683	-1.157609	0.2491

Determinant residual covariance	2.78E+14

Long-run causality is determined by the error correction term, whereby if it is significant, then it indicates evidence of long run causality from the explanatory variable to the dependent variable.

The null hypothesis being that the coefficients are not statistically important, according to our findings only the $\lambda_2$coefficient can come up to our expectations because of the low p-value. We therefore conclude in declining the Ho and accept the alternative hypothesis, where the $\lambda_2$is considered to be an important factor in our study.

That being said we can state that in the long run, it is only the Spot price that affects the FFA fluctuations, and not the other way round.

GRANGER SHORT TERM CAUSALITY TEST

The Granger (1969) causality, tests the statistical hypothesis for determining whether one time series is useful in predicting one another. The simple causal model for two stationery time series with zero means

$$X_t=\sum_{j=1}^{m} a_jX_{t-j}+ \sum_{j=1}^{m} b_jY_{t-j} + u_t$$

$$Y_t=\sum_{j=1}^{m} c_jX_{t-j}+ \sum_{j=1}^{m} d_jY_{t-j} + u'_t$$

Where u_t, u'_t are the two uncorrelated white noise series $E[u_t, u_s] = 0 = E[u'_t, u'_s]$ and $s \neq t$.
In our regressions m can equal infinity but in real time series m is a finite number.
The definition of causality given above implies that Y_t is causing X_t (provided that $b \neq 0$) and respectively X_t causes $Y_t$as long as $c \neq 0$. If both events occur simultaneously then there is said to be a feedback relationship between the two variables. The more general model of the aforementioned equations is given by :

$$X_t+ b_0Y_t=\sum_{j=1}^{m} a_jX_{t-j}+ \sum_{j=1}^{m} b_jY_{t-j} + u_t$$

$$Y_t+ c_0X_t=\sum_{j=1}^{m} c_jX_{t-j}+ \sum_{j=1}^{m} d_jY_{t-j} + u'_t$$

The equations will be tested through Wald for all possible pairs of (X,Y). The Wald statistics for the joint hypothesis of $a_1=c_1=a_i=c_i$ are reported in the F-statistics sector. If variables are such, that this kind of representation is needed, then instantaneous causality is occurring and the knowledge of Y_t will improve the "prediction" or goodness of fit of the first equation of X_t

Pairwise Granger Causality Tests:

Null Hypothesis:	Obs	F-Statistic	Prob.
FFA does not Granger Cause SPOT	75	3.21116	0.0463
SPOT does not Granger Cause FFA		202.451	0.000

In every hypothesis of ours, the null is rejected and therefore we come to conclusion that there is a short-term relationship between Spot and FFA variables. The relationship between spot and FFA goes both ways, as they both prove to have a strong short-term effect on each other.

AUGMENTED CAUSALITY

Toda-Yamamoto (1995) introduced a method to estimate VAR's formulated in levels and test general restrictions on the parameter matrices, regardless of the series being integrated or cointegrated of an arbitrary order.

Studies, like Park-Philips (1990) and Sims-Stock-Watson (1990) have shown the conventional asymptotic theory, which is in general not applicable to hypothesis testing in levels VAR's if the variables are either integrated or cointegrated. While vector autoregression (VAR) models are heavily used by applied econometrics, aforementioned problems are present if someone is interested in the cointegrated relationship. In that case Toda -Yamamoto below causality method provides us with a robust procedure to avoid the possible pretest biases.

In particular, Johansens method is based on a VAR representation of time series (for cointegration testing) making it very sensitive to the values of the nuisance parameters in finite samples and not particularly reliable in small numbers.

Granger test is another typical example of the causality in the VAR framework, where null hypothesis is formulated as zero restrictions on the coefficients of the lags subset of the variables.

The Toda-Yamamoto procedure allows us to apply a usual lag selection procedure to a possibly integrated or cointegrated VAR, since the standard asymptotic theory is valid.
Then we estimate an augmented VAR model :

$$k+d_{max}$$

Where : k is the optimal lag length (using lag length criteria like AIC, LR or SC) and
d_{max} is the maximal order of integration of the variables in the VAR system

The Toda-Yamamoto causality test applies a modified Wald test statistic to test zero restrictions on the parameters of the original VAR (k) model. The test has an asymptotic (chi-square) distribution with k degrees of freedom.

$$Y_t = \alpha + \sum_{i=1}^{h+d} \beta i \; Y_{t-1} + \sum_{j=1}^{k+d} c \; X_{t-j} + u_{yt}$$

$$X_t = \alpha + \sum_{i=1}^{h+d} \theta i \; X_{t-1} + \sum_{j=1}^{k+d} \delta \; Y_{t-j} + u_{xt}$$

Where : d, is the maximal order of integration order of the variables (d_{max})
h,k are the optimal lag lenght of Y_t, X_t
u, is the white noise error

All we need is to determine d_{max} and construct a VAR model of a total (k+d) lags.

From Previous tests have calculated our variables as integrated of order 1, hence k=1.
At first we estimate our variables with an unrestricted VAR model adding up to 2 lag intervals. Additional information on the model is displayed next to the coefficient summary, presenting standard OLS statistics for each equation.

Vector Autoregression Estimates
Standard errors in ( ) & t-statistics in [ ]

	SPOT	FFA
SPOT(-1)	1.157862	0.891912
	-0.11312	-0.04533
	[10.2357]	[19.6749]
SPOT(-2)	-0.504536	-0.373422
	-0.25381	-0.10171
	[-1.98786]	[-3.67133]
FFA(-1)	0.538696	0.359448
	-0.26625	-0.1067
	[2.02324]	[3.36877]
FFA(-2)	-0.270024	0.128629
	-0.11791	-0.04725
	[-2.29007]	[2.72218]
C	1793.77	-6.609109
	-1310.54	-525.194
	[1.36872]	[-0.01258]

	SPOT	FFA
R-squared	0.91364	0.985804
Adj. R-squared	0.908706	0.984993
Sum sq. resids	3.37E+09	5.41E+08
S.E. equation	6937.779	2780.283
F-statistic	185.1412	1215.219
Log likelihood	-767.1884	-698.606
Akaike AIC	20.59169	18.76283
Schwarz SC	20.74619	18.91733
Mean dependent	26791.05	27640.55
S.D. dependent	22961.41	22695.27

Determinant resid covariance	3.63E+14
Determinant resid covariance	3.16E+14
Log likelihood	-1464.88
Akaike information criterion	39.33005
Schwarz criterion	39.63904

The bottom right hand corner of our table are the summary statistics of the VAR system as a whole.

The two information criteria are computed as :

$$AIC = -2\frac{l}{T} + 2\frac{n}{T} \quad , \quad SC = -2\frac{l}{T} + n\frac{logT}{T}$$

Where n = k (d + pk) is the total number of estimated parameters in the VAR.

We are going to use these criteria to determine the optimal lag length of our model.

Moving forward to find the proper lag in which to test our model, we are going through different lag length criteria to determine the right one. As we can derive from the calculated criteria table below, the optimal lag length for our model is 4 lags. This is supported by the majority of the criteria (including Akaike) with only Schwarz suggesting otherwise.

VAR Lag Order Selection Criteria
Endogenous variables: SPOT FFA
Exogenous variables: C

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1530.209	NA	3.53E+16	43.77739	43.84163	43.80291
1	-1381.988	283.7372	5.73E+14	39.65679	39.84952	39.73334
2	-1368.928	24.25433	4.42E+14	39.39793	39.71914*	39.52552
3	-1362.528	11.52009	4.13E+14	39.32936	39.77906	39.50798
4	-1353.038	**16.53855***	**3.54e+14***	**39.17252***	39.7507	**39.40218***
5	-1349.305	6.292422	3.57E+14	39.18015	39.88682	39.46085
6	-1345.514	6.174534	3.61E+14	39.18612	40.02127	39.51785
7	-1344.421	1.717165	3.94E+14	39.26918	40.23282	39.65195

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC:Akaike information criterion
SC: Schwarz information criterion
HQ:Hannan-Quinn information criterion

As stated above, optimal lag is 4 and since both series are I(1) we should estimate an augmented VAR(5) model. Upon calculating the new model, we choose to not include the coefficients of all five lags, for then, the Wald test statistic would not have the usual asymptotic chi-square distribution. Instead the additional lag will be declared as an extra exogenous variable which is not included when the subsequent tests are conducted [see appendix 1 for VAR(5)].

We can perform the Granger non causality test :

VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: FFA

Excluded	Chi-sq	df	Prob.
SPOT	463.3962	4	0
All	463.3962	4	0

Dependent variable: SPOT

Excluded	Chi-sq	df	Prob.
FFA	10.24295	4	0.0365
All	10.24295	4	0.0365

Degrees of freedom in each part the above Granger test is 4. The extra 5th lag has not been included in the tests.

Results are definite yet this time. In both cases we can reject the null hypothesis of non causality and state that there is indeed a causal relationship between the variables. In other words we have reasonable evidence that Spot causes FFA and vice versa (at 5% significance level).

The Toda-Yamamoto test managed to lift any of the previous limitations affecting causality. Aforementioned restrictions such as the cointegrated relation of the timeseries or the high variance in the beginning of our data series are proven to have no significant effect on the results. A two way causal interaction is indeed present, as stated by Granger and Johansen's causality tests, but since we are not able to extend the analysis and determine the strength of their bond, the short and long term effect between Spot and FFA remains as is.

CONCLUSION

This thesis investigates and analyses the unbiasedness hypothesis of Forward Freight Agreements, against the aggregate 4time charter route, spot market, on Panamax size vessels. Our purpose is to test whether the FFA rates can be viewed as effective predictors of the spot freight market in the short future. Our initial attempt to use a simple autoregressive model failed to operate due to existence of cointegrating relationship between the variables. Moving on to more involved models and after including cointegration correction tests to the analysis, we manage to waive any constraints and conclude that the unbiasedness is in fact present. We therefore verify our assumption and conclude that forward freight rates can be used as a safe prediction (unbiased) for spot freight prices.

Johansen's and Granger's tests on parameter restriction reveal the short and long term relevance referred to our time series. Concerning the short term effect there is a two-way connection between spot and forward prices. As to long term relationship, our findings indicate that only the spot market may affect FFA rates. This way of interaction led us believe that only short term decisions can be made, but even with small maturity contracts, the highly volatile first period of our sample might have played a more intense role (more than expected) to our analysis.

Finally, the outcome of this thesis is in line with current literature published by Kavussanos and Visvikis (2002) or Moore and Cullen (1995) with regard to the unbiasedness part. Said studies concluded that unbiasedness is present in one and two months maturity contracts but disappear in three month period. Mentioned literature on this matter is specified in each trade route separately with conflicting results among them. As for the cointegration part, there is no question about the two series been closely correlated (as expected from a future price and the market value of the same underlying asset). The lead-lag relationship between them is a stated fact for the market, but the short and long term connection seems to be a matter of sample size or period and the variance that comes with it.

APENDIX 1

Vector Autoregression Estimates
Standard errors in ( ) & t-statistics in [ ]

	FFA	SPOT
FFA(-1)	0.296517	0.277367
	-0.12657	-0.35999
	[2.34275]	[0.77048]
FFA(-2)	-0.121247	-0.964939
	-0.11981	-0.34076
	[-1.01201]	[-2.83170]
FFA(-3)	-0.375255	0.431598
	-0.12393	-0.3525
	[-3.02789]	[1.22440]
FFA(-4)	0.214209	-0.491402
	-0.11625	-0.33065
	[1.84265]	[-1.48619]
SPOT(-1)	0.891015	1.267707
	-0.04374	-0.12441
	[20.3710]	[10.1901]
SPOT(-2)	-0.284612	-0.478738
	-0.1282	-0.36463
	[-2.22006]	[-1.31293]
SPOT(-3)	0.156598	0.71139
	-0.1291	-0.3672
	[1.21298]	[1.93734]
SPOT(-4)	0.314082	-0.407185
	-0.12612	-0.35873
	[2.49026]	[-1.13507]

	FFA	SPOT
C	-438.5235	791.1488
	-490.817	-1396.01
	[-0.89346]	[0.56672]
FFA(-5)	0.039206	0.201789
	-0.05066	-0.14408
	[0.77396]	[1.40053]
SPOT(-5)	-0.104802	0.411889
	-0.10894	-0.30985
	[-0.96203]	[1.32933]

R-squared	0.990554	0.924519
Adj. R-squared	0.989005	0.912145
Sum sq. resids	3.56E+08	2.88E+09
S.E. equation	2416.849	6874.13
F-statistic	639.6519	74.71469
Log likelihood	-657.0909	-732.3525
Akaike AIC	18.55808	20.64868
Schwarz SC	18.9059	20.99651
Mean dependent	27192.59	26129.97
S.D. dependent	23049.06	23191.76

Determinant residcov. (dof. aver.)	2.73E+14
Determinant resid covariance	1.96E+14
Log likelihood	-1389.051
Akaike information criterion	39.19585
Schwarz criterion	39.8915

VAR(4) model with the fifth variables as the exogenous ones.

No serial correlation detected in the previous VAR model. Lags up until 12 are found not to be autocorrelated.

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h

Lags	LM-Stat	Prob
1	7.202556	0.1256
2	1.540011	0.8195
3	1.997497	0.7362
4	2.079355	0.7212
5	1.610281	0.8069
6	2.343155	0.6729
7	1.741072	0.7832
8	3.787339	0.4356
9	4.134517	0.3881
10	1.208676	0.8767
11	5.886791	0.2078
12	9.845768	0.0431

Probs from chi-square with 4 df.

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